Strategies for managing grape pests in North Carolina

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Muscadines are tolerant to many pests of other grape species...this has led to less research & extension focus – We need to revisit this discussion!

Are cutworms & flea beetles significant issues?

Grape rootworm presence throughout the state

Sustainable GRB management strategies (multiyear research needed)

Emerging pests, such as spotted lanternfly
Key extension & research considerations

Faculty are split between multiple commodities

No dedicated technical support

Lack of ability to fund research & extension collaborations beyond one year

Disconnect between research interests and needs/feasibility – Today!
Key insect management questions?

Spotted lanternfly

https://extension.psu.edu/spotted-lanternfly-what-to-look-for
Muscadine grape pests

- Dormant
- Prebloom
- Bloom
- Fruit Growth
- Harvest
- Post harvest

Mites (Rarely)
Green June Beetle (Rarely)
Grape root borers (Rarely)
Cutworms & flea beetles
Japanese beetles (Rarely)
Aphids
Leafhoppers

Feeds on fruit or flowers
Feeds on stems/branches
Feeds on leaves
Potential muscadine pests

- Leafhoppers and other PD vectors (Carlos only)
- Grape berry moth
- Grape rootworm
- Flower thrips (sometimes)

<table>
<thead>
<tr>
<th>Dormant</th>
<th>Prebloom</th>
<th>Bloom</th>
<th>Fruit Growth</th>
<th>Harvest</th>
<th>Post harvest</th>
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</thead>
</table>

Feeds on:
- fruit or flowers
- stems/branches
- leaves
These are NOT grape pests

Grape leaf skeletonizer

Wasps and bees

Spotted wing drosophila*
Wasps and bees

Rarely injure sound fruit, more attracted to damaged fruit
Wasps and bees

Rarely injure sound fruit, also more likely attracted to damaged fruit
Spotted wing drosophila & African fig fly

SWD has been reared from grapes, but unlike in blackberries, raspberries, and blueberries, it is **not** the only *Drosophila* spp. present.

- Laboratory assays conducted in hybrid bunch grapes on 21 and 23 August 2013
- Surface penetration force averaged 76.2 cN (rep 1) and 59.8 cN (rep 2) – We previously observed that SWD may not lay eggs in fruit with penetration forces greater than 52 cN
- No eggs laid in sound fruit (with stem attached)
- No eggs laid in damaged fruit (crushed)
Spotted wing drosophila & African fig fly

When observed, found in previously damaged fruit along with other Drosophila spp.
Host Potential Summary for Spotted Wing Drosophila

