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VISUAL RESPONSES OF *LYGUS LINEOLARIS* AND *LYGOCORIS* SPP. (HEMIPTERA: MIRIDAE) ON PEACHES

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ABSTRACT

The visual response of *Lygus lineolaris* (Palisot de Beauvois) and insects in the genus *Lygocoris* to pink and white sticky traps was evaluated in a peach orchard. Pink traps significantly captured more tarnished plant bugs. For the entire season, the mean (\pm S.E.) number of *L. lineolaris* per trap was 1.29 ± 0.064 for pink traps and 0.72 ± 0.067 for white traps. In contrast, both trap colors performed similarly in their average timing of capture and ability to track the occurrence of fruit injuries. Unlike *L. lineolaris*, few *Lygocoris* insects were captured and no difference was detected between captures from each trap color.

Keywords: Tarnished plant bug, sticky traps, catfacing insects

RESUMEN

La respuesta visual de *Lygus lineolaris* (Palisot de Beauvois) y de insectos del género *Lygocoris* hacia trampas pegajosas de color rosado y blanco fue evaluada en un huerto de durazno. Las trampas rosadas capturaron significativamente más chinches deslustrados de plantas. En la estación entera, el número promedió (\pm S.E.) de *L. Lineolaris* por trampa fue 1.29 ± 0.064 para las trampas y rosadas 0.72 ± 0.067 para las trampas blancas. En contraste, ambos colores de pas trampas dieron resultado similares en el promedio del tiempo de la captura y la habilidad para rastrear la ocurrencia del daño en las frutas. Al contrario de *L. lineolaris*, pocos insectos del género *Lygocoris* fueron capturados y ninguna diferencia en el número de insectos capturados en cada color de trampa fué detectada.

One of the pest problems encountered by peach growers is the complex of 'catfacing' insects which includes the tarnished plant bug *Lygus lineolaris* (Palisot de Beauvois), *Lygocoris* spp. and several species of stink bugs. Insects in this complex can cause serious fruit injury, they are highly mobile and difficult to monitor (Hogmire 1984). The feeding injuries on fruit cause fruit deformation, scarring, water-soaked areas and gummosis (Rings 1958). The most abundant catfacing insect is *L. lineolaris* which is a serious pest of several cultivated plants, having a host range of over 120 plant species in 30 plant families found in the U.S. (Snodgrass et al. 1984). It reproduces and overwinters in weedy groundcover, hedgerows or fields adjacent to peach orchards. Adults move into the orchard in the spring. Feeding by this insect can cause blossom and fruit drop from bloom to about 30 days after bloom (Rings 1958). Other Hemiptera reported to feed on peaches include insects in the genus *Lygocoris*. *Lygocoris* spp. and the tarnished plant bug produce similar types of injury (Rings 1958). Species in this group include *Lygocoris quercalbae* (Knight) (the white oak plant bug), *Lygocoris caryae* (Knight) (the hickory plant bug) and *Lygocoris omnivagus* (Knight). These species closely resemble each other and are usually referred to as oak-hickory bugs (LeFevre 1984; Leahy 1991).

Guidelines exist on how to readily monitor *L. lineolaris* in apples using white sticky traps (Prokopy et al. 1980; Prokopy et al. 1982; Coli et al. 1985), but similar information is lacking for peach growers concerned about tarnished plant bugs and oak-hickory bugs. Thus, we investigated the visual response of tarnished plant bugs and oak-hickory bugs to two sticky trap colors. Compared to direct counts, limb jarring and net sweeps, sticky traps have been shown to be the most effective method of detecting *L. lineolaris* adults (Prokopy et al. 1982; LeFevre 1984) and *Lygocoris* spp. (LeFevre 1984). We compared pink and white sticky traps for two reasons. First, previous work in Connecticut (LeFevre 1984) and in Massachusetts (Leahy 1991) indicated that pink sticky traps may be useful in monitoring *Lygocoris* spp. Traps painted with Pink Tiara (Pittsburgh Paints Co.) gave the most consistent results as compared to other colors tested (LeFevre 1984). Second, while some extension publications state that white sticky traps could be used for *L. lineolaris* monitoring in peaches, Hogmire (1995) noted that white traps have been used without success in peach orchards. The objective of this work was to test the response of both tarnished plant bugs and *Lygocoris* bugs to the aforementioned trap colors. In addition, we collected data on the fruit injury observed throughout the season to determine how well trap catches tracked injury occurrence.

