NYWGF RESEARCH -FINAL REPORT

SECTION 1:

Project title: Biology and management of sour rot and its important insect vectors

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New Research ☐ **Continued Research** ☒ (CHECK APPROPRIATE BOX)

Amount Funded **$** 39,672

SECTION 2:

Project Summary Impact Statement:

The overall goal of this project was to optimize timing for chemical control of sour rot disease that achieves effective management while minimizing economic costs and selection pressure for insecticide resistance and improve our understanding of risk factors associated with insect vectors and/or pests in addition to Drosophila fruit flies. In small plot trials, using the highly sour rot susceptible Vignoles cultivar, over two field seasons, one where there was low incidence and severity of sour rot (2020) and one with very high incidence and severity of sour rot (2021), we found that applying two treatments of insecticide plus microbial pesticide, one after veraison (exact timing varied) and one near harvest, was as effective in reducing sour rot incidence and severity as weekly applications starting after variason (exact timing varied). Monitoring fruit flies using traps, starting after veraison, does not appear to be very useful in providing early indication of sour rot problems in the vineyard and we were unable to fully determine if volatile or spectral signals could be used to help determine timing of control measures. Field experiments using the highly susceptible Vignoles cultivar clearly showed that berry injury from various sources, including mechanical wounding and feeding by yellowjackets, significantly enhanced the incidence and severity of sour rot when adult Drosophila fruit flies were present. Several species of yellowjackets were found causing feeding damage in research and commercial vineyards, with *Vespula germanica* most commonly observed followed by *V. maculifrons.*

Objectives:

Objective 1: Evaluate alternative methods for early detection of sour rot.

Objective 2. Test the hypothesis that control can be achieved with fewer than weekly insecticide applications.

Objective 3: Evaluate interactions among insect damage to berries, Drosophila and sour rot.

Materials & Methods:

Objectives *1 and 2.* The same experimental set up was used to address both objectives 1 and 2 using a research block of Vignoles grapes located at Cornell AgriTech. The vineyard was conventionally managed except for sour rot and insect pests. We established replicated plots assigned to the following treatments: unsprayed control, 2) conventional weekly control (initiate insecticide + Oxidate treatments at 15 Brix and apply weekly until near harvest, 3) Early and late sprays, one at 15 Brix and second near harvest, 4) Early and late sprays, start at 12 Brix, and 5) initiating weekly sprays at first sign of sour rot symptoms on fruit within the research plots. Each plot was comprised of 10 to 12 vines, replicated five times in a completely randomized block design for a total of 25 plots. We rotated insecticides between Mustang Maxx and Delegate at label rates. Treatments were applied using an air assist backpack sprayer at 50 gallons water per acre rate. Brix was assessed from a haphazard collection of berries from all plots two to three times per week using a hand-held refractometer starting after veraison. Incidence and severity of sour rot on 40 clusters per plot was rated twice per week starting after veraizon until near harvest. Presence of Drosophila flies was assessed weekly using two monitoring methods: two transparent sticky cards placed within the canopy of each plot and a single deli cup trap baited with a Scentry lure in each plot. Traps were checked once per week. Also, volatiles from two clusters per plot, chosen randomly, were collected with SKC pocket pumps at 250ml/min for 15 min using baked plastic containment and filtered external air onto 30mg Tenax thermal desorption filters that have been frozen for subsequent analyses using an Agilent 7890 GC-MS. Volatile samples were collected once per week, starting after veraison. Clean clusters not showing any symptoms of sour rot were initially chosen for volatile collections. Subsequently, the incidence and severity of sour rot on these clusters was assessed each time volatiles were collected. Finally, we had originally planned to assess several clusters per plot for spectral characteristics weekly, as weather conditions allowed, using a handheld spectrometer (SVC-1024i). However, due to circumstances beyond our control related to covid-19 and the availability of trained personnel and equipment, we were not able to successfully accomplish measurements of spectral traits associated with clusters.

Objective 3. This objective was addressed with surveys (3a) and a manipulative experiment (3b). Objective 3a. To develop a better understanding of the species of yellowjackets causing damage to grapes, we conducted surveys of research vineyards at Cornell AgriTech and at commercial vineyards in the Finger Lakes region near harvest time for presence of yellow jackets on clusters (adults collected for later species identification), evidence of feeding damage on clusters and presence of sour rot symptoms. We focused surveys of sour rot susceptible cultivars (e.g. Riesling, Pinot Noir, Vignoles, Sauvignon Blanc).

