Michigan Grape & Wine Industry Council
2015 Research Report

# Biology and management of invasive insect pests in Michigan vineyards 2015

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## ABSTRACT

Fifteen Michigan vineyards were monitored for four species of invasive moths, with no detections in 2014 or 2015. Spotted wing *Drosophila* (SWD) was present in all sampled locations, and the highest SWD captures occurred during harvest, while African fig fruit fly was only found at one site in 2015. Brown marmorated stink bug was not detected in vineyards. Early ripening red varieties may be the most susceptible to SWD infestation, and infestation by other *Drosophila* species was similar across varieties. Leaf-pulling and insecticide application reduced fruit fly numbers and sour rot incidence, but these differences were not statistically significant.

## GOALS AND OBJECTIVES

In recent years, European grapevine moth and light brown apple moth have been detected in California vineyards. Both of these pests are damaging to grapevines, so a detection program has been established to support monitoring for these pests at 15 vineyard sites in SW and NW Michigan. In addition, monitoring for the summer fruit tortrix (a Eurasian pest of primarily tree fruit), and European grape berry moth are also part of this effort. This project includes research with a more detailed focus on spotted wing *Drosophila,* because it has now been found in all major fruit production regions of the state. The research described below is helping us to assess the link between SWD infestation and fruit quality. Finally, we monitored for brown marmorated stink bug to assess its activity in Michigan vineyards. This project will ensure that Michigan grape growers have the information needed to be prepared for these invasive insect pests, and have information to address spotted wing *Drosophila* and other vinegar flies as potential sources of cluster rot problems at harvest-time.

### Objectives

Objective 1. Monitor Michigan vineyards for invasive insect pests.
Objective 2. Assess Michigan-grown grape cultivars for their susceptibility to SWD.
Objective 3. Determine the performance of different management approaches to minimize vinegar fly and sour rot infestation.

## PROJECT PERIOD

This project began in 2014 and ran through 2015, with field work occurring from May to October in both years.

This report summarizes the first two years of a project focused on invasive insect species that are potential threats to the Michigan grape industry. Whether these pests are yet to arrive, present in Michigan at low levels, or here in abundance, we need to learn about their biology, management, and economic impact. The project is also linked to ongoing projects in the Isaacs Lab that are addressing spotted wing *Drosophila* (SWD) in blueberry and raspberry, and to a CAPS project on monitoring for invasive grape pests. However, that project only has funding sufficient for sampling every 2 weeks, for part of the season, and in a restricted number of locations. There is research underway currently in Virginia, New Jersey, and Minnesota on SWD in grapes but their cultivars, climate, and management practices are different. This project is the primary effort on this topic within the Great Lakes region.

## WORK ACCOMPLISHED DURING THE PERIOD

### *Objective 1. Monitor Michigan vineyards for invasive insect pests.*

Fifteen vineyards across the grape production regions of Michigan were selected and monitored for the following exotic pests: European grapevine moth, *Lobesia botrana*; Light brown apple moth, *Epiphyas* posivitanna; European grape berry moth, *Eupoecilia ambiguella*; summer fruit tortrix, *Adoxophyes orana,* spotted wing Drosophila, *Drosophila suzukii,* African fig fruit fly, *Zaprionus indianus* and brown marmorated stink bug, *Halyomorpha halys.* Seven of the monitored vineyards produce juice grapes and wine grapes are grown at eight vineyards. The vineyards were located in the following counties: Ingham (1), Ionia (1), Berrien (4), Van Buren (3), Allegan (1), Antrim, (1), Benzie (1), Grand Traverse (1) and Leelanau (2). At each vineyard, one sex pheromone baited delta trap for each of the moth species *L. botrana, E. posivitanna*, and *A. orana* were hung on the trellis on the border of the vineyard facing a woodlot. A bucket trap made from a 32 oz clear plastic deli cup containing a 2x3 in yellow sticky card and baited with apple cider vinegar and a fruit fly lure (Trece Inc.) was also hung at the vineyard border to monitor for SWD. In vineyards in southwest and mid-Michigan, traps were set between May 12th and May 30th, in vineyards in northwest Michigan traps were set between May 29th and June 2nd. Traps were set during different time spans to account for differences in seasonal development of vineyards and pests between regions. Moth traps were checked each week for 12 weeks from May through August, and lures and traps were changed every three to six weeks depending on the species. Any insects that were suspected to be the exotic moth species mentioned above were removed from the trap and returned to the lab for examination under magnification.