MATERIALS AND METHODS

Trap Color Evaluation

The experiment was carried out in two sections of a commercial orchard. One section was located in a block of 4 year old trees and the second section in a block of 14 year old trees. Rows in the younger block were planted to the varieties 'Red Haven' and 'Harbelle Bailey'. The variety in the older block was 'Jersey Queen'. Experimental sections, which were located on the periphery of the block, did not receive insecticide applications but received only applications of sulfur as a fungicide. Twelve trees were selected for the experiments in each section. Traps were hung vertically on branches in the canopy approximately at 1.8-2 m high for the old trees and 1.5-1.6 m high for the young trees. Traps were placed at this height because traps placed higher in the tree canopy have been shown to capture more oak-hickory bugs than traps placed at a lower height (LeFevre 1984). The canopy was divided into quadrants according to NE, NW, SE, and SW orientation. One trap was placed per quadrant and the same number of pink and white traps were used for each orientation. Thus, every tree started with 2 white and 2 pink traps. Due to branch pruning early in the season, two trees retained only one trap of each color in the canopy. White traps were purchased from Gempler's (Belleville, WI) and pink traps were made by painting the same plastic substrate used in Gempler's white sticky traps (16 × 19.8 cm). The plastic rectangles were painted with Pittsburgh Paints' Pink Tiara (Pittsburgh, PA) and then covered with Tangle-Trap sticky coating (Tangle Foot Co., Grand Rapids, MI). Pink Tiara has similar spectral reflectance pattern as peach petals with a peak at 435-440 nm, lower reflectance in the yellow green range and with a second highest peak around 610nm (LeFevre 1984).

Traps were checked weekly and any *L. lineolaris* or *Lygocoris* bugs were removed and taken to the laboratory for removal of sticky material and identification. Removal of Tangle-Trap was accomplished by rinsing the specimens in BioShield citrus paint thinner (EcoDesign Co., Santa Fe, NM). Traps were cleaned of insects or were changed as needed. Traps were set out on April 21 (before petal fall) and monitoring of traps stopped well after harvest time on September 9, 1999. In addition to weekly trap inspections, the presence of stink bugs was determined through limb jarring because extremely few were being caught by the traps. This was done to assess the presence of these other 'catfacing' insects. Each week, 6 trees without traps received three limb strikes with a rubber-coated rod and a beating sheet received any dislodged insects.

Fruit Injury Inspections

At the same time the traps were inspected, damage to fruit was recorded as follows. Just af-

ter shuck-split on May 20, ten fruit per tree were randomly selected and marked by placing a wooden clothespin on the same branch as the fruit. Pins were placed far enough away from the fruit so there would be little interference to the insects. Five fruit were at a height level of 1.8-2 m and 5 others were at a lower level of 1-1.3 m in the old trees. In the young trees, fruit were selected irrespective of height since the canopy was more compact. Compass coordinates were randomly generated and used to select the fruit around the tree. These same 10 fruit per tree were inspected weekly to determine the presence of new injuries. Damage to fruit was classified according to the size of the injury as follows: pin holes, punctures, large holes and catfacing deformation. As the fruit grew, pin hole injuries usually turned to punctures and eventually became holes on the fruit. Fruit inspections stopped before harvest time on August 3.

Statistical Analysis

Data from trap captures were checked for normality and homogeneity of variances. The data for tarnished plant bug and *Lygocoris* spp. captures were transformed using the transformations \log_{10} and a $\log_{10}(x + 1)$ respectively. To determine trap color effect on insect captures, trap data were analyzed using Proc GLM (SAS Institute 2000). Trap captures were classified according to trap color, orientation, tree on which the trap hung, and orchard block. The analysis took into consideration that each tree had two traps of the same color tested and trees were treated as a fixed effect to control for any differences associated with the trees. Data were aggregated over all sampling dates and the means for each tree were analyzed. Preliminary analysis showed no difference in the results from each orchard block, thus the data were pooled into one analysis.

A second analysis was performed to determine if trap color influenced the average time to insect capture. If one trap color captured more insects but was delayed in detecting them it would not be very useful. The average time of insect capture was calculated by determining when during the field season each insect was captured (e.g., the first weekly sampling corresponded to day 7 after traps were set out) and considering the total number of insects caught through the season. These data were analyzed using Proc GLM (SAS Institute 2000) and were not transformed.

Data from the various categories of fruit injuries were summed into one variable to give the total number of injuries for each fruit on a given sample day. Means were obtained for each sample date and weekly increments were calculated to determine how well trap captures tracked these increments. Fruit injury increments reflect only the new injuries appearing in any given week. In

addition, these data were used in a partial Spearman rank correlation analysis where the fruit injury observed in the tree was correlated to the trap captures (*L. lineolaris* and *Lygocoris* spp.) on that tree. The partial analysis adjusted for the two different orchards sections used.

