Trap Designs for Monitoring Drosophila suzukii (Diptera: Drosophilidae)

JANA C. LEE,1,2 PETER W. SHEARER,3 LUZ D. BARRANTES,4 ELIZABETH H. BEERS,5 HANNAH J. BURRACK,6 DANIEL T. DALTON,7 AMY J. DREVES,8 LARRY J. GUT,9 KELLY A. HAMBY,10 DAVID R. HAVILAND,11 RUFUS ISAACS,9 ANNE L. NIELSEN,12 TAMARA RICHARDSON,13 CESAR R. RODRIGUEZ-SAONA,14 CORY A. STANLEY,15 DOUG B. WALSH,4 VAUGHN M. WALTON,7 WEE L. YEE,16 FRANK G. ZALOM,10 AND DENNY J. BRUCK17

ABSTRACT Drosophila suzukii (Matsumura), an invasive pest of small and stone fruits, has been recently detected in 39 states of the United States, Canada, Mexico, and Europe. This pest attacks ripening fruit, causing economic losses including increased management costs and crop rejection. Ongoing research aims to improve the efficacy of monitoring traps. Studies were conducted to evaluate how physical trap features affect captures of D. suzukii. We evaluated five colors, two bait surface areas, and a top and side position for the fly entry point. Studies were conducted at 16 sites spanning seven states and provinces of North America and nine crop types. Apple cider vinegar was the standard bait in all trap types. In the overall analysis, yellow-colored traps caught significantly more flies than clear, white, and black traps; and red traps caught more than clear traps. Results by color may be influenced by crop type. Overall, the trap with a greater bait surface area caught slightly more D. suzukii than the trap with smaller area (90 vs. 40 cm²). Overall, the two traps with a side-mesh entry, with or without a protective rain tent, caught more D. suzukii than the trap with a top-mesh entry and tent.

RESUMEN Drosophila suzukii (Matsumura), es una plaga que ataca frutas pequeñas así como “frutas con hueso” o drupas. Esta especie ha sido recientemente reportada en 39 Estados de EEUU, así como en Canadá, México y Europa. Esta plaga ataca frutas en estado de maduración, causando pérdidas económicas incluyendo el aumento en los costos de manejo y rechazo del cultivo. La actual investigación tiene por objetivo el mejorar la eficiencia de las trampas utilizadas para el monitoreo de la especie. Se llevaron a cabo estudios para evaluar como las características físicas de la trampa afectan la captura de D. suzukii. Fueron evaluados el color, superficie de exposición del cebo y posición del punto de entrada para las moscas. Los estudios fueron conducidos en nueve cultivos, distribuidos en 16 sitios localizados en siete Estados y Provincias de América del Norte. Se utilizó vinagre de cidra de manzana como cebo estándar en todas las trampas. En análisis general, las trampas de color amarillo capturaron significativamente mas moscas que las trampas transparentes, blancas y negras, y las trampas rojas capturaron mas que las trampas transparentes. Resultados por color pueden estar influenciados por el tipo de cultivo. En general, las trampas con mayor área de exposición del...
Drosophila suzukii (Matsumura) (Diptera: Drosophilidae), commonly called spotted wing drosophila, was first detected on the mainland of the United States in 2008 (Hauser 2011). In a short amount of time, this invasive pest has been detected in 39 states (Lee et al. 2011, National Agricultural Pest Information System [NAPIS] 2013, H.J. Burrack, personal communication). This pest is of concern to small and stone fruit industries, and growers may need multiple insecticide applications to manage infestations (Beers et al. 2011, Bruck et al. 2011). Furthermore, growers risk rejection of their harvested fruit at the processing plant and export terminal if an infestation is found. Rejection of exported fruit may also occur when residual pesticide levels exceed the maximum residue limits (Haviland et al. 2011). In a short amount of time, this invasive pest has been detected in 39 states (Lee et al. 2011, Bruck et al. 2011). Furthermore, growers risk rejection of their harvested fruit at the processing plant and export terminal if an infestation is found. Rejection of exported fruit may also occur when residual pesticide levels exceed the maximum residue limits (Haviland et al. 2011). Furthermore, growers risk rejection of their harvested fruit at the processing plant and export terminal if an infestation is found. Rejection of exported fruit may also occur when residual pesticide levels exceed the maximum residue limits (Haviland et al. 2011). Furthermore, growers risk rejection of their harvested fruit at the processing plant and export terminal if an infestation is found. Rejection of exported fruit may also occur when residual pesticide levels exceed the maximum residue limits (Haviland et al. 2011). Furthermore, growers risk rejection of their harvested fruit at the processing plant and export terminal if an infestation is found. Rejection of exported fruit may also occur when residual pesticide levels exceed the maximum residue limits (Haviland et al. 2011). Furthermore, growers risk rejection of their harvested fruit at the processing plant and export terminal if an infestation is found. Rejection of exported fruit may also occur when residual pesticide levels exceed the maximum residue limits (Haviland et al. 2011). Furthermore, growers risk rejection of their harvested fruit at the processing plant and export terminal if an infestation is found. Rejection of exported fruit may also occur when residual pesticide levels exceed the maximum residue limits (Haviland et al. 2011).}

