Evaluation of Diluted Grape Juice as an Inexpensive Attractant for the Invasive Fruit Pest, Spotted Wing Drosophila

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The Spotted Wing Drosophila (SWD), *Drosophila suzukii*, is a fruit fly native to southeast Asia and invasive to the United States and Europe. The fly's preference for ripening fruits and the female's ability to pierce soft-skinned fruits during egg-laying make SWD a pest of great economic significance. SWD is primarily a pest of berry crops, including brambles (e.g., blackberries and raspberries), strawberries, blueberries, and currants. Soft-skinned grapes and tree fruits (e.g., cherries, peaches, nectarines, plums, and Asian pears) are also hosts for SWD.

Current pest management practices for SWD require frequent insecticide applications, which come at a high environmental and economic cost. In order to effectively time these sprays to mitigate damage, growers need to monitor SWD populations. Commercial food-based lures are available for monitoring purposes. However, those lures are based on fermentation materials and consequently they also attract a comparatively high number of other fly species that belong to the same family (Drosophilidae) as SWD, as well as other non-target insects. Captures of unwanted insects hinders trap performance and increases sorting time.

Here, we present results of laboratory and field studies conducted during the summer of 2018, which aimed at assessing the relative attractiveness of grape juice to male and female SWD. The main goal of this research is to provide fruit growers with inexpensive options for monitoring SWD populations. A secondary objective was to determine whether grape juice attracts fewer non-target insects compared to the commercial SWD Scentry® lure.

Materials & Methods

Experiment 1: Evaluation of various types of fruit juices in cages. The relative attractiveness of 5 types of fruit juices to laboratory-reared male and female SWD was evaluated from 29 May to 8 June 2018, in the tree fruit entomology / IPM laboratory at UMass Amherst campus. We used 60 cm^3 screen cages for the experiments. Four equidistant hanging wires (15 cm in length) were positioned at the roof of the cage to hang small plastic tubes containing either, fruit juices or water. For each experiment, 200 microliters of each fruit juice were pipetted onto clear 1.5 ml centrifuge tubes. Water was used as control. Prior to treatment application, the lids of the tubes were removed, a 3 cm wire was wrapped around their neck, and a thin coating of Tangletrap insect coating was applied to the outer surface of the tubes to capture alighting flies. Because only four treatments could be evaluated simultaneously inside a cage, then we conducted 3 separate bioassays. Under this approach, each bioassay evaluated 3 fruit juices (selected at random) and a water control.

For each observation day, 10 males and 10 females (2-3 days old) were released (at 8:00 am) inside each cage. Observations were initiated immediately after introducing the treatments. One person quantified the number of males and females that landed on the sticky tubes every 5 minutes for 1 hour, then again at 2 hours and again at 4 hours. Results show the number of males and females that responded over the entire 4-hour period. During the observations, cages were rotated 90° every 5 min for the first hour. With this ap-

proach, we were able to minimize the tendency of flies to accumulate on the cage wall receiving highest light intensity, which could have biased females in favor of alighting on the nearest dish. Five replicates were completed for each bioassay.

Experiment 2: Comparison of various concentrations of grape juice in cages. From 12 June to 26 June 2018 we evaluated grape, one of the best performing juices, either, undiluted or at 75% (= 3 parts of juice and one part of water) and 50% concentrations, against a water control. While cherry and pomegranate performed well in experiment 1, they were excluded from additional testing due to their higher price and reduced availability. Observations were as described in the first experiment. Tests were replicated 5 times.

Trap used to capture male and female SWD. Trap consists of a plastic 1-liter container (3.5 cm of radius and 15 cm in height) with 12 lateral holes (3/16" in diameter) that allow relatively small insects to get inside the trap.

Experiment 3: Comparison of various concentrations of grape juice in the field. This study was conducted from 12 July to 8 August 2018 at the University of Massachusetts Cold Spring Orchard (CSO) in Belchertown, MA. The goal of this experiment was to quantify the response of wild male and female SWD to the 3 concentrations of grape juice that were evaluated in cages (Experiment 1). Four low density polyethylene traps (1 liter in capacity) (see picture) were deployed in each of four cherry trees. Each trap received 200 ml of a particular juice concentration or 200 ml of water as a control. Each cherry tree served as a replicate. To minimize fermentation effects, all traps were serviced, washed, and re-baited twice a week (on Mondays and Thursdays). Insects captured were transported to the laboratory in labeled zip-lock bags for identification.

