1) Title: Monitoring and management of spotted wing drosophila in Michigan cherries

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3) Objectives: The invasion of spotted wing drosophila (SWD), *Drosophila suzukii* into North America has caused millions of dollars of crop loss. In Michigan, cherry and berry cherry crops have been especially vulnerable to this pest. Michigan tart cherries growers are applying 3-6 insecticide sprays to combat this pest and still incurring crop losses and load rejections. IPM programs that were developed around other pests have effectively been curtailed in these cropping systems. Monitoring and trapping is an important component of an SWD management program. An MSU-led trapping network and weekly statewide reports remain the best means of keeping the MI cherry industry informed about the status of SWD activity during the season. The management of natural habitats should be integrated into IPM programs for SWD. A particularly promising approach, attract and kill, combines the use of behaviorally-active compounds to lure flies to a device and insecticides to kill the attracted insects. Attract and kill uses low amounts of active ingredient, reduces selection pressure, and does not contribute to insecticide residues on fruit. Our research team has developed an innovative attract-and-kill pouch to control tree fruit pests, providing excellent control of several insects. Based on this design, SinoGreen Biological Technology developed a Smartgreen killing pouch that was effective in reducing SWD population up to 86% when deployed at 210/ac prior to cherry ripening orchard. Recent studies have provided substantial evidence of SWD movement between fruit crops and adjacent habitats, highlighting the importance of wild hosts on pest pressure. Michigan cherry growers have reported that SWD appear to move into their orchards from adjacent habitats and that fruit infestation is concentrated along the orchard margins. Indeed, several growers indicated that they were able to provide a clean crop to the processor by not harvesting the border rows. Knowing more about how SWD moves between noncrop habitats and cherry is key to the development of perimeter-based approaches to controlling SWD.

Objective 1. *Establish and maintain a systematic network of traps for detection of SWD.*
Objective 2. *Determine the efficacy of the Smartgreen attract and kill device deployed along the perimeter of a cherry orchard for intercepting and controlling SWD.*
Objective 3. *Investigate SWD within-orchard distribution and the movement of flies between tart cherry orchards and adjacent natural habitats from early season to harvest.*

4) Activities, Accomplishments, Impacts:

Trapping network: Standard deli-cup style traps baited with a Scentry lure as the attractant were deployed at 95 sites in May or early June and checked weekly through the end of July. A total of six (6) reports were posted to the MSU Extension News for Ag Fruit & Nut Digest beginning on June 26th with a final report posted on July 30 (http://msue.anr.msu.edu). the number of flies caught started off higher than in any

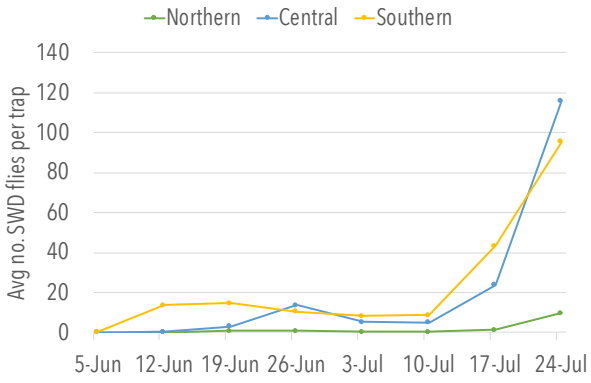

Figure 1. SWD captures in trapping network, 2020.

previous season in the southern and central sites, increasing rapidly after July 10th (Fig. 1). However, Northern trap numbers remained near zero until after July 17th in association with a period of hot and dry weather. By the end of the season, 2020 looked a lot like the season before in terms of overall numbers with a few sites driving up the averages late in the season.

