So Your Mosquitoes are Resistant Now What?

CHARLES ABADAM
SUFFOLK MOSQUITO CONTROL
2018

- Training
  - CDC, Dr. Janet McAllister

- Preparation
  - Equipment
    - Bottles, pooters, pipettes, mixing tubes, disposables, etc.
Pesticides

- **Group 1**
  - Organophosphates
    - Chlorpyrifos
    - Malathion
    - Naled
  - Pyrethroids & Pyrethrins
    - Permethrin
    - Sumithrin
    - Prallethrin
    - Deltamethrin
    - Etofenprox
2018

- Mosquitoes
  - *Aedes albopictus* (DT1, 3, & 4)
    - Field caught
  - *Culex pipiens* (DT 1, 3+4; NW1+3; NE1+3)
    - Egg rafts

- Implementation
  - Beginning (*Aedes albopictus*, Asian Tiger Mosquito)
  - Middle (*Culex pipiens*, Southern House Mosquito)
  - End (*Aedes albopictus*)

- Results
  - Susceptible
  - Resistant
WHO recommendations for assessing the significance of detected resistance:

- 97%–100% mortality at the recommended diagnostic time indicates susceptibility;

- 90%–96% mortality at the recommended diagnostic time suggests the possibility of resistance that needs to be confirmed;

- <90% mortality at the recommended diagnostic time suggests resistance.

**Note:** Where <95% mortality occurs at the diagnostic time in bioassays that have been conducted under optimum conditions and with a sample size of >100 mosquitoes, then resistance can be strongly suspected.
### 2018 Results

- **June, July, & August**

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<thead>
<tr>
<th>Zones</th>
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<tr>
<td></td>
<td>Permethrin</td>
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<tr>
<td><strong>Ae albopictus</strong></td>
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<tr>
<td>DT 1</td>
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<td>DT 3+4</td>
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<td><strong>Cx pipiens</strong></td>
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<td>DT 1</td>
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<td>DT 3+4</td>
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<td>NW 1+3</td>
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<td>NE 1+3</td>
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Why So Stressed
What to do? What to do?
## 2018 Follow Up Testing & Results

### October & November

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<td>DT 1</td>
<td>Chlorpyrifos</td>
<td>October &amp; November</td>
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<td>DT 3</td>
<td>Deltamethrin</td>
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<td>DT 4</td>
<td>Etofenprox</td>
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Aedes albopictus
(Asian Tiger Mosquito)

- Susceptible to every adulticide it was tested against
- We could use any adulticide in stock
  - DUET – prallethrin, sumithrin
  - Envion – permethrin
- Target Ae albopictus using handheld adulticide sprayers
  - Trap to identify problem areas
  - Spray to reduce problem
  - Trap again to verify population decrease
Culex pipiens
(Southern House Mosquito)

- Resistant to all regularly ground applied adulticides
  - Group 1
    - chlorpyrifos (DT1 resistant), malathion
  - Group 3
    - permethrin, prallethrin, sumithrin, deltamethrin, etofenprox,
- Susceptible to only one group of adulticides
  - Group 1
    - naled, chlorpyrifos (DT3 susceptibility)
Naled (Dibrom)

- Organophosphate (Group 1)
  - Binds to Acetylcholine esterases which in turn effects the central and peripheral nervous system
- Most commonly used as an aerial adulticide
- Can be sprayed from a truck but...
  - No one in the United States is using it this way
  - AMVAC advises against it due to an increased health hazard
- Didn’t want to defy all the recommendations and be the ONLY program in the U.S. to operate in this manner
- Also with regular registration review of Naled by the EPA, we didn’t want to risk more scrutiny of the product by any negative effects that we could possibly incur
So many questions?

- What would we do about Cx. *pipiens*?
  - We would not adulticide for 2019 with the hope of susceptibility to any pesticide would return
  - Focus our efforts on solely larvaciding this mosquito, will this be a reliable solution
  - In an emergency situation we decided that we would use chlorpyrifos
    - Chlorpyrifos was not registered in VA
- If we treated *Ae. albopictus* with the adulticides we have in stock would we inadvertently increase Cx. *pipiens* resistance to our Group 3 adulticides (permethrin, prallethrin, sumithrin)?
  - Partly because of this question we thought it would be best not to adulticide for this species in 2019
What would adulticide operations look like?