Objective 3b. Fine mesh bags were used to assess the impact of damage by insects (grape berry moth, yellow jacket wasps) and mechanical damage to simulate bird damage, with and without fruit flies, using Vignoles vines at the research block at Cornell AgriTech. After reaching around16 Brix, intact, undamaged clusters were individually contained in fine mesh bags and the following treatments applied: 1) undamaged control, 2) mechanical damage to 20% of berries using the sharp points of scissors to simulate bird injury, 3) 5 grape berry moth larvae, 4) 2 field-collected yellowjacket adults, 5) undamaged clusters followed 7d later by 10 mated female *D. melanogaster* flies, 6) mechanically damaged berries followed 7d later by *D. melanogaster*, 7) grape berry moth followed 7d later by *D. melanogaster*, and 8) yellowjacket adults followed 7d later by *D. melanogaster*. Five days after flies were introduced, clusters were harvested and evaluated for sour rot incidence and severity. There were ten replicates/treatment using vineyard panel as a experimental block.

Results/Outcomes/Next Steps:

Objectives 1 & 2

There was a significant effect of at least one of the tested insecticide treatments on the proportion (incidence) of sour rotted cluster (X^2 =73.89, P <0.001). We observed a lower proportion of sour rotted berries in blocks sprayed twice at 12 Brix and near harvest (Z = - 7. 516, P = <0.001), sprayed twice at 15 Brix and near harvest (Z= -6.93, P <0.001), sprayed weekly, starting from 15 Brix (Z = - 0.38, P <0.001) and sprayed weekly, starting from the first sign of sour rot compared to the control blocks without chemical spray. We also observed a greater proportion of sour rotted berries in blocks sprayed with insecticides every week starting from 15 Brix than the blocks sprayed two times at 12 Brix and near harvest (Z = 3.14, P = 0.01) (Figure 1).

While respect to the severity of sour rot (percentage of clusters with sour rot), we observed an interaction between insecticide treatment and date X^2 = 64.17, P <0.001 (Figure 2). In addition, we found a decrease in the percentage of sour rot in plots sprayed at 12 Brix and near harvest (Z = - 6.50, P = <0.001), sprayed twice at 15 Brix and near harvest (Z= -3.86, P = 0.001), sprayed weekly, starting from 15 Brix (Z = - 4.83, P <0.001) and sprayed weekly, starting from first sign of sour rot were lower compared to the control blocks (Figure 2). Our results suggest no difference in the severity of sour rot in plots that varied by frequency and timing of insecticide applications.

We did not observe an interaction effect of date and an average number of drosophilids on sticky cards (X^2 = 4.27, P = 0.23). Our findings did not show any correlation between number of drosophilids captured in sticky cards and sour rot percentage (X2 = 1.35, P = 0.24). Thus, we could not predict the sour rot severity based on the overall drosophilids population in the tested vineyard. There was no difference in the number of drosophilids trapped on sticky cards (Figure: 3), scentry lure (Figure 4), or reared freared out of sample berries (data not shown) among different pesticide treatments.

Overall, our 2021 study reinforces our finding from the 2020 trial, suggesting that the weekly application of pesticides will not provide much benefit compared to a few applications for sour rot management.

Objective 3:

In the bag inclusion experiment, despite the effort to keep grape berry moth larvae active on bagged grapes for understanding the role of injuries from different insect sources, there was a lack of establishment of grape berry moth larvae. After excluding data related to grape berry moth, we observed a significant interaction between *Drosophila melanogaster* status (presence or absence) and source of injury (X^2 = 6.94, P = 0.03). We observed a strong effect of mechanical injuries or injuries by yellowjackets in the presence of Drosophila fruit flies on the percentage of sour rot in bagged grape clusters (Figure 5). However, even in the absence of Drosophila fruit flies, we observed an increase in sour rot percentage in grape clusters injured by yellowjackets or mechanical damage relative to control clusters. This is expected as the berries were already sprayed with sour rot-associated microbes. We can also conclude that if the grape clusters already contain sour rot microbes, then mechanical injury or yellowjacket injury is sufficient to induce sour rot whether there is presence or absence of fruit flies (Figure 5). However, the severity of sour rot is made worse when fruit flies are present in combination with berry injury. We reared out significantly more fruit flies out of clusters mechanically damaged or damaged by yellowjackets compared to control clusters, which is consistent with the idea that damage provides an entry way into the berry for egg laying by the flies (Figure 6).

