CONTINUING PROJECT PROPOSAL **YEAR**: 1 of 3

WTFRC Project Number: ST-16-100

Project Title: Spotted wing drosophila management in stone fruit

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Cooperators: stone fruit growers

Total Project Request: **Year 1:** $17,658 **Year 2: $33,667** **Year 3:** $34,900

Other funding sources: None

Budget 1
Organization: WSU **Contract Administrator:** Joni Cartwright, Carrie Johnston
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Item	**2016**	**2017**	**2018**
Salaries[1]	10,695	22,245	23,135
Benefits[2]	4,128	8,587	8,930
Wages	0	0	0
Benefits	0	0	0
Equipment	0	0	0
Supplies[3]	1,000	1,000	1,000
Travel[4]	1,835	1,835	1,835
Miscellaneous	0	0	0
Plot Fees	0	0	0
Total	17,658	**33,667**	34,900

Footnotes: [1]Salaries 0.40 FTE Research Intern, [2]Benefits, Research Intern 38.6%; [3]SWD rearing supplies, traps and lures, office supplies/electronics; [4]Travel to plots, $0.575/mile x 3,192 miles/year.

Objectives:

1. Determine skin penetration force and flesh firmness levels necessary to allow SWD oviposition
2. Test the use of synthetic lures to predict damage by SWD
3. Determine the number of traps per unit area needed to provide accurate prediction of damage risk.

Significant Findings:

- SWD oviposited in, and emerged from, ripening nectarines at very low levels compared to a known susceptible host, sweet cherry
- Fruit skin penetration and flesh firmness of nectarine decreased as fruit became more mature, but these parameters were unrelated to the ability of SWD to attack the fruit
- The liquid traps captured both more males and total SWD than the yellow sticky cards, but the threshold was trigged at the same point in time for all trap types and densities (likely due to the low threshold)
- Damage due to SWD was found in harvest samples, but successful emergence occurred only in split fruit (one of three orchards only)
- A higher threshold may be more appropriate

Methods:

Obj. 1. Previous research has shown that peaches and nectarines are low risk host crops for SWD. However, this insect can oviposit in them if they are over-mature; thus there must be a point in fruit development when they become susceptible. We will determine where along this continuum this point lies in terms of fruit maturity characteristics.

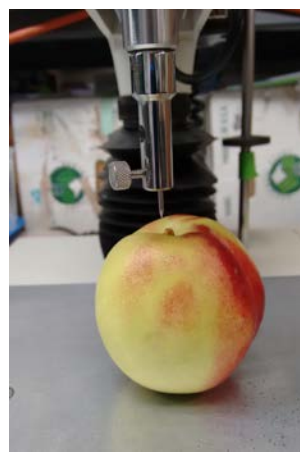


Plate 1. Fruit texture analyzer used to measure skin penetration force

Fruit maturity was measured on a sample of 10 fruit/block on six dates (1 to 29 August, 2016). Fruit maturity measurement included weight, flesh firmness, and skin penetration force (Plate 1). On the final three dates closes to harvest, an additional 10 fruit were used to bioassay the ability of female SWD from a lab culture to oviposit and successfully develop to the adult stage. Fruit was picked in the morning, transferred directly into individual plastic containers, and exposed to females the same day. Mated females SWD (five per arena, 10 days old) were deprived of an oviposition substrate for 24 h, then exposed to a single nectarine fruit for 16 h. For comparison, a known susceptible host (sweet cherry) was assayed at the same time, using 12-14 cherries to provide an equivalent weight to the single nectarine. At the end of the exposure period, females were removed, and the fruit was examined for oviposition punctures with breathing filaments (internal egg deposition) or eggs laid on the surface of the fruit (external oviposition); the latter is an indication of poorer host acceptance. Skin penetration force was regressed against the number of oviposition punctures (internal + external) and emerged adults to determine if this parameter can predict the ability of SWD to use nectarines as a larval host.

Obj. 2. The first synthetic lure was available for testing in 2013, based on the Cha-Landolt blend of acetic acid, ethanol, methionol, and acetoin. Three commercial lures are now available, generally providing higher capture than apple cider vinegar. Several seasons of tests indicate that the Scentry lure consistently captures more SWD, and thus offers the best opportunity for early detection of adult activity in an orchard, and to base a spray threshold on trap capture.