Monitoring traps are used to delimit the distribution of D. suzukii and record seasonal activity. However, growers consider current traps of limited value until they can predict fly populations and risk of infestation, that is, until a threshold is developed. This is based on a meeting that requested stakeholder feedback on a grant-funded spotted wing drosophila project (J. Brunner, personal communication). Researchers have been working steadily to improve the attractiveness of the bait formulation and physical design of the trap. Currently, apple cider vinegar is a common bait because it is easily found, inexpensive, and transparent to captured flies, but it is not the most attractive bait. The combination of wine and apple cider vinegar has caught more D. suzukii in the field compared with apple cider vinegar alone (Landolt et al. 2011), as has a combination of wine, molasses, and vinegar (E.H.B., unpublished data), blends of wine and vinegar volatiles (Cha et al. 2012), and a yeast–sugar–water solution when warm temperatures are present (A.J.D., unpublished data, R.I., unpublished data). Commercialized dispenser lures are also being evaluated, and is a key step toward making trapping a more viable monitoring tool, given its convenience of use.

Before the launch of this study, limited information was available on physical features of traps that improve capture of D. suzukii. Traps with narrow entry points were considered better than those with wide openings because the narrow openings slowed the evaporation of the bait and prevented entry of insects larger than D. suzukii (Kanzawa 1939), but this was not explicitly tested. In 2011, six commonly used trap types were compared across 16 sites in nine states/province of North America (Lee et al. 2012). The number of D. suzukii captured increased consistently in traps with greater entry areas, but the proportion of nontarget drosophilids captured remained the same. Some trap designs clearly caught more D. suzukii than others, and the role of color, surface area of the bait–air interface, container shape, tent coverings, and position of entry points was highlighted for testing. The visual abilities and cues preferred by Drosophila melanogaster Meigen may provide insight on D. suzukii, given their phylogenetic relatedness (Yang et al. 2004). Tall 31-cm vertical posts are attractive to flying D. melanogaster compared with short 1.3-cm posts (Malmon et al. 2008). These results might suggest traps with a taller opaque shape might be attractive stimuli for D. suzukii.

The goal of this study was to identify physical features of traps that increase the catch of D. suzukii. Specific objectives tested how 1) five colors, 2) two bait surface areas, and 3) top- vs. side-entry position affected captures. These objectives were tested broadly across North America in multiple crop types. A subset of sites were tested for variation in catch among traps between four crop types, between in-season and postharvest periods, and the selectivity of traps for D. suzukii vs. other drosophilids.

Materials and Methods

Sites and Protocols. Research was conducted across 16 sites within nine crop types and seven states or provinces in North America. Traps were set up in three or four blocks at each site with 52 replicated blocks in the color study and 51 blocks in the bait surface area and fly entry position studies (Table 2). Blocks were set up in one or multiple varieties with similar ripening times. All blocks were separated by a minimum of 40 m from other blocks or were in separate fields. Within a block, the locations of the five trap types pertaining to the color study were randomized, as were the locations of the five traps pertaining to the bait surface area and entry position study. Traps within a block and randomization group were placed
Table 1. Description of traps used for *D. suzukii*