For the bag experiment, we used yellowjacket species- *Vespula germanica* and *Vespula maculifrons* collected from vineyards at Cornell Agri Tech. Although we did not observe species' impact on the sour rot mediated by yellowjackets, the Vespula species used in this study are commonly found in vineyards in upstate New York. We also collected and mainly identified *V. germanica* and *V. maculifrons* in our preliminary survey in sour rot susceptible grape cultivar (mainly Riesling) in three vineyards (Table: 1) where most of them were found on either healthy or sour rotted grape clusters.

As a future direction, we can assess the microbes' community in yellowjackets that further help to understand the their role as a vector in sour rot disease etiology in vineyards. We have not applied for any research grants yet to build upon this project, but we look forward to understanding the role of grape berry moth in sour rot disease in controlled conditions.

Technology Transfer Plan:
Results from this research are being communicated to NY grape growers through well-established channels, working closely with our Cornell Cooperative Extension colleagues. Loeb and Gold hold the primary extension responsibilities for pathology and entomology (respectively) for the grape community of New York. We have presented some of the results at winter meetings for Long Island grape growers (2022 Long Island Hort Show, Viticulture section, Jan 2022) and the 2022 Lake Erie Winter Grape Meeting held in March 2022. Some of the results were presented at the 2021 CRAVE (Cornell Recent Advances in Viticulture) held virtually in the fall of 2021. We are currently preparing an extension article on the role of insects in sour rot biology and management to be published in *Application Cornell.* Results have been incorporated into revisions of the *New York and Pennsylvania Pest Management Guidelines for Grapes*.

Attachments: relevant charts and graphs, photos etc.