Experiment 4. Comparison of additional dilutions of grape juice in the field. This study, conducted at the UMass CSO, compared the attractiveness of 50% and 25% (prepared by mixing 1 part of juice in 3 parts of water) concentrations of grape juice against water control. Trap deployment and inspection frequency was done as in Experiment 3. Tests were replicated 4 times.

Experiment 5. Field performance of diluted grape juice when compared to a commercial lure. This study was conducted from 7 to 24 August 2018 in one section of a vineyard (table grapes) at Clarkdale Fruit Farms in Deerfield, MA. Three treatments were compared: (1) grape juice alone, (2) grape juice in combination with two synthetic plant volatiles dispensed

from centrifuge tubes, and (3) commercial SWD Scentry® lure (purchased from Great Lakes IPM). Two separate experiments were conducted. The first experiment compared grape juice at 50% concentration, whereas the second experiment involved grape juice at 25% concentration.

Four sets of 3 traps (one per treatment) were deployment along the lower horizontal wire of the trellis. Each set was considered a replicate. The distance among traps was 3 meters, and the distance among sets was 6 meters. To minimize fermentation effects, all traps were serviced twice a week (on Tuesdays and Fridays). Fruit juices were replaced at each service session. The SWD Scentry® lures were not replaced.

Results

Results from the first laboratory experiment using cages indicated that the most attractive juices to male and female SWD were grape, tart cherry, and pomegranate. Red tart cherry and blueberry were the least attractive juices (Figure 1A-C).

Results from the second experiment revealed that the response of male and females to undiluted grape juice did not differ significantly from the response shown to grape juice at 75% and 50% concentrations (Figure 2). All grape juice