Suspect moths were not captured at any of the monitored vineyards in 2015. In late May and early June, at several locations in southwest Michigan, the *Adoxophyes orana* traps consistently attracted a contaminant moth, *Croesia semipurpurana,* the oak leaf tier. In late June and early July a moth similar in appearance to *A. orana* was captured in more than half of the traps for that species in southwest Michigan. Samples of this moth were sent previously to John Brown USDA-Beltsville Systematic Entomology Lab, and it was identified as *Pandemis limitata,* the three-lined leafroller. Using materials we obtained from the USDA-Beltsville Systematic Entomology Lab we were able to positively identify all specimens of this suspect moth collected in 2015 as *P. limitata*; therefore no samples were sent to USDA-SEL for identification in 2015.

SWD traps were deployed at all vineyards from early June through harvest in September or October, and these were checked weekly. Traps were strained and contents and yellow sticky cards were returned to the lab where the number of male and female SWD were recorded. Apple cider vinegar bait was changed each week and SWD lures were changed every three weeks. Every week when we visited the vineyards to check and service traps we also examined 5 vines along the vineyard border and 5 vines in the vineyard interior to look for brown marmorated stink bug. On each sampled vine, we checked five clusters and five shoots for the presence of insects or signs of feeding damage. Spotted wing *Drosophila* was captured at all the vineyards we monitored, with the first catches occurring during the first week of July in southern and northern Michigan. The period of peak activity was on week later in northern as compared to southern Michigan. Across vineyards, the average of the total number of SWD captured during 2015 season was higher in southern Michigan (180 flies per trap) compared to vineyards in the northern part of the state (136 flies per trap). This is the opposite of what was found in 2014. This result may be a result of a shortened season in 2015 compared to that in 2014 in northern Michigan.

African fig fruit fly was not detected in any of our traps in 2014, but we did find this species in a trap at one site in Berrien County in 2015. Brown marmorated stink bugs were not detected in traps or during scouting in any of our sampled vineyards. This is important because BMSB was found in other crop systems and natural areas in the vicinity of our focal vineyards.

***Objective 2. Assess Michigan-grown grape cultivars for their susceptibility to SWD.***

This study was performed in the grape variety plantings at the Horticulture Teaching and Research Center (HTRC) in East Lansing in 2014 and 2015. We sampled the hybrid and labrusca varieties: Petite Pearl, Marechal Foch, Marquette, Concord, St. Croix, Frontenac, Frontenac Gris, La Crescent, Vignoles, Seyval blanc, Cayuga and Niagara. During the time of this investigation, no insecticides were applied to the planting, and SWD traps placed in the variety planting were checked weekly during this trial, and SWD and other fruit flies were caught through the duration of the study. We also sampled clusters from vinifera varieties planted at the Northwest Michigan Horticulture and Research Center in Traverse City in 2014, but there was no fruit to sample in 2015 due to winter-kill that occurred during the harsh winter of 2014-15.

In the two to six weeks prior to harvest, three replicate clusters of each variety were collected each week. Individual clusters were weighed and the number of berries and % Brix of the terminal berry were recorded. A cluster was then placed onto a 2x2x1 inch piece of sponge in a 32 oz clear deli cup. A 2x3 in. yellow sticky card was placed in each cup to catch emerging flies and each cup was covered with a mesh lid. Clusters were stored at room temperature with a 16:8 light:dark cycle for two weeks to allow any fruit fly larvae in the fruit to develop into adults. At that time the number of SWD and other fruit flies on the sticky card were recorded. The total number of flies that emerged from clusters was compared among varieties with analysis of variance using cluster numbers as replicates.

In 2014, the average number of SWD that emerged from clusters ranged from 0 to 12 files per 10 clusters, and the number of other *Drosophila* ranged from 0 to 44 flies per 10 clusters (Figure 2a and 2b). No SWD or other *Drosophila* emerged from fruit collected from the planting at NWMHRS in 2014, therefore only data from HTRC were included in the analysis. In 2015 the

average number of SWD that emerged from clusters ranged from 0 to 43 per 10 clusters, and the number of other *Drosophila* ranged from 0 to 248 (Figure 2c and 2d).