- Only adulticide *Ae albopictus* with handheld treatments
- No adulticiding for *Cx pipiens*
- Other species would be sprayed based on abundance
  - *Aedes Canadensis*
  - *Coquillitedia perturbans*
  - *Culex erraticus*
  - *Culex salinarius*
  - *Psorophorans (ciliate, columbiae, ferox, howardii)*

Moving forward

- Continue annual resistance testing
- Cage Field Trials
2019

- Implemented the testing

- Mosquitoes Tested
  - *Ae Albopictus* from DT1 & DT3/4
  - *Cx pipiens* from DT1, DT3/4, NW3, & NE1

- Pesticides tested against mosquitoes
  - Chlorpyrifos
  - Permethrin
  - Prallethrin
  - Sumithrin
## Results

### May & June

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<td>NW 3</td>
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Eureka!!!
Thresholds for Adulticide Operations

- Positive mosquito pools
  - WNV – site/zone would be sprayed
    - Cx. pipiens - 2-3 days consecutively
    - Ae. albopictus - 2-3 days consecutively
  - EEE – site/zone would be sprayed
    - Cs. melanura – 1-3 days consecutively
    - Ae. albopictus – 2-3 days consecutively

- Abundance thresholds
  - Cx. pipiens/restuans - 50 mosquitoes
    - Adulticide with chlorpyrifos in spray truck
  - Ae. albopictus – 100 male/female total
    - Adulticide with chlorpyrifos in spray truck
  - Ae. albopictus – 300 male/female total
    - Adulticide with DUET (prallethrin & sumithrin) in a handheld sprayer
### November

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**Results**
Tested DUET handheld sprays

- *Ae. albopictus* populations
  - Trap – Spray – Trap
    - BG Sentinel Traps primarily
  - 2018 limited spray missions but very effective
  - 2019 increased spray missions and monitoring
    - Used abundance thresholds
    - 27 spray missions over 10 sites (urban, suburban, rural)
    - 26 missions significantly decreased *Ae. albopictus* populations
      (Paired t-Test, p = 5.777E-09)
  - **Note** – 6 Gravid Traps were set along with BG traps for a few sprays and saw a decline in Cx. pipiens/restuans
Tested Chlorpyrifos

- Trap – Spray – Trap
  - 2019 spray missions
    - Used abundance thresholds
    - 20 spray missions across 7 sites (urban, suburban)
    - *Ae. albopictus* showed a significant decrease in the population across the missions (Paired t-Test, p = 0.0002)
    - *Cx. pipiens* showed a significant decrease in the population across the missions (Paired t-Test, p = 0.02)
      - When the spray mission was within 1hr +/- sunset
      - Sprays within the peak activity hours of *Cx. pipiens* 1 hr +/- sunrise and sunset are most effective
Larvaciding & WALS Spraying

- Increasing larvicide applications to target Cx. pipiens
  - It’s the obvious choice to target catch basins
  - Our larval surveillance is giving us mixed results
  - So impact on the adult population is questionable

- WALS Spraying
  - Wide Area Larvicide Spraying
  - 2018 Bioassay performed for proof of concept
    - 10 sites with 4 bottles each (open, sparse, dense, and covered)
    - 10 controls
    - Urban sites in Downtown Suffolk
    - Results: Open 86%, Sparse 63%, Dense 75%, Covered 84% Overall mortality of 77%
2019 field study
- 4 sites 3 jars (open, sparse, dense)
- 2 control sites with 2 jars at each
- 4 replicates
  - Replicate 1: 54% (O), 23% (S), and 34% (D) with 3% mortality in both controls
  - Replicate 2: 2% (O), 0% (S), 1% (D) with 0% mortality in both controls
  - Replicate 3: 53% (O), 36% (S), 36% (D) with 4% mortality in both controls
  - Replicate 4: 2% (O), 10% (S), 24% (D) with 3% mortality in one control and 0% in the other

Unfavorable Results
- Difficult Spray to apply scheduling and weather play a huge role in a successful spray
Acknowledgements

- My Motley Crew
  - Karen Akaratovic
  - Junior Harrel
  - Ann Herring
  - Jay Kiser
  - Cassidy Mckelvie
  - Kaitlyn Price
  - Alex Riley
  - Richard White