<table>
<thead>
<tr>
<th></th>
<th>Blackberry</th>
<th>Blueberry</th>
<th>Cherry</th>
<th>Grape</th>
<th>Peach</th>
<th>Raspberry</th>
<th>Strawberry</th>
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<tbody>
<tr>
<td><strong>Larval Performance</strong></td>
<td></td>
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<tr>
<td>Kurtosis, $\tau_2$</td>
<td>5.13$^B$</td>
<td>2.32$^B$</td>
<td>6.54$^{A,B}$</td>
<td>3.80$^B$</td>
<td>10.80$^A$</td>
<td>5.21$^B$</td>
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<td>Adult fem mass (mg)</td>
<td>1.50$^B$</td>
<td>1.48$^B$</td>
<td>1.80$^A$</td>
<td>1.44$^B$</td>
<td>1.51$^B$</td>
<td>1.83$^A$</td>
<td>1.45$^B$</td>
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<tr>
<td>Mean develop time (d)</td>
<td>10.2$^B$</td>
<td>10.7$^{A,B}$</td>
<td>9.7$^B$</td>
<td>12.1$^A$</td>
<td>10.3$^{A,B}$</td>
<td>10.1$^B$</td>
<td>10.9$^{A,B}$</td>
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<td>D-score</td>
<td>0.75</td>
<td>0.32</td>
<td>1.22</td>
<td>0.41</td>
<td>1.56</td>
<td>0.96</td>
<td>0.63</td>
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<td>$HPI_{17}$</td>
<td>267</td>
<td>221</td>
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<td><strong>Flight Bioassay</strong></td>
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<td>C-score</td>
<td>980.25</td>
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<td><strong>Population Oviposition</strong></td>
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<tr>
<td>Mean SWD/Fruit</td>
<td>6.56$^B$</td>
<td>1.90$^{C-D}$</td>
<td>7.01$^B$</td>
<td>0.43$^D$</td>
<td>0.04$^D$</td>
<td>5.39$^{B,C}$</td>
<td>26.45$^A$</td>
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<tr>
<td>% total emerging</td>
<td>18.6$^B$</td>
<td>8.1$^C$</td>
<td>19.9$^B$</td>
<td>2.4$^C$</td>
<td>0.0$^D$</td>
<td>22.9$^{A,B}$</td>
<td>28.1$^A$</td>
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<tr>
<td>M-score</td>
<td>0.15</td>
<td>0.03</td>
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<td>0.00</td>
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<td><strong>Individual Oviposition</strong></td>
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<tr>
<td>Freq. of Oviposition</td>
<td>0.58</td>
<td>0.57</td>
<td>0.23</td>
<td>0.26</td>
<td>0.00</td>
<td>0.60</td>
<td>0.72</td>
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<tr>
<td>Mean SWD/Fruit</td>
<td>1.32$^{B,C}$</td>
<td>1.74$^{B,C}$</td>
<td>0.89$^C$</td>
<td>0.57$^C$</td>
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<td>3.54$^{A,B}$</td>
<td>5.11$^A$</td>
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<td>Standardized SWD/Fruit</td>
<td>2.63$^B$</td>
<td>5.23$^{A,B}$</td>
<td>2.66$^B$</td>
<td>1.71$^B$</td>
<td>0.00$^B$</td>
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<td>5.11$^{A,B}$</td>
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<td>M-score</td>
<td>0.51</td>
<td>1.07</td>
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<td>0.12</td>
<td>0.00</td>
<td>1.56</td>
<td>2.10</td>
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<td>$HPI_{14}$</td>
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<td>283</td>
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<td><strong>Overall HPI</strong></td>
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<td>$HPI_{total}$</td>
<td>274.9</td>
<td>251.7</td>
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<td>232.4</td>
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<td>Host Potential Ranking</td>
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<td>4</td>
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</table>

Row values not connected by the same letter are significantly different (Tukey-Kramer HSD, $\alpha = 0.05$)

Summary of results for all four studies examining host potential for spotted wing drosophila.

doi:10.1371/journal.pone.0061227

http://journals.plos.org/plosone/article?id=info:doi/10.1371/journal.pone.0061227
Spotted wing drosophila & African fig fly

What about secondary damage?

*European studies have suggested greater native drosophila presence and Botrytis infection in clusters previously attacked by SWD*

*But...this has not been related to crop loss*
What about stink bugs?

Issue
Grapes with brown, dried seeds
Growers are concerned that this type of damage may be due to stink bug feeding.

However, stink bug feeding causes external fruit damage, usually with a “corky” mass underneath. (Photos, below: University of California IPM).
What about stink bugs?

Issue

Targeting insects such as stink bugs and Japanese beetles with insecticides can cause other problems. Applications of broad spectrum insecticides, such as pyrethroids, can flare mite populations. Miticides should be used for mites, if needed. Grape miticides include: Zeal, Portal, Acramite, Agri-Mek, Nexter, Vendex, Envidor, and Onager.

Twospotted spider mite populations in strawberries following artificial infestation (red arrow) and chemical application (blue arrow). Note the dramatic increase in mites in plots treated with bifenthrin.
Identifying, monitoring, and managing key grape pests – METHODS

General sampling methods
Sample at least 20 vines, randomly distributed throughout your vineyard. These recommendations and sample sizes are based on California research unless otherwise noted, as little sampling research has been conducted in North Carolina. Sampling should be conducted weekly during the growing season, and at least twice during the dormant season.
Identifying, monitoring, and managing key grape pests - BLOOM

What?
Thrips, primarily eastern flower thrips

How?
Tap one cluster per vine on a white piece of paper and count the number of adults & larvae using a 10x hand lens

Then?
Note increasing populations and consider treating when numbers are >25/cluster. No research based threshold for muscadine grapes has been developed

Western flower thrips (*Frankliniella occidentalis*, top) and Eastern flower thrips (*Frankliniella tritici*, bottom) are the most likely species present in grape blooms. (UC IPM and U FL photos)
What? 
Grape berry moth

How? 
Observe all clusters on scouted vines. Monitor adults with pheromone traps. Then?