RESULTS

Both pink and white traps performed well in capturing tarnished plant bugs during the whole season. Figure 1 shows the mean number of *L. lineolaris* captured weekly for each trap color. The two traps show the same seasonal trends but pink traps significantly captured more insects (Table 1). The mean number of tarnished plant bugs captured per pink trap was 1.29 ± 0.064 and that of white traps was 0.72 ± 0.067 . In addition to trap color, trap orientation and tree on which the trap hung had significant effects on *L. lineolaris* trap captures. The traps in the NE, NW, SE and SW quadrants captured an average of 1.28 ± 0.09 , 0.81 ± 0.09 , 1.18 ± 0.09 and 0.74 ± 0.09 *L. lineolaris*, respectively. We also found a significant interaction between orientation and trap color. The differences in trap captures between the two colors were not as large in the NE and SW quadrants

as compared with the SE and NW quadrants. However, pink traps consistently had larger mean captures of tarnished plant bug across quadrants. Trap captures of *Lygocoris* were not influenced by trap color (Table 1). Very few *Lygocoris* were captured throughout the season and this may be preventing a clear assessment of trap color effect. *Lygocoris* spp. were caught between June 3 and August 3 and the mean number captured weekly per trap was 0.05 ± 0.007 for pink traps and 0.03 ± 0.007 for white traps. With the exception of the tree effect, other sources of variation listed in Table 1 did not have a significant effect on the mean number of *Lygocoris* captured. Sticky traps captured very few stink bugs and limb-jarring sampling detected few and not until the end of the season. Also, very few *L. lineolaris* and no *Lygocoris* were captured using this sampling method.

In addition to testing the effect of trap color on the number of tarnished plant bug captures, we also examined which trap color detected insects earlier. Both trap colors had a similar average time for all *L. lineolaris* captures ($F = 0.27$; $df = 1,64$; $P = 0.61$). The mean in days was 77.9 ± 1.09 for pink traps and 78.6 ± 1.09 for white traps. Trap orientation also did not have a significant

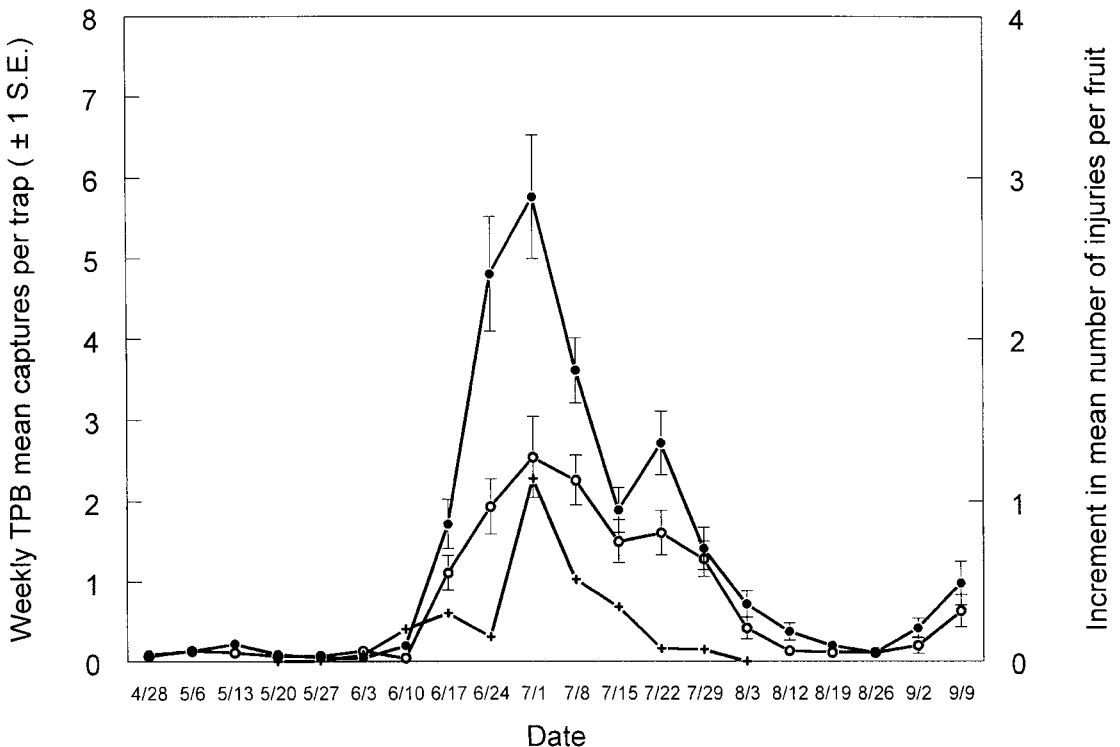


Fig. 1. Weekly trap captures of tarnished plant bug *Lygus lineolaris* (Palisot de Beauvois) as influenced by pink (—●—) or white (—○—) sticky trap color. Weekly increments in fruit injury through the season (—+—) are also shown.