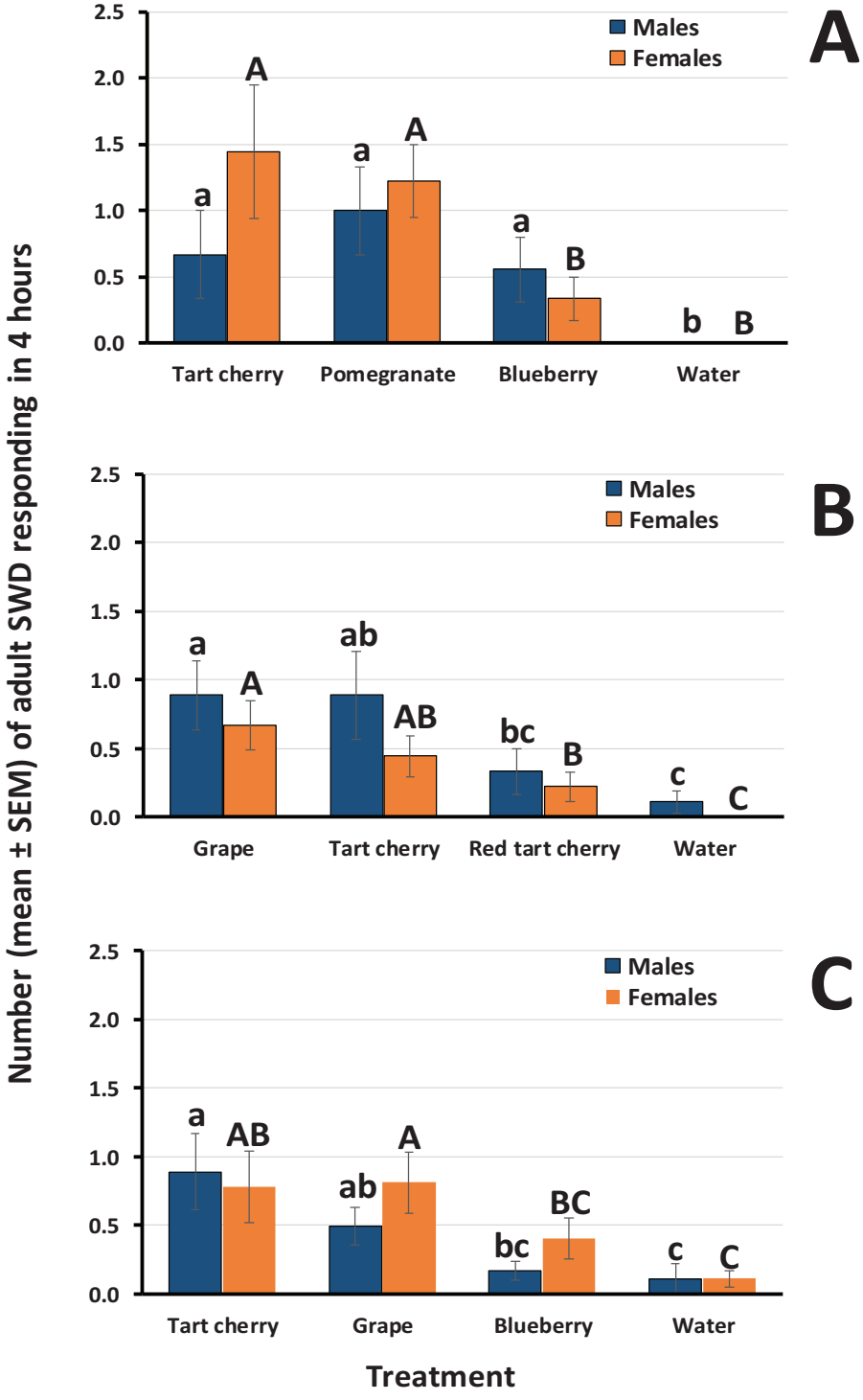

Figure 1. Response of laboratory-reared male and female SWD to fruit juices in cages. Three sub-experiments (denoted by letters A-C) were conducted separately. For each comparison, means superscribed by the same letter (lowercase= treatment comparison among males; uppercase= treatment comparison among females) are not significantly different at odds of 19:1.