<table>
<thead>
<tr>
<th>Study</th>
<th>Trap</th>
<th>Container, volume, source</th>
<th>Point of entry</th>
<th>Tent*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Color</td>
<td>Black</td>
<td>Colored cups, 473 ml, Creative Converting,</td>
<td>All have 12.05 cm holes arranged in a 15.2-cm zigzag</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>Red</td>
<td>Co. Lake Forest, WI, and Clear lid, Solo Cup</td>
<td>on upper side</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Yellow</td>
<td>‘white,’ ‘black velvet,’ ‘classic red,’ and</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>White</td>
<td>‘school bus yellow’</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Clear</td>
<td>Clear cup, 473 ml, Walmart, Bentonville, AR</td>
<td></td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td>and same lid as above</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bait surface area</td>
<td>90 cm²</td>
<td>Clear plastic bowl with 10.7 cm diameter</td>
<td>All have a lid with 8.3-cm-diameter opening with</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>with red lid, 760 ml, Rubbermaid, Huntersville, NC</td>
<td>5,410 cm² plastic mesh with 0.32-cm grid,</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Darice, Strongsville, OH</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>40 cm²</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Entry position</td>
<td>Top</td>
<td>All are a clear deli cup and lid, 946 ml, Solo</td>
<td>Mesh placed on top opening (as above)</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cup Co.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Side</td>
<td>Two sides plastic mesh panels 6.7 by 4 cm</td>
<td>Two sides plastic mesh panels 6.7 by 4 cm rectangles</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>with 5,410 cm²</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Side-tentless</td>
<td></td>
<td>Two sides plastic mesh panels 6.7 by 4 cm rectangles</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>with 5,410 cm²</td>
<td></td>
</tr>
</tbody>
</table>

* A protective tent prevents rain or irrigation water from entering trap, tent is an inverted white bowl, 591 ml, Kroger Co., Cincinnati, OH, held 5–5 cm above the trap.

b Distance between the bait surface and lid is 5 cm in both traps of the bait surface area study.

2–3 m apart in shady spots of crops, adjacent to hanging fruit. Traps within a block from different randomization groups were spaced ≥10 m apart. All traps were baited with 150 ml of apple cider vinegar with 5% acidity. Approximately 4 ml of unscented Ultra Pure + Clear dish soap (Colgate–Palmolive Co., NY, NY) was added per 3.78 liters of vinegar to break the surface tension. At weekly intervals, fly captures were recorded, vinegar replaced, and traps randomly reassigned to a new position. The numbers of male and female *D. suzukii* were recorded with the aid of a stereomicroscope, and other nontarget drosophilids were recorded at five sites.

**Color.** Five colors were selected to test the effect on fly captures. Red and black caught more *D. suzukii* than other colors in greenhouse and field trials (J.C.L., unpublished data). Other colors were selected for their ubiquity; bright yellow is a common color among insect traps; and white and clear are common in traps currently used for *D. suzukii*. A small 473-ml cup was used because various bright colors were commercially available (Table 1; Fig. 1a). Cups were characterized by a colorimeter (Konica Minolta CR-400, Ramsey, NJ) in Wapato, WA. The yellow cup had an L*a*b* value of −74.23, −2.21, and 64.01; red had 38.03, 35.15, and 19.06; black had 28.57, 0.09, and -0.08; and white had 81.82, −1.14, and −3.81. The L* value is 0 for black and 100 for white, a* is negative for green and positive for magenta, and b* is negative for blue and positive for yellow (Hanbury and Serra 2001). While certain colors such as yellow are known to be attractive, the specific hue of the color can influence attraction to a trap, as shown for thripsid flies (Yee 2012). Hues refer to a gradation within a color. A secondary study compared the capture of *D. suzukii* to traps of various red and yellow hues with choice cage (Supp. 1 [online only]) and field tests (Supp. 2 [online only]). Field tests revealed that the commercially available red and yellow cups caught similar or more *D. suzukii* than various red- or yellow-hued painted cups.

**Bait Surface Area.** Bait surface area was tested by using a clear 760-ml plastic bowl (Fig. 1b, Table 1) because the surface area could be manipulated, and this trap type performed well in the study by Lee et al. (2012).

**Entry Position.** Entry position (top- and side-mesh) was tested by using a clear 946-ml deli cup (Fig. 1c; Table 1) because its height prevented bait from spilling out of traps with a side entry, and it performed well in the study by Lee et al. (2012). In addition, the side-entry traps were tested, with and without protective tents, to determine the effect on captures. The trap with a top-entry point requires a tent to prevent bait dilution from rain or irrigation water.