The use of traps for spray thresholds was tested in three nectarine orchards, cv ‘Summer Blush’ in eastern Washington in August of 2016. Traps were deployed in late July and checked twice weekly beginning through the harvest period at the end of August. A 1-acre section of trees was designated as the study area, and six traps were deployed near the center (3 per row with one buffer row between) (Fig. 1). Three of the traps were a liquid-based jar trap (Scentry trap) baited with the Scentry synthetic lure. The drowning fluid was 300 ml of water with a surfactant (liquid dish soap) and a preservative (sodium benzoate) added. The second set of 3 traps was Scentry lures backfolded in AlphaScents yellow sticky traps (Plate 2). The drowning fluid in the liquid traps was collected and replaced at each visit, and the contents counted in the laboratory with the aid of a microscope. The AlphaScents sticky traps were counted *in situ*, scanning only for males, which were removed after counting. The trap positions were rotated between rows at each visit. A provisional threshold of 5 SWD in any of the six traps per block was the trigger to begin protective pesticide applications, to be continued through harvest at 7-10 day intervals at the grower’s discretion.

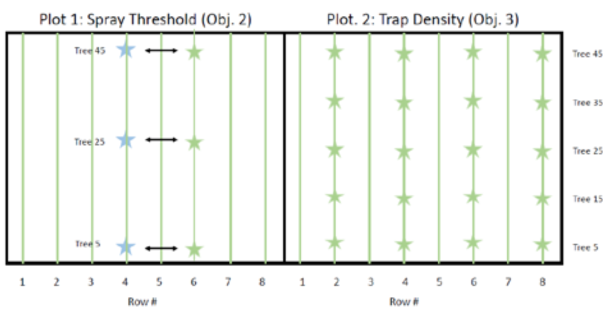


Fig. 1. Plot layout schematic showing trap position (1 acre plots, ‘Summer Blush’ nectarine).

Scentry Lure | Scentry Trap | AlphaScents Yellow Sticky Card

Plate 2. Lure and traps used in the stone fruit study

The success of the threshold was determined by examining *in situ* 1,000 fruit in each plot. All damaged fruit were collected and returned to the lab to rear out any arthropods found in the fruit.

Obj. 3. Little is known about the source of SWD occurring in blocks, specifically whether the major source comes from habitat surrounding the block, or from within the block itself. This makes the number and position of traps used for action thresholds difficult to determine. Observations to date indicate that the older ACV traps have a limited range of attraction, but newer lures are untested.

To address this question, the same blocks used in Obj. 2 were used, locating a second 1-acre plot next to the Obj. 2 plot (Fig. 1). In contrast to the low trap density used in Obj. 2, and the second plot had a high trap density, using only the Scentry lure/yellow AlphaScents sticky trap combination. Traps were laid out in a grid pattern throughout the block, 5 traps in each of 4 rows, or 20 traps per 1-acre plot. Traps were checked twice weekly *in situ*, without changing the lure or trap, and removing males after counting. The same threshold of 5 SWD (males) in any trap used in Obj. 2 was used, as well as the same method of determining success of the threshold.

Results and Discussion:

Obj. 1. Determine skin penetration force and flesh firmness levels necessary to allow SWD oviposition. Both skin penetration force and flesh firmness decreased over time as the fruit matured (Fig. 2) in all three orchards. Oviposition in nectarine fruits was negligible on all three lab bioassay dates (Fig. 3), ranging from 0 to 0.8 ovipositions/fruit. The majority of the ovipositions in nectarine were external (69%; range 0 to 100%), compared to 42% in the known susceptible host, sweet cherry. Total ovipositions in cherries were variable, but about 34-fold higher overall than in nectarines (range 5-23 ovipositions/arena).

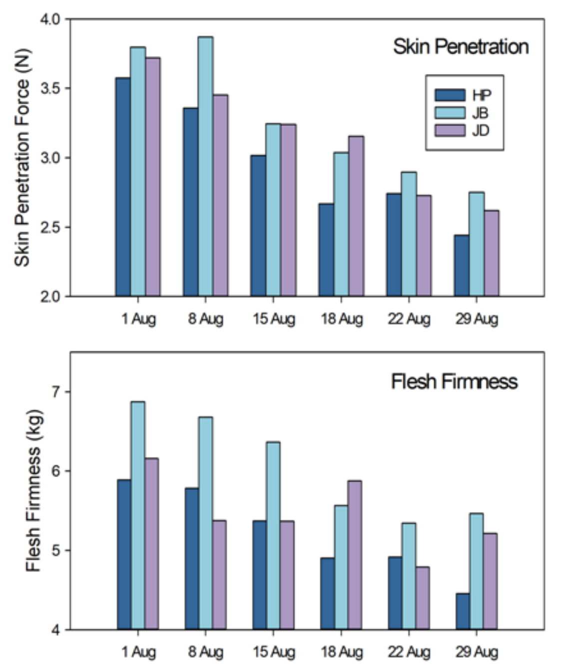


Fig. 2. Fruit maturity indices on 5 dates in 3 nectarine orchards, 2016.