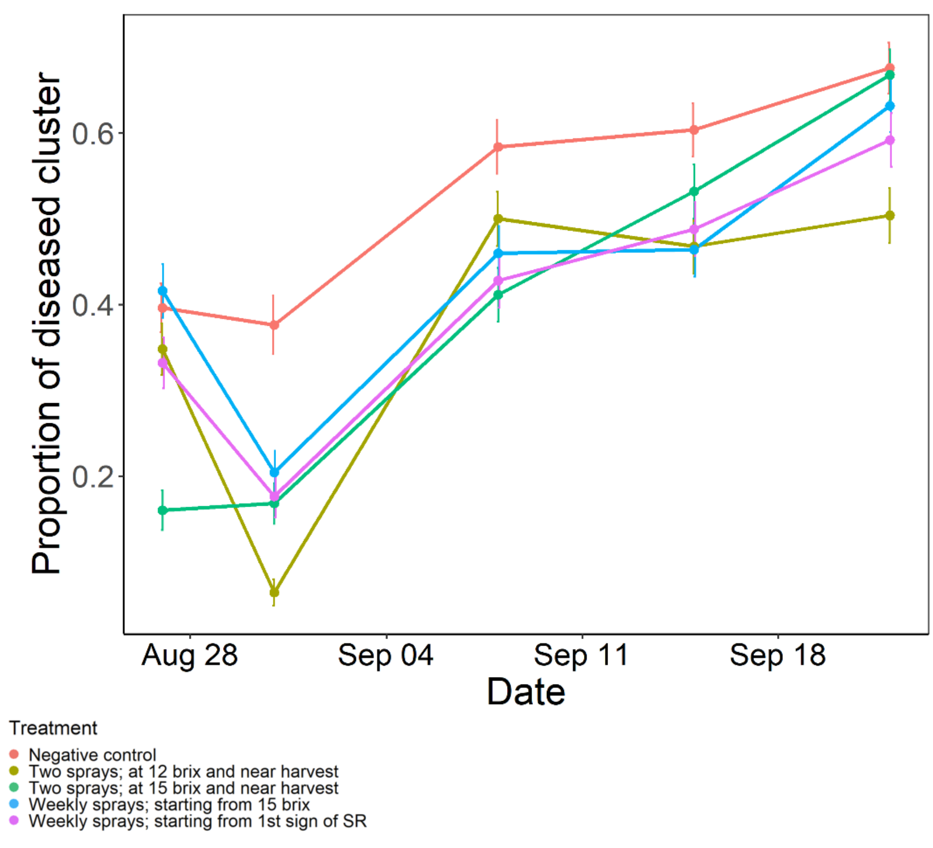


Figure 1 Insecticide timing trial 2021: Proportion of sour rotted cluster

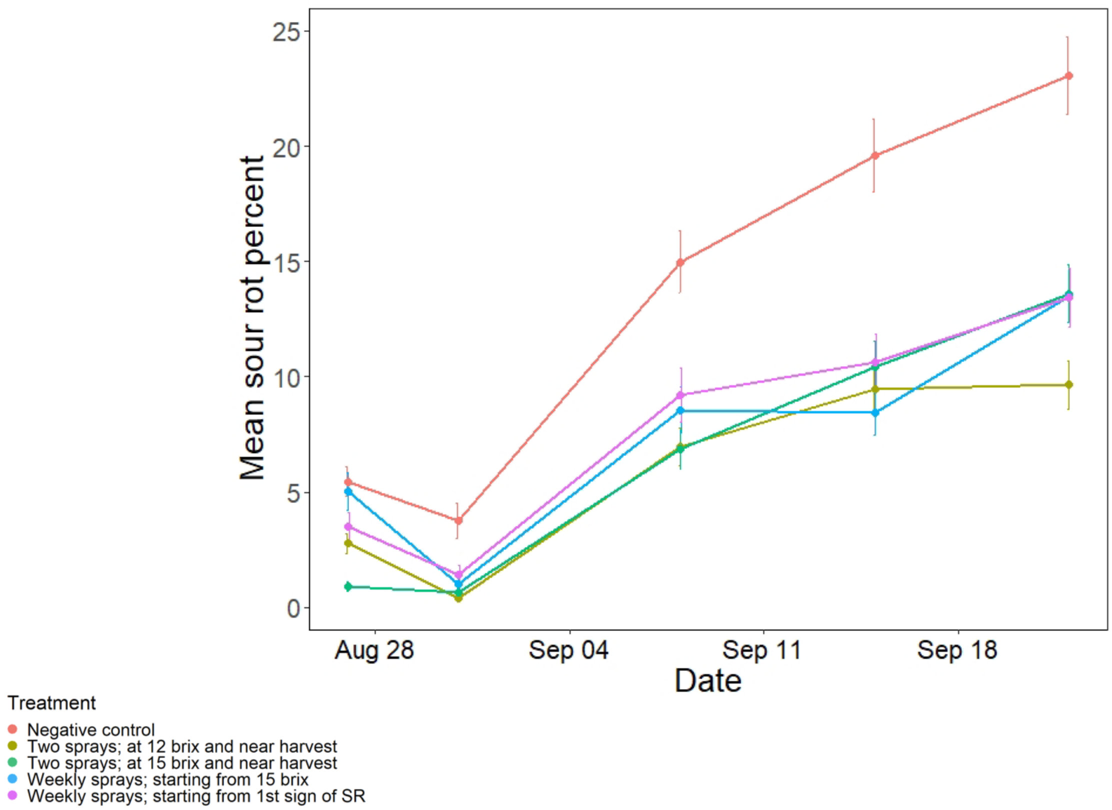


Figure 2 Insecticide timing trial 2021: Percentage of sour rotted clusters.