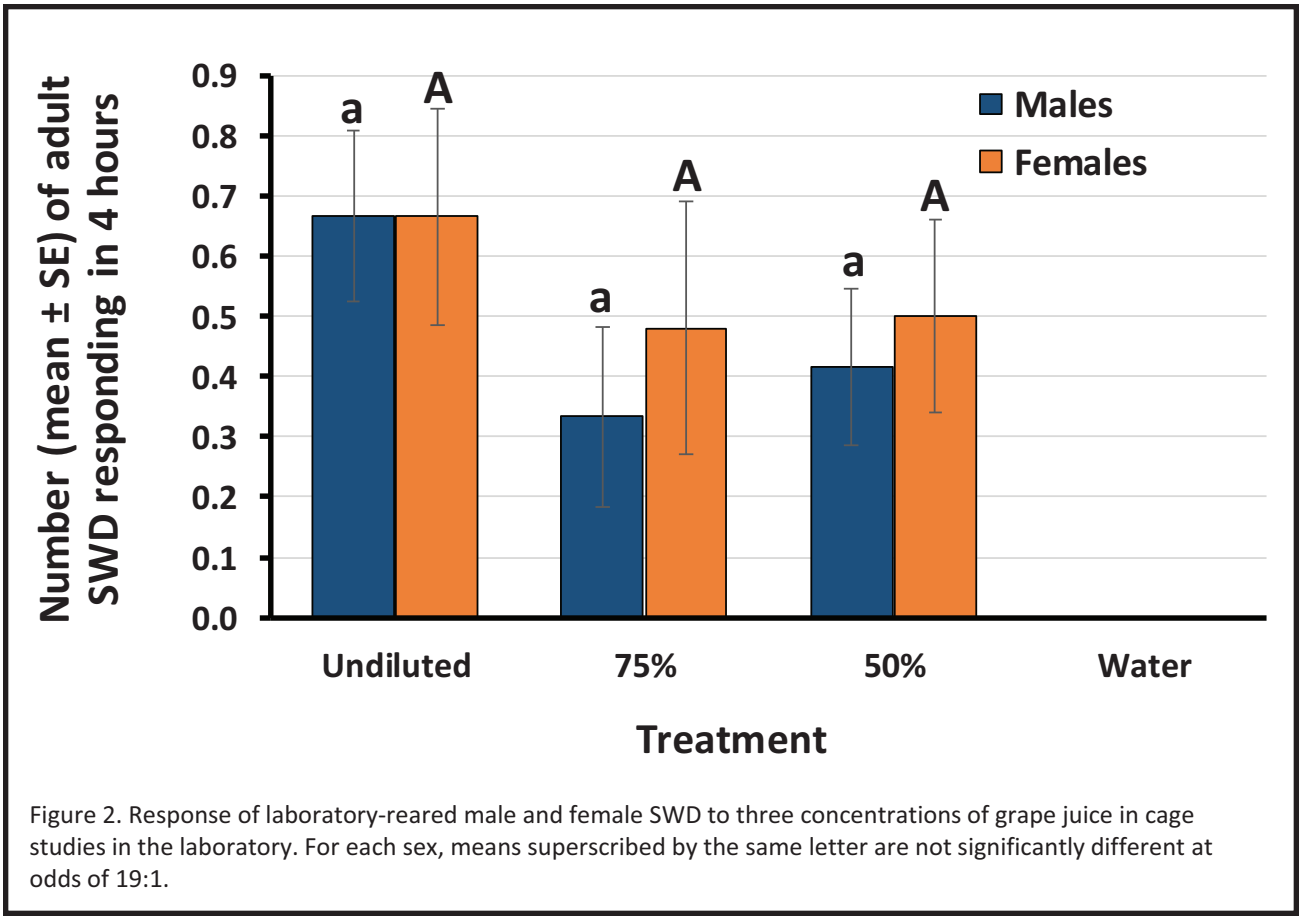

Figure 2. Response of laboratory-reared male and female SWD to three concentrations of grape juice in cage studies in the laboratory. For each sex, means superscribed by the same letter are not significantly different at odds of 19:1.

treatments were very attractive to male and female SWD when compared to the water control.

The third experiment evaluated the field response of male and female SWD to the same treatments (using traps) that were evaluated in the laboratory (Experiment 2). Over a 3-week period, traps captured 115 males and 109 females, indicating comparatively low SWD populations. Figure 3A shows that the level of response of male and female SWD to undiluted and diluted (75% and 50% concentrations) grape juice was similar, confirming the results from the second experiment. No differences in the number of non-targets (fruit flies belonging to the same family as SWD) were noted across treatments (Figure 3B).

In the fourth experiment, traps captured 372 males and 665 females in an 9-day period, indicating comparatively high SWD populations. Results show that wild male and female SWD responded in a similar manner to grape juice at 25% (= 1 part of juice in 3 parts of water) and 50% concentrations (Figure 4A). A similar pattern of response was noted for captures of other species belonging to the same fly family (Drosophilidae) (Figure 4B).

In the fifth and final experiment, 465 males and 1,010 females were captured by traps over a 17-day period, indicating comparatively high SWD populations. Results from this study revealed that when grape juice was evaluated at 50% concentration, diluted grape juice attracted 2.3 and 2.6 times more males and females, respectively, than the commercial SWD Scentry® lure (Figure 5A). The addition of plant volatiles to 50% grape juice reduced trap captures when compared to 50% grape juice alone. When grape juice was further diluted to a 25% concentration, its performance was even better than when evaluated at the 50% concentration. As shown in figure 5A, traps baited with the 25% concentration of grape juice alone captured 2.8 and 3.8 times more male and female SWD, on average, than traps baited with the SWD Scentry® lure. For the 25% concentration, the additional of plant volatiles did not increase of decrease the response of male and female SWD, relative to grape juice alone. Remarkably, diluted