Efficacy of Smartgreen attract-and-kill technology: The Smartgreen attract and kill device (AK) is a pouch that has the outer surface treated with deltamethrin and is filled with a solution of Cha's SWD attractant blend (ethanol, acetoin, acetic acid, and mathionol in water). It has 2 holes (1.8 cm in diameter) through which attractant volatiles are emitted and flies potentially enter the pouch. Smartgreen AK devices were deployed along the perimeters of cherry orchards at three locations: Southwest (TNRC), West Central (WC), and Northwest (TC). A 2.5-ac sweet cherry orchard at TNRC was treated at the end of petal fall (May 18) with 68 AK devices, 1/tree along the perimeter. At the West central orchard, 99 AK devices, 1/tree were deployed along the perimeter of a 5-ac tart cherry orchard 1 week after petal fall (May 27). At the Traverse City site, 81 AK devices were deployed on every other tree along the perimeter of the shorter side of a 5-ac tart cherry orchard, then continuously on the other side until the 26th tree, 1 week after petal fall (June 6). The longer side of orchard was bordered by a large natural habitat. Six standard cup traps baited with scentry lures and filled with 150 ml soapy water were used to monitor adult SWD population. Traps were placed along a transect extending from the perimeter to the interior of the orchard. Control cherry orchards similar in size and topography also were monitored with 6 cup traps deployed in a transect. The control plot in West Central MI unfortunately was treated with insecticide sprays for SWD control starting June 12, therefore was considered an insecticide-treated rather than untreated control. Monitoring traps were service weekly until harvest (except for TNRC) and the number of SWD flies were counted at each inspection. AK devices were refilled as needed. A fruit injury evaluation for SWD infestation was conducted prior to the harvest. A total of 25 trees were selected in the control and AK plots from the edge to the center of orchard by sampling a group of 5 trees along every line passing through each cup trap (except for T_0) and perpendicular to the trap transect line. Two pounds of cherries were picked from each tree. Among these fruits, 1.5 pound was subjected to the brown sugar method to extract larvae from the fruit, while 0.5 pound was held in a 16oz rearing container until SWD flies emerged. The number of male and female SWD was recorded.

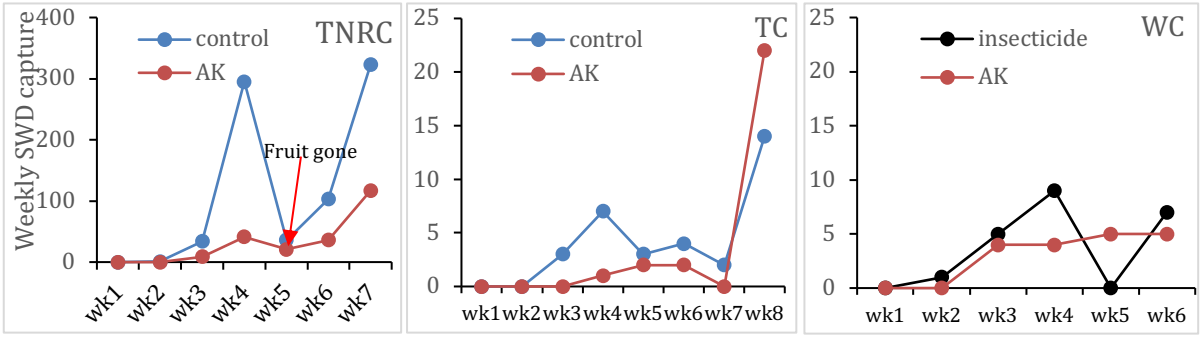

Figure 2. Weekly SWD capture in control/insecticide plots and AK plots at three sites.

Weekly SWD captures were constantly higher in the control plot than in the AK treated plot at the TNRC site during the experimental period (Fig. 1). Overall, the total number of SWD captured for the whole season was nearly 6 times more in the control than in the AK treated plot. More flies were captured in the control plot than in the AK plot at the TC site except for the

final week before harvest. Overall SWD populations at the TC site was very low compared to that at TNRC, but captures were lower in the AK compared to the control plot. AK and insecticide plots at the WC site had comparable SWD populations. Due to early frost damage, approximately 20% of a sweet cherry crop developed this season at TNRC. Unfortunately, this small crop was consumed by birds in a couple of days, just prior to our plans to complete the fruit injury evaluation. Thus, we do not have fruit injury data to support the substantial reduction in SWD captures in the AK compared to the control plot. At the TC site, one SWD larva was found in the AK plot and no larvae were detected in the control using the brown sugar method of larval extraction. At the WC site, no larvae were found in the insecticide spayed plot, while 2 larvae and 1 pupa were found in the AK plot. No SWD adults emerged from the rearing test from any fruit collected from the TC or WC sites.