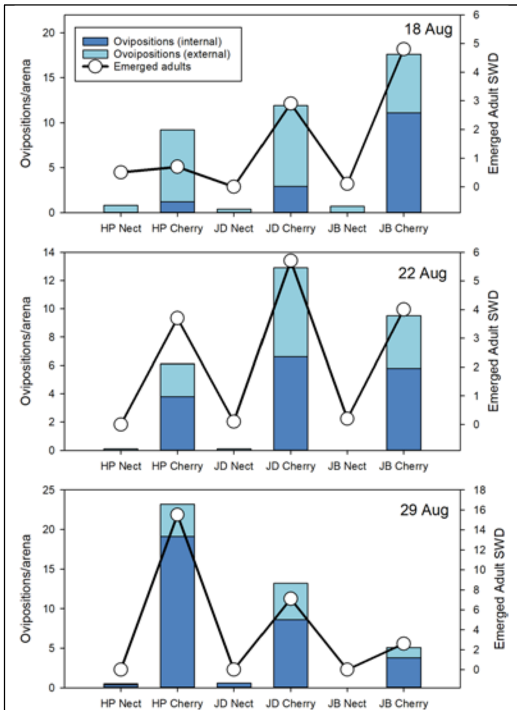


Fig. 3. Ovipositions and emerged adults from nectarine compared to cherry, August, 2016.

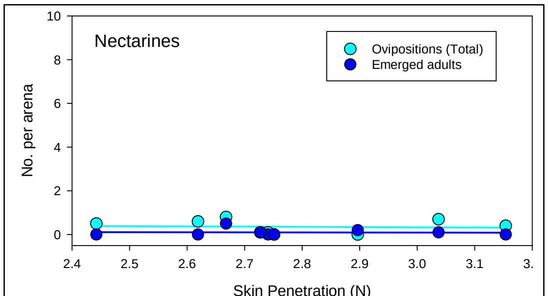


Fig. 4. Relationship between skin penetration, successful oviposition and emergence of SWD.

The average skin penetration force for each orchard and date was regressed against the average oviposition and adult emergence of SWD in lab bioassays. There was no relationship between skin penetration force and resulting oviposition and emergence of SWD from nectarine fruit (Fig. 4).

Obj. 2. Test the use of synthetic lures to predict damage by SWD. Two fruit damage assessments were made (1,000 fruit/plot) on 23 and 29 August (corresponding to 2 harvest dates) in the six study plots. Fruit were examined *in situ*, and damaged fruit were picked and returned to the lab for further study. Damage was categorized as 0) none, 1) split, 3) pock marked, 3) skin defect, 4) divot, and 5) calloused. A total of 12 damaged fruit were found in the 23 August sample; however, no SWD or other *Drosophila* were found in the incubated fruit.

A total of 21 damaged fruit were found on the 29 August sample. From the damaged fruit, 2 were found to have SWD (based on emergence), yielding 10 adult SWD. All of the fruit with SWD were categorized as ‘split’, indicating that a prior physical or physiologically induced wound may have been responsible for the entry point. Other *Drosophila* species were also found in the damaged fruit (n=24), some of which overlapped with fruit in which SWD were found.

An additional sample of damaged nectarine fruits from the same growing region was taken on 26 August (Plate 3). Each fruit was photographed to record the appearance the damage, and then incubated for 16 days to determine if any *Drosophila* spp. were present. Of the 11 fruit, 9 were infested with *Drosophila* (SWD or other species), and 5 with SWD. While these results confirm that SWD infestation is occurring in the field, it is unknown whether the infestation with SWD occurred in injured or uninjured fruit.

For a discussion of the correspondence with trap capture, see Obj. 3, Table 1.

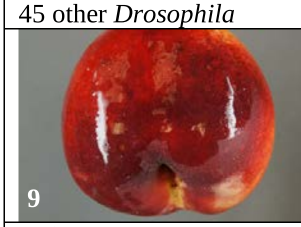
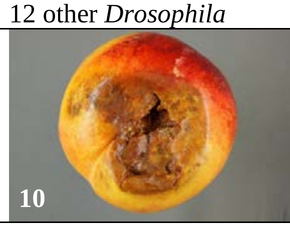
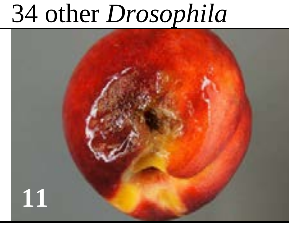
 1	 2	 3	 4
1 ♂ SWD, 5 ♀ SWD 1 other *Drosophila*	0 ♂ SWD, 0 ♀ SWD 16 other *Drosophila*	2 ♂ SWD, 0 ♀ SWD 0 other *Drosophila*	0 ♂ SWD, 0 ♀ SWD 0 other *Drosophila*
 5	 6	 7	 8
0 ♂ SWD, 0 ♀ SWD 45 other *Drosophila*	0 ♂ SWD, 0 ♀ SWD 12 other *Drosophila*	0 ♂ SWD, 0 ♀ SWD 34 other *Drosophila*	0 ♂ SWD, 0 ♀ SWD 0 other *Drosophila*
 9	 10	 11	
0 ♂ SWD, 2 ♀ SWD 0 other *Drosophila*	2 ♂ SWD, 3 ♀ SWD 0 other *Drosophila*	1 ♂ SWD, 1 ♀ SWD 0 other *Drosophila*	

