Project Title: Manipulating horticultural practices to manage spotted wing drosophila

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Rationale: Spotted wing drosophila (SWD) represents a significant and real-time threat to the livelihood of raspberry and blackberry growers in the USA. SWD is a recently established invasive pest present in 45 states, decimating caneberries crop yield and quality. SWD attacks healthy, intact blueberries, caneberries, strawberries, and cherries by laying eggs in ripening fruit before harvest (Atallah et al. 2014). In the United States, total losses from SWD are estimated to potentially reach $718 million annually (Walton 2013). Emerging maggots feed in the fruit causing rapid quality decline and consumer rejection. Low thresholds for damage and infestation in fresh markets and zero tolerance for infested fruit for exportation have led some growers to either cease production or begin applying weekly or semi-weekly preventative insecticide applications in the absence of sensitive monitoring tools (Beers et al. 2011, Bruck et al. 2011, Landolt et al. 2012, Lee et al. 2013). The current cost increase for controlling spotted wing drosophila is $183/acre (eFly Working Group 2012). This approach is not ecologically or economically sustainable. Alternative strategies for managing SWD in commercial small fruit operations that reduce the need for frequent insecticide applications, prevent outbreaks of secondary pests, and improve ecosystem services provided by beneficial arthropods are critically needed.

Fig. 1. Sentinel sticky-coated ripe raspberry used to capture foraging SWD adults.

Fruit density can alter insect foraging behavior. The resource concentration hypothesis predicts pest abundance will increase with greater host plant density (Root 1973, Kareiva 1983). For instance, the apple maggot fly lays more eggs, and remains in host plants that have high fruit densities compared with plants with less fruit (Roitberg et al. 1982, Roitberg and Prokopy 1984, Prokopy and Roitberg 1984, 1987). Likewise, tarnished plant bug density increases with strawberry patch size (Rhainds and English-Loeb 2003). Therefore, cultural practices, such as fruit thinning that reduce the availability of ripe fruit in raspberry plots may reduce SWD infestation rates and total insecticide use.

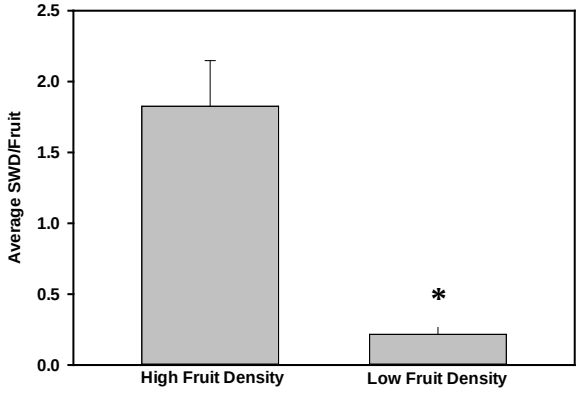

Fig. 2. Mean number of SWD captured in plots with high and low ripe fruit densities.

Our preliminary studies suggest that the density of ripe fruit strongly influences SWD foraging behavior. When ripe fruit availability was low, the number of SWD captured on sentinel sticky-coated ripe raspberries (Fig. 1) was reduced, compared with high ripe fruit density (Fig. 2). We predict that maintaining low densities of ripe fruit via refined horticultural practices will reduce SWD population size in raspberries, increase the efficacy of management tactics, and decrease fruit infestation. Here we propose to examine the effect of ripe fruit density in combination with attracticidal spheres for SWD management to improve the overall efficacy of this low-input approach.

Objectives:
Quantify SWD foraging activity and damage among raspberry plots with low and high densities of ripe fruit

Methods
Eight raspberry field plots were established at the Appalachian Fruit Research Station in Kearneysville, WV. Each plot consisted of five rows with six plants per row of 'Joan J' primocane-bearing raspberry (240 total plants) (Fig. 3). Plots were randomly assigned to one of the following treatments: 1) low density of ripe fruit or 2) high density of ripe fruit (standard practice). Plots were maintained at low or high SWD density by a twice weekly or once weekly interval of fruit harvest, respectively. To quantify SWD infestation, five plants were sampled each week. Ten fruit were placed into individual 473-ml paper cups with a mesh lid. Cups were stored in environmental conditioned chambers (25 ± 2ºC, 50 ± 10% RH and 16:8 L:D) for 9-10 d and emerging adults and pupae were recorded. Fruit collections continued for four weeks. Infestation rates between treatments were compared using repeated measures ANOVA.

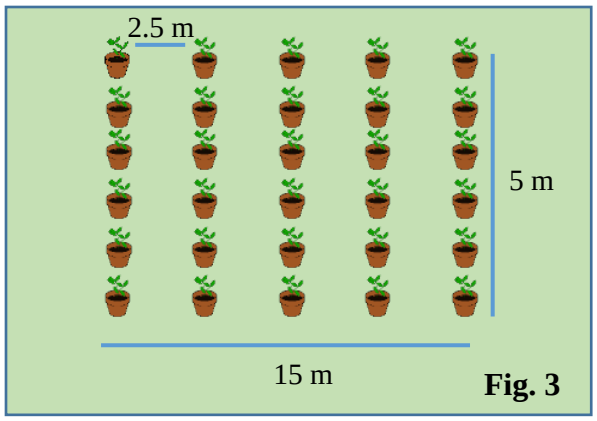

Fig. 3

Results and Discussion
Our results suggest that increased harvest intervals can significantly reduce SWD infestation rates ($F = 20.7$, $P < 0.0001$) (Fig. 4). However, further studies will need to verify these findings at commercial scales. Increased harvest intervals may be more effective when SWD population densities are high compared to low population densities and additional studies should investigate these interactions.

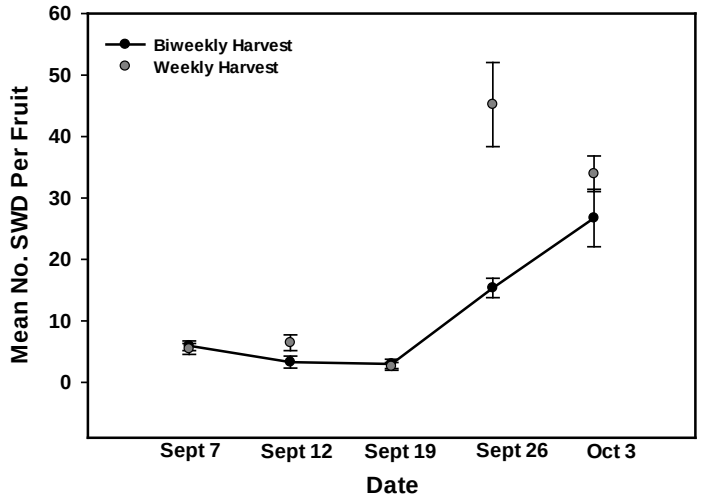

Fig. 4. Biweekly fruit harvesting reduced SWD infestations compared to weekly harvests.