**Statistical Analyses.** For analyses, the capture of adult *D. suzukii* from each trap of each block was averaged on a weekly basis. Data were analyzed with males and females combined together because there were no significant trap × gender interactions in preliminary analyses. Data were Log10(x + 1)-transformed to homogenize variances or improve the fit of the model. First, to test the effect of color, bait surface area, or trap entry position, data from all 16 sites were analyzed by using generalized linear mixed models in Proc Glimmix (SAS 9.2, Cary, NC). The main model had trap, crop, and trap × crop as fixed effects and site (crop) [site nested within crop] and block (site) as random effects. Degrees of freedom were calculated with a Kenward Rogers adjustment, and trap means separated by lsmeans and Tukey honestly significant difference tests. Second, to test trap variation by crop type, data were sliced by crop type when trap × crop interactions were significant (P < 0.05) in the main model. Slicing by crop type occurred when testing occurred at two or more sites: blueberry, sweet cherry, grapes, and raspberry. The effect of trap type...
was compared with site and block(site) as random effects. Third, to further explore variation by crops, post hoc analyses were conducted for red, black, and orange fruit colors where two or more crop types shared the same color. The variable color was not tested in the main model because crop and fruit color were not independent variables. Fourth, to test variation by period, the “in season” (preharvest and harvest combined) and “postharvest” periods were analyzed among five sites: Blackberry WA, Blueberry OR, Cherry CA, Cherry WA, and Grape OR. Analyses were performed with trap, period, trap × period as fixed effects and site and block(site) as random effects. Fifth, to test species selectivity, analyses were conducted on proportions, the number of *D. suzukii* divided by the total drosophilids caught in a trap. This was done at five sites: Blueberry NC, Blueberry OR, Cherry WA, Grape OR, and Raspberry NC. Untransformed proportions were analyzed with trap as a fixed effect and site and block(site) as random effects.

**Results**

Total number of *D. suzukii* caught among sites varied from 109 at Blueberry NC with 4 wk of collection to 23,452 at Blueberry MI with 7 wk of collection. Females comprised 29% of the catch at Cherry OR to 83% at Blueberry NC (Table 2). Although total fly counts were low at Blueberry NC and Blackberry WA, these sites provided trap comparisons under low-capture conditions. Traps placed in the early season often catch fewer flies, but early season detection is an important monitoring period, as growers make management decisions. Trends regarding trap × crop interactions, fruit colors, trap × period interactions, and species selectivity suggest potential points to investigate further. These results should be interpreted with caution, given the unbalanced experimental design and testing with a subset of sites.

**Color.** Overall, the yellow trap caught more *D. suzukii* than black, clear, and white traps, and the red trap caught more than the clear trap, and there were no differences between red and yellow (Tables 3 and 4). There was a significant trap × crop interaction (Tables 3 and 4). The high capture of *D. suzukii* in yellow or red traps was not consistent across crops. In blueberry, there were no significant trends (Table 4). In sweet cherry, the black, red, and white traps caught more than the clear trap, and the yellow trap was not different from any trap (Table 4). In grape, the clear trap caught fewer flies than the other four colors (Table 4). In raspberry, the red trap caught more than clear and white traps, and black and yellow traps were not different from any trap (Table 4).

Next, when data from all red-colored fruits were analyzed together, more flies were caught in red traps than white or clear traps (Table 4). When data from all black/purple fruit were grouped together, more flies were caught in yellow than clear or white traps, and more flies were caught in red or black than clear traps (Table 4). No trends appeared among the orange-colored fruit. When analyzing the data for seasonal trends, there was no interaction between trap and period (Table 3). Finally, trap color had no effect on the selectivity; *D. suzukii* comprised 62.9 ± 8.9–71.3 ± 7.4% of the total number of drosophilids caught (Table 3).

**Bait Surface Area.** Overall, the trap with a bait surface area of 90 cm² caught 12% more *D. suzukii* than the trap with an area of 40 cm² (Tables 3 and 4). No trends occurred when comparing traps during the in-season and postharvest periods (Table 3). Bait surface area had no effect on selectivity; *D. suzukii* comprised 58.7 ± 9.1–61.9 ± 8.9% of total drosophilids (Table 3).