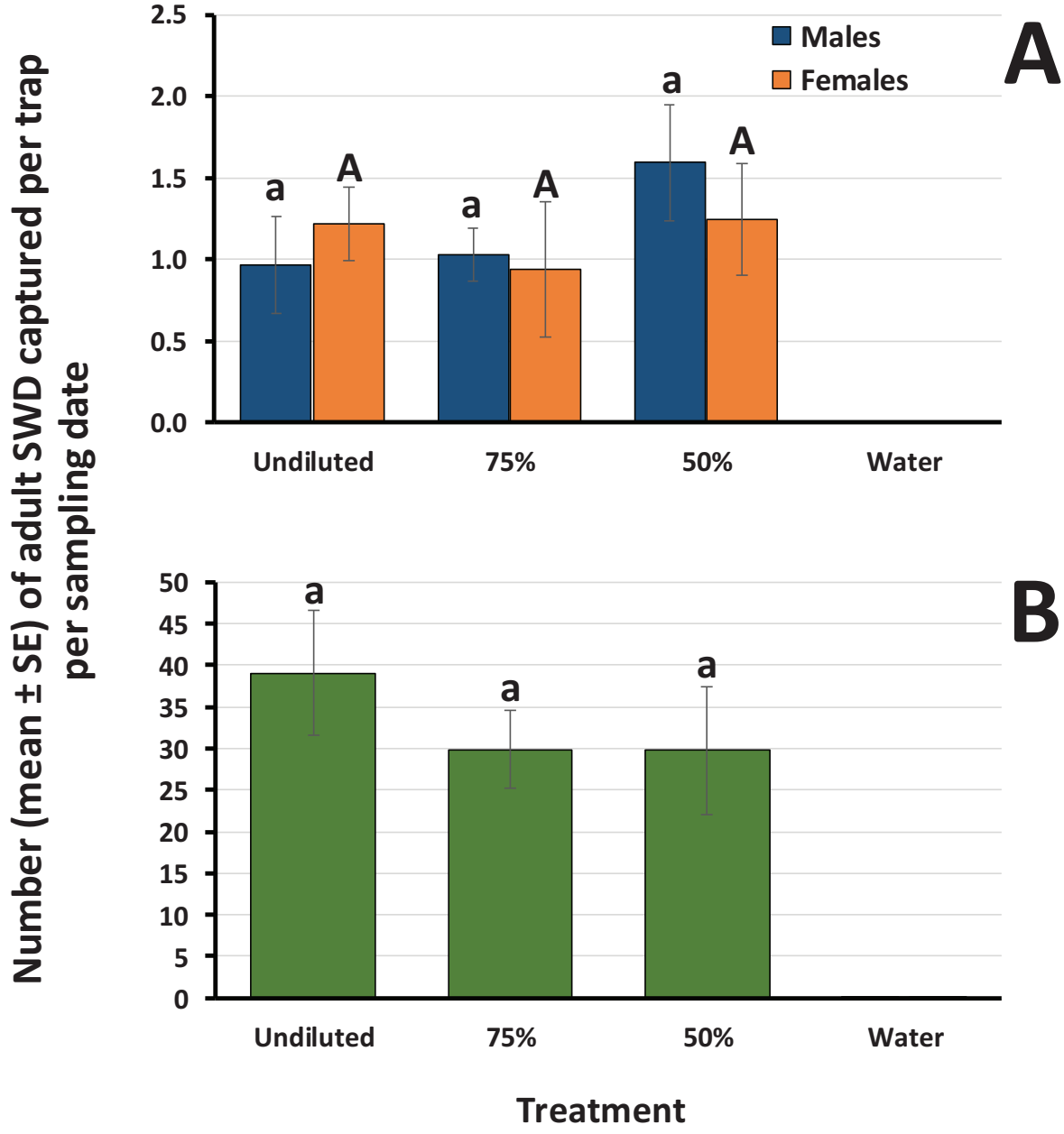

Figure 3. Response of (A) wild male and female SWD and (B) non-targets (other Drosophilidae) to three concentrations of grape juice evaluated using traps deployed on cherry trees at Cold Spring Orchard. For each sex, means superscribed by the same letter are not significantly different at odds of 19:1.

grape juice attracted significantly fewer (about three times less) non-targets than the Scentry® lure. The Scentry® lure is based on fermentation materials, which are known to attract a comparatively high number of other Drosophilid species (and other non-target insects). While effective at monitoring SWD populations, this lure can hinder trap performance and increase sorting time. Our findings indicate that an inexpensive and readily available material, grape juice, can increase SWD captures while decreasing captures of non-targets.