Grape berry moth damage is relatively uncommon in NC. 3 to 4 generations occur per year, first generation not main management target. NY threshold 2% of clusters infested. Mating disruption (200 lures/acre) can be highly effective/

(Michigan State University photos)
Identifying, monitoring, and managing key grape pests – MID SUMMER THROUGH HARVEST

**What?**
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(Michigan State University photos)
Identifying, monitoring, and managing key grape pests – MID SUMMER THROUGH HARVEST

**What?**

*Grape root borer*

Endemic to the eastern US
Oligophagous on Vitaceae (grape)
Eggs laid above-ground
Neonates burrow to find roots
Larvae mine the root cortex
Vines express symptoms similar to those from other conditions
"Slow vine decline"
  - reduced cane growth
  - smaller leaves & berries
  - fewer bunches
  - susceptibility to winter injury
  - potential vine death

(University of Kentucky photos)

(Information via Chris Bergh, Virginia Tech University)
Identifying, monitoring, and managing key grape pests – MID SUMMER THROUGH HARVEST

How?

Pheromone traps
- Highly effective for GRB
- Proxy for relative differences size of local populations

Pupal exuviae monitoring
- Non-destructive means to confirm vine infestation

(Information & images via Chris Bergh, Virginia Tech University)
• GRB pupal cases found in 47 of 50 blocks sampled
• Large variation in number of pupal cases per vine

Rijal et al. 2014. Effects of biotic and abiotic factors on grape root borer (Lepidoptera: Sesiidae) infestations in commercial vineyards in Virginia. Environ. Entomol. 43: 1198-1208

(Information & images via Chris Bergh, Virginia Tech University)
Mean ± SE % of total exuviae (2008 – 2012)

73.6%

Sufficient to sample during peak emergence

(Information & images via Chris Bergh, Virginia Tech University)
Pupal exuviae were found to be spatially aggregated in vineyard blocks in which mean pupal exuviae densities were ≥ 0.5 per vine.

Vines infested by grape root borer larvae were aggregated within a mean distance of 8.8 ± 2.7m.

Based on sampling from 2008–2012, weekly sampling throughout the 3 or 4 wk period of peak emergence should provide a reasonable estimation of GRB abundance in most seasons, with least effort.

We recommend a grid of sample vines (~9 m apart) constituted of vines in every second row and of a minimum of 50 vines per vineyard block of average size (~1–2 ha).
Captures varied widely among all vineyards, including among those within production regions.
qPCR revealed variation in *H. bacteriophora* abundance within and among production regions (combined data from June and July samples)
Spearman’s analysis:
P = 0.3337
Captures were not correlated with total vineyard acreage

Spearman’s analysis:
P = 0.0997
Captures were not correlated with age of oldest vines
Conclusions

• GRB and *H. bacteriophora* abundance varied within and among vineyard production regions
• Strongest predictors of GRB abundance were *H. bacteriophora* presence assessments from July and vineyard soil clay content
• Optimal regression model of GRB abundance included vineyard clay content, *H. bacteriophora* abundance in July, and their interaction, explaining 62% of the variability in GRB abundance
• Including additional variables in the model, such as other measures of soil texture and vineyard area, did not improve explanatory power

(Information & images via Chris Bergh, Virginia Tech University)
What?

Grape rootworm
Two species:
*Fidia viticida* and *F. longipes*
Two year life cycle
Larvae feed on roots
Adults feed on leaves, creating a distinctive “chain link” pattern

Images via [http://www.virginiafruit.ento.vt.edu/rootworm.html](http://www.virginiafruit.ento.vt.edu/rootworm.html)
Muscadines are tolerant to many pests of other grape species...this has led to less research & extension focus – We need to revisit this discussion!