**Entry Position.** Overall, the side-entry traps, with and without a tent (side, side-tentless), caught more *D. suzukii* than the trap with a top entry and tent (top) (Tables 3 and 4). There was a significant trap × crop interaction (Table 3). In blueberry, there were no sig-
significant trends. In sweet cherry and grape, the side-
tentless trap caught more flies than the top trap, but the side trap was not different from other traps (Table 4). In raspberry, the side and side-tentless traps caught more flies than top traps (Table 4).

As for seasonal trends, there was a trap × period effect among the five sites (Table 3). There was no difference between trap designs in the season, but during postharvest, side and side-tentless traps caught more flies than top traps (Table 4). Entry position had no effect on selectivity; *D. suzukii* comprised 61.2 ± 9.5–68.9 ± 9.1% of the total drosophilids (Table 3).

Finally, the five traps tested for bait surface area and entry position were randomized and analyzed together (Table 3). Overall, the side and side-tentless trap caught significantly more flies than the top and 40-cm² trap. The 90-cm² trap was not significantly different from any trap.

**Discussion**

Yellow and red traps caught more *D. suzukii* than clear traps in overall results spanning 16 sites. Black traps captured less than yellow traps overall, but more than clear traps within sweet cherry and grape sites. Basoalto et al. (2013) also studied color preference of *D. suzukii*, and attraction to red and black was evident in several cage tests. More *D. suzukii* were caught in clear traps with red or black caps than white caps placed in choice cages. More *D. suzukii* landed on red, burgundy, and black cards compared with white, yellow, and light blue cards placed in choice-cage studies. Finally, CAPtiva traps (also called “Zorro”) with red-black-red banding pattern caught more *D. suzukii* than all-red or all-black traps in cages with two choices. However, field trials with CAPtiva traps indicated that they were no more effective than some clear traps baited with apple cider vinegar or a yeast-sugar solution (Basoalto et al. 2013, A.J.D., unpublished data, R.I., unpublished data).

To our knowledge, this study is the first to demonstrate higher captures of *D. suzukii* with yellow. In contrast, Basoalto et al. (2013) observed just as many *D. suzukii* landing on yellow cards as white, which was fewer than on red or black cards. Such differences could be because of differences among hues. The yellow cup used in our study had *L**a* *b* values of 74.23, −2.21, and 64.01, whereas these values were 89.96, −10.99, and 90.31, respectively, in the study by Basoalto et al. (2013). The yellow used in their study was lighter, as indicated by the greater *L* value, where 0 is black and 100 is white. Reasons as to why some
hues are more attractive than others are not known; in outdoor choice cages, the yellow hues that trapped more *D. suzukii* had L* values ranging from 76 to 93 (Supp. 1 [online only]).

The attractiveness of different colors may also be influenced by crop type. Red traps caught more flies in crops with red fruits based on combined data from two raspberry sites, three sweet cherry sites, and seven red-colored fruit sites. Attractiveness of traps that share the same color as the fruit host has been observed with tephritid flies. The apple maggot, *Rhagoletis pomonella* (Walsh), was attracted to red traps in apple orchards (Kring 1970); the western cherry fruit fly, *Rhagoletis indifferens* Curran, was attracted to red traps in cherry orchards (Mayer et al. 2000); and walnut fly, *Rhagoletis juglandis* Cresson, was attracted to green traps in walnut orchards when oviposition occurs on green fruit (Henneman and Papaj 1999).

However, the color of the fruit changes over time and other colors associated with food sources and mate location may also be attractive. In the combined data for wine grapes or black/purple fruit, more flies were caught in yellow than clear traps. This preference for yellow may be based on attraction to foliage-like hues (Prokopy and Owens 1983). In the case of *D. suzukii*, which has a large host range, attraction to colors may not be fully explained by host association. A combination of volatile cues or physical contrast with the environment may also affect their attraction to colors.