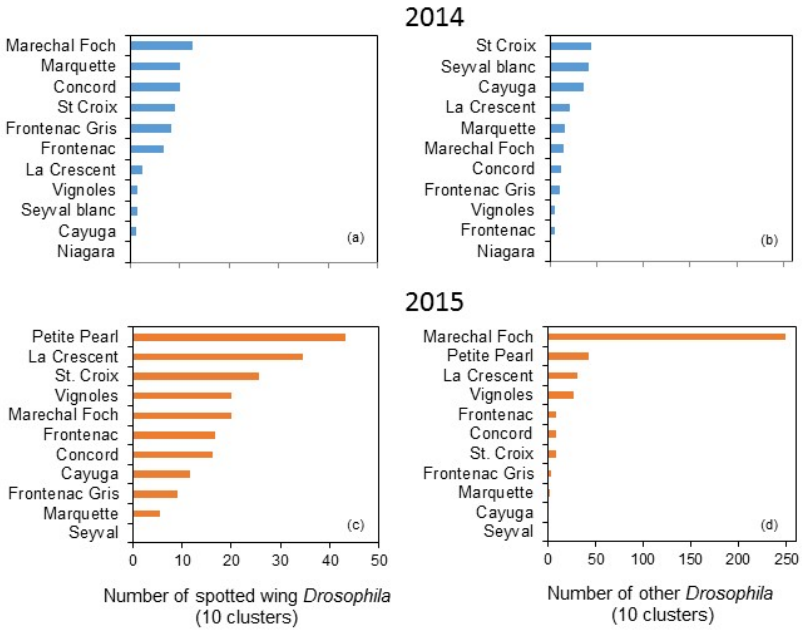


**Figure 1.** Total number of SWD (a, c) and other *Drosophila* (b, d) that emerged from clusters collected from the variety planting at HTRC in 2014 and 2015. In 2014, no significant differences among varieties were detected in the number of SWD ($F_{10, 32} = 1.07$, $P = 0.42$) or other *Drosophila* ($F_{10, 32} = 0.82$, $P = 0.61$). A very similar result was obtained in 2015: SWD ($F_{10, 24} = 0.94$, $P = 0.51$); other *Drosophila* ($F_{10, 24} = 1.40$, $P = 0.24$). Note overall increase in emergence in 2015 compared to that in 2014. Niagara was only sampled in 2014 as these vines were removed in the spring of 2015. Petite Pearl was not sampled in 2014 because the vines were not yet mature.

There were no significant differences among varieties in the number of SWD or other *Drosophila* that emerged in either year (Figure 2). Within varieties there was substantial variation in the total number of flies that emerged from clusters, and this is most likely why no differences were detected in fly emergence between grape varieties. Nevertheless there are several interesting trends in these data. No SWD or other *Drosophila* emerged from any of the Niagara clusters that we collected in 2014, and the same was true for Seyval in 2015. In general SWD emergence from clusters was higher for red varieties than for white, particularly in 2014 (Figure 2a and 2c), but the same trend between fruit colors was not observed for other *Drosophila* (Figure 2b and 2d). Overall, the number of other *Drosophila* that emerged was much higher than the number of SWD. However this trial shows there was a substantial increase in the number of spotted wing *Drosophila* that were reared from clusters in 2015 compared to 2014, and this difference in SWD emergence between the two years is statistically significant ($F_{1,8} = 10.4$; $P = 0.012$). A similar relationship was found when comparing emergence of other vinegar flies between years ($F_{1,8} = 7.78$ $P = 0.024$). Whether this represents an overall increase in SWD and other *Drosophila* populations at this site, or just reflects normal inter-annual variability is not known. These results show that all the varieties we sampled are at some risk of infestation, but red varieties appear to be more susceptible to SWD infestation than white. This may also be a function of their harvest date, as the population of SWD increases rapidly through September and into October.

***Objective 3. Determine the performance of different management approaches to minimize vinegar fly and sour rot infestation.***

To determine the relative importance of canopy management and insecticidal control of vinegar flies for reducing the incidence and severity of sour rot at harvest, a field trial was established in July 2015 in a ¾ acre section of an 8 acre commercial vineyard (cv. Vignoles) in Berrien County. This vineyard section did not receive fungicides after Veraison and one row of vines was used as a buffer between the experimental area and the rest of the vineyard. Sixteen plots of five vines each (200 sq ft) were randomly assigned to receive one of the following treatments, each replicated four times:

I. **Untreated**
II. **Leaf pulling and shoot positioning in mid- July to increase cluster exposure**
III. **Insecticide applications for cluster protection against *Drosophila***
IV. **Combination of treatments II and III.**

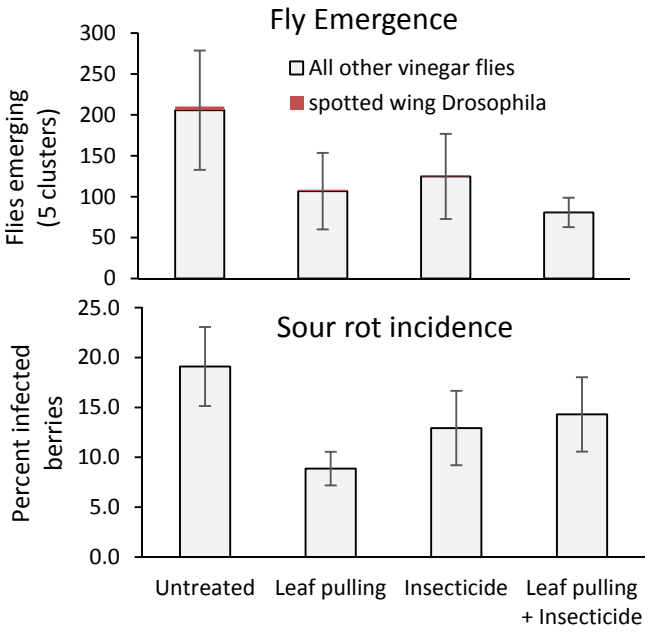


**Figure 2.** Vinegar fly emergence (top) and incidence of sour rot (bottom) in sampled clusters from vines that received canopy management, insecticides, or a combination of the two for vinegar fly management in 2015. Note spotted wing *Drosophila* emergence was low relative to the emergence of other vinegar flies (shown as small bars on top of columns in upper graph).