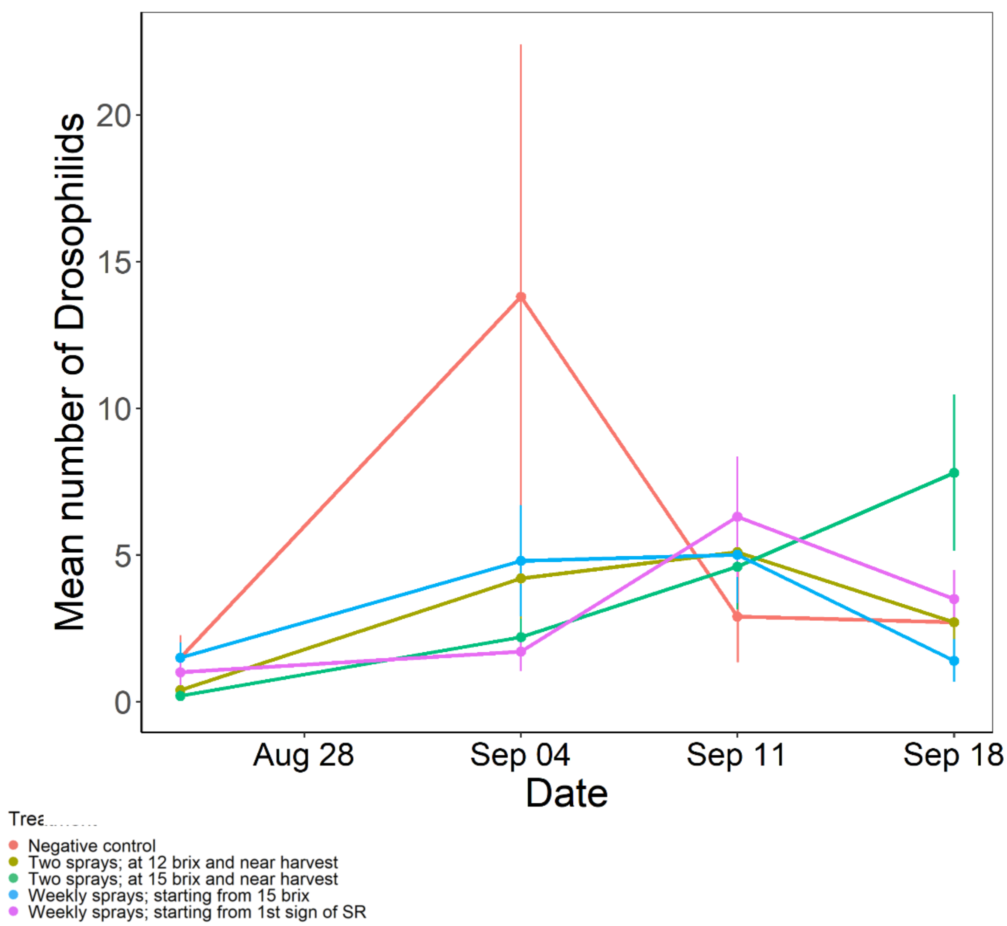


Figure 3 : Figure showing mean number of Drosophilids captured in sticky cards.