Plate 3. Infestation of damaged nectarine fruit collected from HP orchard, 26 August 2016.

Obj. 3. Determine the number of traps per unit area needed to provide accurate prediction of damage risk. The liquid traps (mean=8.7) caught more male SWD per trap than the sticky card (mean=2.2) traps during the 7 collection dates, although the average is biased by a very high count on the last date (29 August) that occurred only in the liquid traps (Fig. 5). This is at variance with previous tests (in a cherry orchard) where the sticky card caught more males than the liquid traps. There was little difference in mean capture when the sticky cards were deployed at a low density (3/acre; 2.7 males/trap) versus a high density (20/acre; 2.12 males/trap). The AlphaScents traps frequently had mean captures below 5 SWD males/trap throughout the study period.

Table 1 shows the number of traps out of the total deployed that triggered the threshold of 5 or more SWD per trap in four categories: 1) the 3 liquid traps in the low trap density plot, but counting males only in the lab; 2) the same traps, counting both males and females; 3) the 3 yellow sticky cards in the low trap density plot, males only, counted in the field; and 4) the high density trap plot, counting 20 yellow sticky cards, males only, in the field.

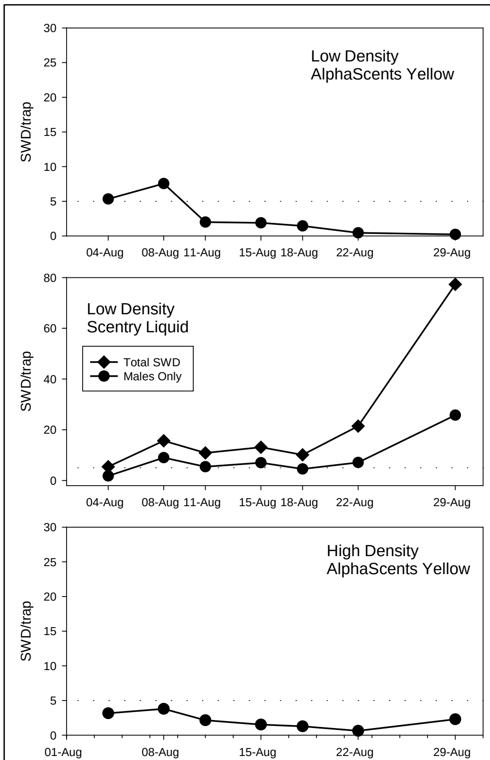


Fig. 5. Trap catch (males only or males + females) in low and high density trap plots.

In the high density trap plot, the average number of SWD/trap (*n*=20, males only) never exceeded the threshold of 5/trap. However, based on the stated criteria (one or more traps with ≥5 SWD), the threshold was trigged in all orchards intermittently throughout the study period (Table 1). Specifically, it was triggered on the first date the traps were checked (4 Aug) in all three orchards. Using the criteria stated in Obj. 2, all blocks would have had continuous pesticide protection through harvest in late August.

Table 1. Number of traps (out of *n* deployed) with ≥ 5 SWD at the time the trap was checked.

Orchard	Date	Obj. 2 - liquid males only *n*=3	Obj. 2 - liquid males+females *n*=3	Obj. 2 - sticky males *n*=3	Obj. 3 - sticky males *n*=20
HP	4-Aug	1	2	3	9
	8-Aug	3	3	2	13
	11-Aug	2	3	0	8
	15-Aug	3	3	0	5
	18-Aug	2	3	0	3
	22-Aug	3	3	0	1
	29-Aug	3	3	0	1
JB	4-Aug	0	0	3	1
	8-Aug	2	1	1	3
	11-Aug	2	3	1	1
	15-Aug	1	3	1	0
	18-Aug	2	3	0	0
	22-Aug	3	3	0	0
	29-Aug	3	3	0	0
JD	4-Aug	0	1	0	4
	8-Aug	0	2	3	0
	11-Aug	0	0	0	0
	15-Aug	0	0	0	0
	18-Aug	0	3	2	2
	22-Aug	1	3	0	0
	29-Aug	3	3	0	4