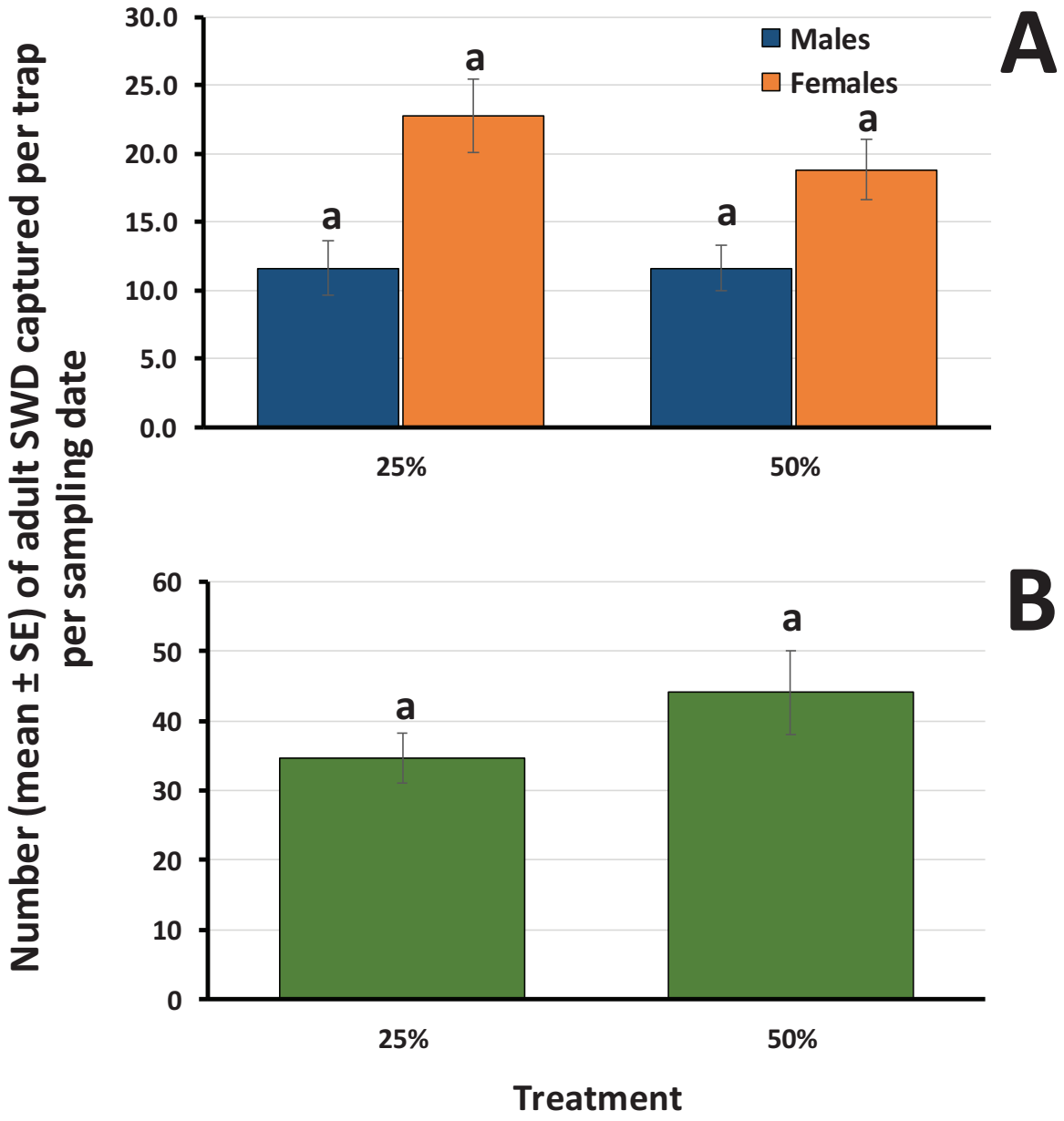

Figure 4. Response of (A) wild male and female SWD and (B) non-targets (other Drosophilidae) to grape juice at 25% (= 1 part of juice in 3 parts of water) at 50% concentrations. Materials were evaluated using traps deployed on cherry trees at Cold Spring Orchard. For each sex and for non-targets (green bars), means superscribed by the same letter are not significantly different at odds of 19:1.