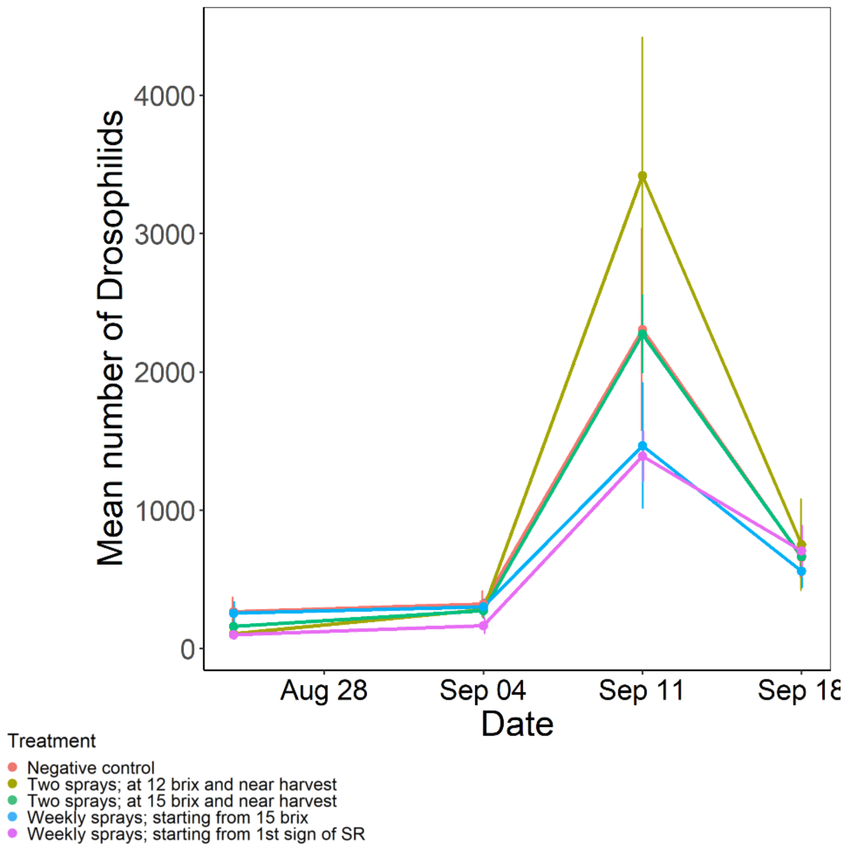


Figure 4. Figure showing mean number of Drosophilids captured in scentry lure.

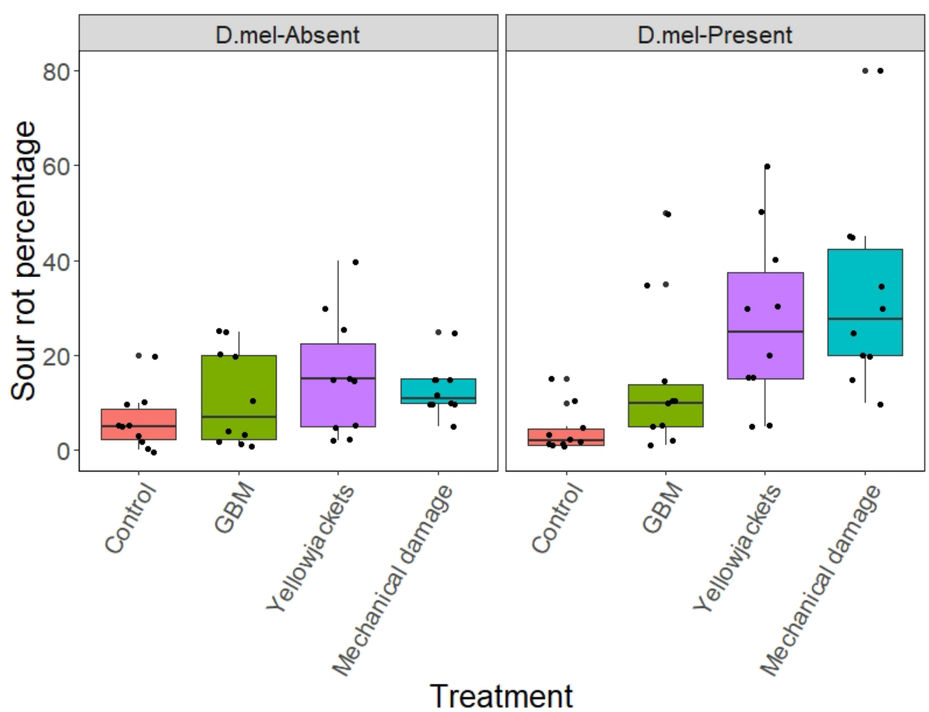


Figure 5 Figure showing mean percentage of sour rot in different treatments from bag experiment.