TABLE 1. RESULTS OF ANOVA FOR THE EFFECTS OF TRAP COLOR, ORIENTATION AND TREE FROM WHICH THE TRAP HUNG ON THE NUMBER OF TARNISHED PLANT BUG (TPB) *Lygus lineolaris* (PALISOT DE BEAUVOIS) AND *Lygocoris* SPP. CAPTURED BY TRAPS.

Source of variation	TPB			<i>Lygocoris</i> spp.	
	df	F	P	F	P
Orientation	3,61	9.54	<0.0001	0.53	0.6637
Trap color	1,61	42.56	<0.0001	3.36	0.0715
Tree	23,61	4.04	<0.0001	1.71	0.0492
Orientation \times color	3,61	3.92	0.0127	0.23	0.8760

effect on average time of captures ($F = 2.01$; $df = 3,64$; $P = 0.12$). Captures by both trap colors tracked very well the pattern of fruit injury occurrence through the season. Early in the season when none or few plant bugs were captured, no injuries were detected on the fruit (Fig. 1). Then, as the number of insects captured increased, the number of injuries per fruit rose as well. On July 1, when both traps showed a peak in insect captures we also observed a peak in injuries per fruit. The tree by tree correlation analysis showed that trap captures on a given tree did not correlate well to the amount of fruit injury observed on the tree. Correlation coefficients were 0.39 ($P = 0.07$) for white traps and 0.35 ($P = 0.11$) for pink traps.

DISCUSSION

The results of this project indicate that visual traps should be considered for monitoring tarnished plant bug in peach orchards. Visual traps have been shown to be an effective monitoring method for thrips (Gillepsie & Vernon 1990; Childers & Brecht 1996), flea beetles (Adams & Los 1986) and apple blotch leafminers (Green & Prokopy 1986). In apples, white sticky traps have been useful for determining if tarnished plant bug populations are sufficiently great to merit insecticide application (Prokopy et al. 1987) and for detection of other mirid species present in apple orchards (Boivin et al. 1982). In addition, they are very practical because they also work well in monitoring the European apple sawfly (Owens & Prokopy 1978).

Pink Tiara was a trap color selected by LeFevre (1984) because its spectral reflection pattern closely mimicked the color of peach flower petals. Our results show that this color is highly attractive to *L. lineolaris* but it is difficult to assess why this is happening. When most insects were trapped, all of the petals were gone and only developing fruit were present. Thus, the color did not mimic any particular peach resource for the insect. Developing fruits have a spectral reflectance pattern more similar to leaves (LeFevre 1984) and fruit did not start turning pink until the end of July or August. Although no significant

differences were found among several colors tested, LeFevre's (1984) work indicated that *L. lineolaris* tended to be attracted by light colors such as gloss white and yellows over dark colors such as red and black. A similar result was observed by Prokopy et al. (1979) where *L. lineolaris* were attracted to traps painted gloss white, Zn white, Zoecon Yellow and to clear plexiglass. Zn white and gloss white traps were considered super normal mimics of apple bud and blossom reflectance patterns. Because *L. lineolaris* was also captured in clear plexiglass in numbers comparable to the light colors, Prokopy et al. (1979) concluded that this insect does not specifically orient to colors mimicking those of apple structures. Nevertheless, *L. lineolaris* is exhibiting some color discrimination since they were captured more often by light color traps (Prokopy et al. 1979; LeFevre 1984) and they preferred pink over white traps. It may be possible that the pink traps captured more insects because they provided a better visual contrast against the peach foliage. The response by *Lygocoris* spp. to the two colors could not be determined because too few were caught to discern any trap color effect. Nevertheless, both trap colors were useful in detecting their presence through the season.

Although *L. lineolaris* is more attracted by the pink colored traps, white and pink traps perform similarly in other aspects. Both trap colors have similar average times of insect capture and both tracked well the timing of fruit injury. White or pink trap captures in a given tree did not correlate well with the fruit injuries observed in that tree probably due to the high vagility of *L. lineolaris* and *Lygocoris* insects. This result confirms the utility of these visual traps because there is less concern that, for example, a trap will only reflect insect activity in its host tree. This quality is desirable in common orchard situations where one trap monitors a large area. For instance, the recommended use of sticky traps to monitor tarnished plant bug in apple orchards is at least one trap per 3 acres (Coli 2003). Further evaluation of pink traps should be done in order to assess their effectiveness in integrated pest management programs for *L. lineolaris* in peach orchards.

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