Cost considerations. In terms of costs, 42 traps can be prepared with only $ 3.50, which is the cost of one bottle (1.89 liters = 64 oz.) of grape juice (assuming traps are already available). By mixing the content (1.89 liters) of the bottle of grape juice with 5.7 liters (= 192 oz.) of water to produce a 25% concentration, 7.6 liters (= 256 oz.) of diluted grape juice can be prepared. This amount of bait is enough to prepare 42 traps, each

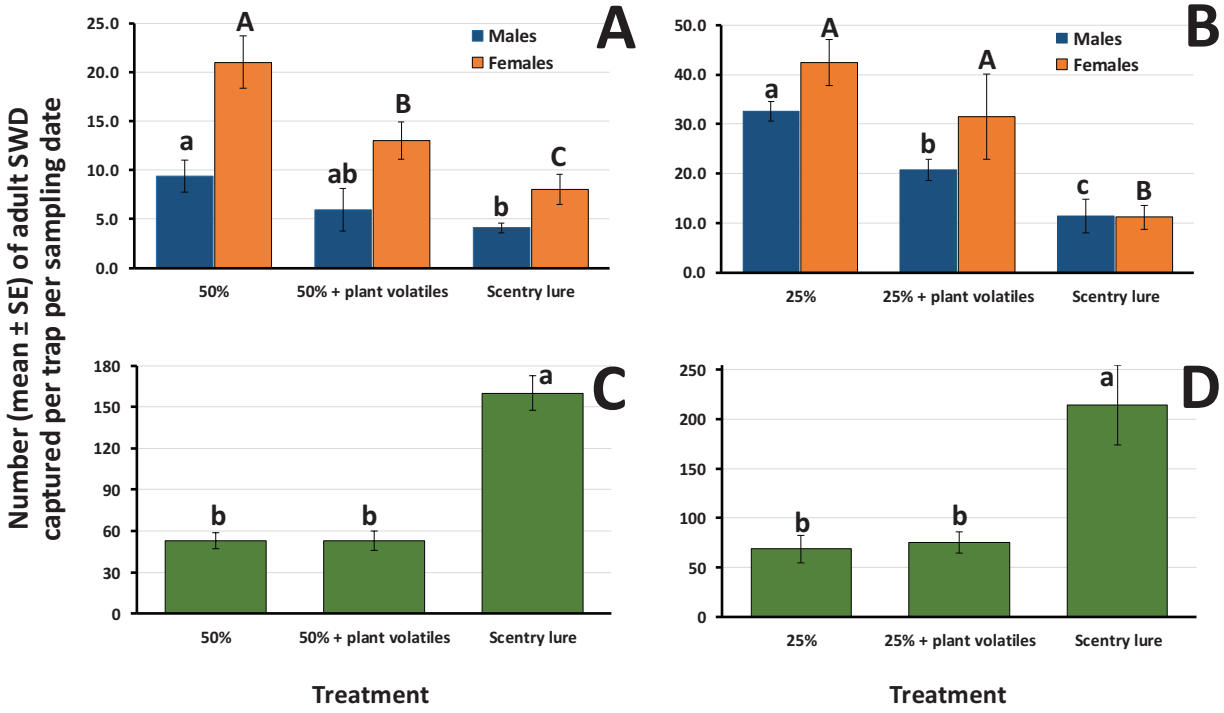

Figure 5. Response of wild male and female SWD to grape juice at (A) 50% concentration and (B) 25% concentration (= 1 part of juice in 3 parts of water), either alone or in combination with two plant volatiles, against the commercial SWD Scentry® lure. Panels C-D show corresponding mean captures of non-targets (Drosophilidae). Materials were evaluated using traps deployed in a vineyard (table grapes) at Clarkdale Fruit Farms in Deerfield, MA. For each SWD sex, and for non-targets (green bars), means superscribed by the same letter are not significantly different at odds of 19:1.

having 200 ml (6.7 oz.) of the diluted juice. The cost of bait per trap is about $0.08, whereas the cost of the SWD Scentry® lure is about $ 7 a piece.

Conclusions

Our combined findings indicate that a 25% concentration of grape juice (= 1 part of juice in 3 parts of water) is an effective and economically viable attractant for SWD. Further studies should reveal the extent to which traps baited with 25% grape juice, deployed at high densities, could reduce SWD populations, potentially making insecticide sprays against SWD more effective.

Acknowledgments

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