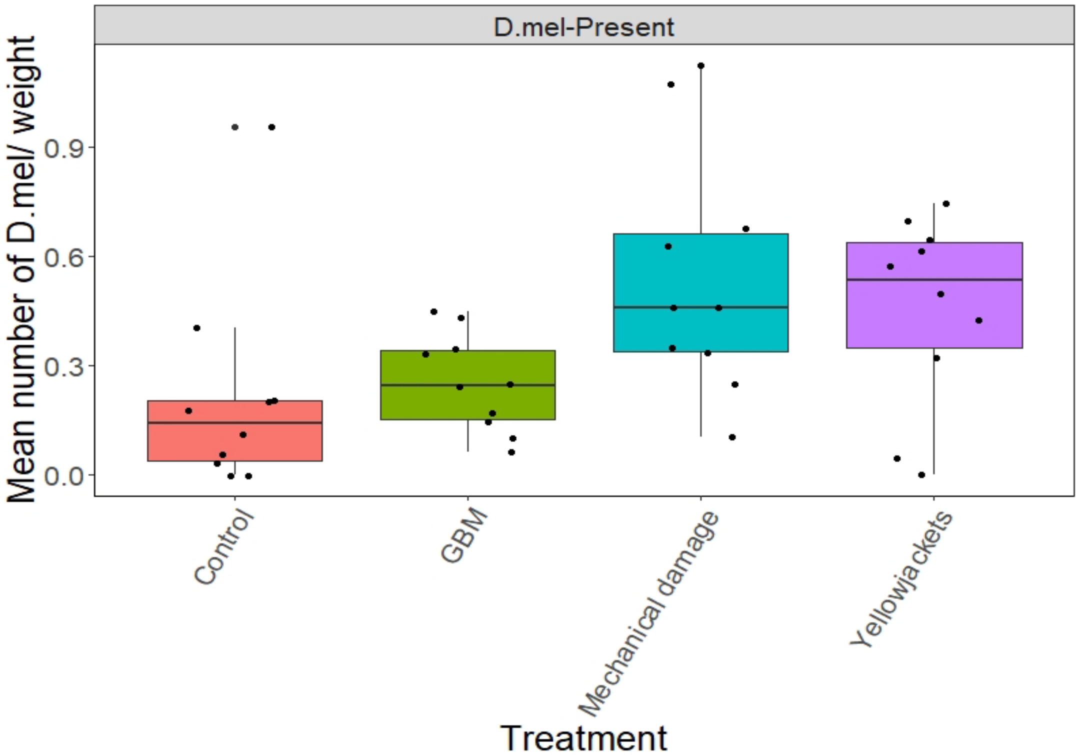
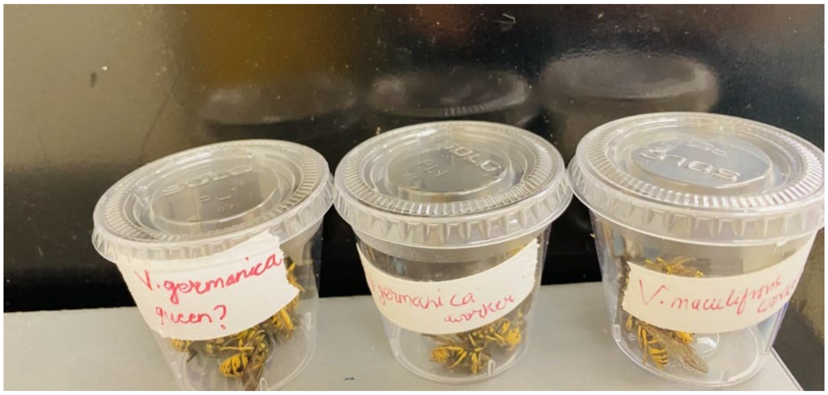


Figure 6 Figure showing mean number of *D. mel* per cluster weight in different treatments from bag experiment.

Row Labels	Sum of observation
Polistes spp.	**4**
Anthony Road	2
Sheldrake Point	2
V. flavopilosa	**1**
Sheldrake	1
V. maculifrons	**24**
Anthony Road	5
Hosmer	10
Sheldrake Point	9
V. germanica	**32**
Anthony Road	3
Hosmer	17
Sheldrake Point	12
Grand Total	**61**

Table 1: Table showing different species of yellowjackets observed in surveys conducted in three locations in the Finger Lakes: Anthony Road winery, Sheldrake Point winery and Hosmer winery.

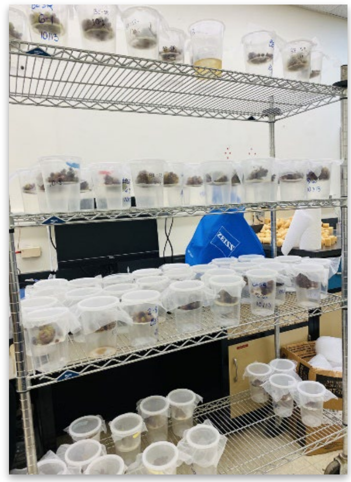
Relevant images



Berries injured by yellowjacket

Yellowjackets survey in Sheldrake

Volatile collection from a healthy cluster



Processing of sticky traps and scentry lure captured fruit flies

Rearing of Drosophilids from samples