On July 17th, in plots that were to receive treatment II or IV, we removed the basal five leaves on each shoot and positioned shoots to open the canopy and increase exposure of the clusters. Beginning at Veraison, plots designated as treatment III or IV received applications of short preharvest interval insecticides using a backpack sprayer delivering a volume equivalent to 30 gallons per acre. Insecticides with different modes of action were rotated for vinegar fly control: Aug 17th - Delegate WP (5 oz/ac); Aug 31st - Malathion 8F (30 fl oz/ac), Sept 10th - Mustang Maxx (4 fl oz/ac). At harvest, five clusters per plot were collected and assessed in the lab to determine the percentage of berries infested by *Drosophila* and disease. Clusters were then placed individually in 32 oz clear deli cups and handled as described above. The number of SWD and other *Drosophila* that emerged and subsequently trapped on a yellow sticky card was recorded.

The number of *Drosophila* that emerged from clusters ranged from 0 to 171 and the level of sour rot infection ranged from 0 to 58 % of berries infected. Interestingly the number of SWD that emerged from a cluster ranged from 0 to 3 which suggests other species of *Drosophila* may have out-competed SWD in these clusters. It also suggests that SWD may not be more of a problem than what growers are already facing with other vinegar flies. Reduction of fly emergence and cluster rot infection was observed in the treated plots, however no significant differences in fly

emergence ($F_{3,9} = 0.85$ $P = 0.50$) or sour rot incidence ($F_{3,9} = 1.6$; $P = 0.27$) were detected between treatments.

## COMMUNICATIONS ACTIVITIES, ACCOMPLISHMENTS, AND IMPACTS

Results from this project have raised awareness about the potential risks of invasive insect pests through presentations at summer and winter grower meetings, including the SWMREC Viticulture Days, Great Lakes Expo, Southwest Hort Days, and the Northwest Orchard and Vineyard Show. Information was also presented in the Vineyard IPM Scouting Updates that were distributed electronically through MSU Extension Grapes News. In addition, information was incorporated into webinars hosted by members of the MSU Grape Team during 2014 and 2015. Results from this project were presented in a workshop covering late-season insect and disease issues in vineyards that was held August 18, 2015 at Cronenwett farms in Lawton, MI.

This project has helped to inform the grape industry regarding the current state of invasive insect species in Michigan vineyards. We did not detect European grapevine moth, European grape berry moth, light brown apple moth, summer fruit tortrix or brown marmorated stink bug in any of our sampled vineyards in 2015, but given the increase in globalization, monitoring for these and other invasive insects remains important to the Michigan grape and wine industry. Spotted wing *Drosophila* and other Drosophila species should still be a concern for growers as the peak in population occurs during grape harvest in Michigan.

## BUDGET NARRATIVE

This project was conducted in accordance with the approved budget, as outlined in the original grant agreement and funds were used to accomplish the objectives of the proposal. Our grower cooperator for the sour rot/vinegar fly trial made in-kind contributions of labor, materials and equipment costs to manage his vineyards to our specifications. This is estimated to be between $1,500 and $2,500 for the section of vineyard we used for this spray trial. Some pesticides were provided to the Isaacs lab by agrichemical companies for use in this research/demonstration project. We estimate this to be an additional $500 of in-kind contribution.

## OUTCOMES

This project is helping to ensure that Michigan grape growers have the information they need to prepare for invasive insect pests and to manage species that are already here. This results from this project has also helped to identify varieties that are susceptible to spotted wing *Drosophila.* It also provided growers with tactics to address spotted wing *Drosophila* and other vinegar flies as potential sources of fruit infestation, cluster rot development, and associated loss of berry quality at harvest-time.

## ACKNOWLEDGEMENTS

We thank the growers who cooperated in this study for providing access to their vineyards to allow for invasive pest monitoring. We thank Jeff Lemon and Lemon Creek Winery for their assistance with the sour rot/vinegar fly trial. We also thank Jordan Brandel and Hayley Sisson for their work sampling traps and fruit for this project. Thanks also to the HTRC and NWMHRS staff, and especially Karen Powers for technical assistance.