SWD within-orchard distribution: Cherry orchards with adjacent natural habitat were chosen for this study. In each of 5 orchards, a transect of 6 trapping sites was established, consisting of locations starting at the edge of each orchard, then spaced at 12-meter intervals into the center of the orchard. We also assessed SWD fruit infestation prior to harvest. A total of 25 trees starting from the border to the center at 12 m intervals (5 at each cup trap location) were randomly selected and approximately 2 pounds of intact ripening cherries from each tree were randomly picked. Cherry samples were divided into two sub-samples. One sample was subjected to the brown sugar method for extracting larvae from the fruit, while the other portion was held in rearing containers until SWD flies emerge. The number of male and female SWD were counted.

Due to a large variation in the numbers of SWD captured among orchards, the total number of flies captured during the whole season was normalized and presented as the proportion of flies captured in each trap. There was a clear pattern whereby the number of SWD flies was the highest at the edge of the woods, followed by the orchard edge, and decreasing toward to the center (Fig. 3). However, SWD larval infestation did not correlate with fly captures. Higher captures at the edge did not correspond to higher injury on the edge. At one site, the brown sugar method detected 5 larvae in fruit in one tree out of 25 trees near the center of orchard. In the rearing test, more than 50 pairs of SWD emerged from cherries sampled from a tree which was about 20 meters from the edge and no flies emerged from the rest of samples. At another site, 34 larvae were extracted from cherries from one tree at the edge row; a tree at the same distance as T_3 from the edge (36 meters) had 1 larva; two trees at the same distance as T_4 (48 meters) had 5 and 3 larvae respectively; one tree in the center of orchard (at the same distance as T_5) had 1 larva. In the rearing test, 16 male and 14 female flies emerged from cherries for an edge tree and 1 pair emerged from a tree at the center of the block.

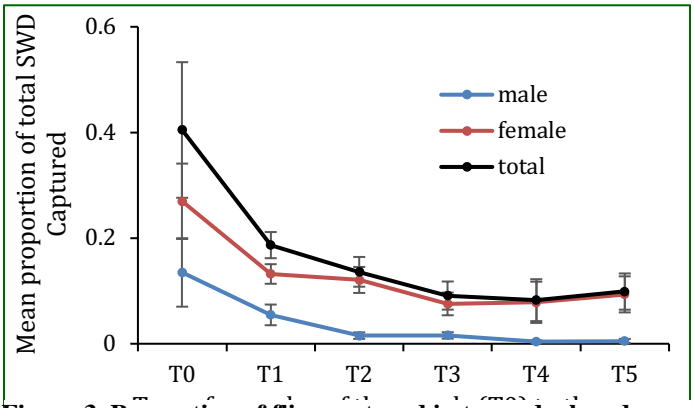

Figure 3. Proportion of flies captured in traps deployed along a transect from the edge to the center of cherry orchards.

5) Information dissemination and impacts:
SWD has the potential to greatly reduce the quality of cherries produced in MI. Over 80% of MI cherry growers rely on the network for making SWD management decisions. We are generating the information that will allow growers to make sound management decisions to keep fruit clean while optimizing insecticide applications. There are a limited number of highly efficacious control materials for SWD, thus we also are examining attract and kill for managing this hard to control pest. Our proposed study will provide valuable insights into SWD distribution within orchards and fly movement from natural habitats into cherry. This will help growers optimize controls for SWD and potentially modify their harvest strategies to avoid crop losses. Project findings will be shared through conferences, field days, newsletter articles, and reports.

6) Funding partnerships: Complementary research on SWD was funded by a USDA SCRI grant ($6.7 million; $152,000 to LG), MDARD Specialty block grant ($99,948; $33,000 to LG) and two MSU Project GREEEN Grants ($40,000 & $36,955).