The attractiveness of colors might vary with the time of the year depending on crop maturity and senescence. For example, the walnut husk fly, *Rhagoletis completa* Cresson, preferred yellow during the early season when reproduction was low, and then preferred green as the season progressed, when green walnuts were present as their ovipositional host (Riedl and Hislop 1985). Similarly, the apple maggot were caught in high numbers in traps with red spheres and yellow panels, but the attraction to yellow decreased as the season advanced and the apples ripened (Kring 1970). However, seasonal trends for *D. suzukii* in the current color study could not be clearly examined from the 16 sites sampled at different times of the year. In this study, responses of *D. suzukii* to colors were consistent both in-season and postharvest periods among the five sites sampled. Moreover, red caught more than other colors at sites tested during the season (Raspberry NC) or postharvest (Blueberry MI, Cherry OR) where the effect of trap color was significant within a site (data not shown). Further balanced studies are needed to determine the influence of crop type and maturity on captures of *D. suzukii* in traps.

More *D. suzukii* were caught overall when the bait surface area was greater in a comparison between two traps with equal distances from the bait to the top-entry point. This was expected because a larger surface area between the bait and air would encourage volatilization. Because captures increased by only 12% when the bait surface area increased 225% from 40 to 90 cm², this may not be a substantial difference to warrant using a trap with a much larger bait surface areas, as practical issues arise. A larger surface area requires a broader container, which may be more bulky and vulnerable to spilling.

The captures of flies in the 40- and 90-cm² traps may have been confounded by headspace, the volume of space between the bait and entry point into the trap. With other trap designs, more *D. suzukii* were caught with a smaller headspace when bait surface areas were
Table 4. Weekly captures of *D. suzukii* in traps (mean ± SE) when comparing traps: 1) overall, 2) by period when trap period was significant, 3) by crop type when trap crop was significant, 4) by fruit color when trap crop was significant.

<table>
<thead>
<tr>
<th>Trap</th>
<th>Overall</th>
<th>Period</th>
<th>Fruit color</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>In-season</td>
<td>Postharvest</td>
<td>Blueberry</td>
</tr>
<tr>
<td>Black</td>
<td>27.3 ± 6.3ab</td>
<td>20.2 ± 4.5a</td>
<td>16.6 ± 4.0ab</td>
</tr>
<tr>
<td>Red</td>
<td>29.0 ± 6.9a</td>
<td>28.0 ± 3.8a</td>
<td>32.0 ± 4.4a</td>
</tr>
<tr>
<td>White</td>
<td>22.4 ± 4.8bc</td>
<td>38.6 ± 4.1ab</td>
<td>26.0 ± 4.4a</td>
</tr>
<tr>
<td>Yellow</td>
<td>33.3 ± 4.4a</td>
<td>30.3 ± 4.4a</td>
<td>35.3 ± 4.4a</td>
</tr>
</tbody>
</table>

*Letters denote significant difference by Tukey HSD on lsmeans of log-transformed counts. In the overall comparison of color traps, the lsmeans estimate of yellow is 1.00, and red is 0.967.*
will enable growers to predict crop risk and optimize timely management decisions.

Acknowledgments

We thank Adam Cave, Richard Little, and Jesse Mindolovich for constructing traps; Peter Chapman for analyzing the L*a*b* values; and Bruce Mackey for statistical assistance. We thank Molly Allscreth, Amy Blood, Bridget Blood, Preston Brown, Peter Caimarca, Steve Castagnoli, Jamie Christensen, Kelly Donahue, Christina Fieland, Mike Haas, Danielle Hicks, Robert Holdcraft, Karissa Johnson, Amanda Lake, Merrill Longmore, Laura Machial, Charlene Marek, Jesse Mindolovich, Amanda Ohrn, Stephanie Rill, Ann Rucker, Erfan Vafaie, Steve Van Timmeren, Jeff Wong, and Sarah Wong for field assistance and fly counting. This project was funded by MBG Marketing, Michigan Department Agriculture and Rural Development Specialty Crop Block Grant, North Carolina Department Agriculture and Consumer Services Specialty Crop Block Grant, Northwest Center for Small Fruits Research, Utah State University Extension Internship Program, USDA CRIS 5358-22000-032-00D, and the USDA Specialty Crops Research Initiative Grant 2010-51181-21167.

References Cited


Kanzawa, T. 1939. Studies on Drosophila suzukii mats. Yamanshi Prefecture Agricultural Experimental Station, Kofu, Japan.


Received 15 May 2013; accepted 6 September 2013.