Chemical ecology of the Hibiscus bud weevil

A. Daniel Greene, Yisell Velazquez Hernandez, German Vargas, Owen MacManes, Kevin Cloonan, Micah Gill, Nurhayat Tabanca, Elena Schnell, Barukh Rohde, Paul E. Kendra, and Alexandra M. Revynthi

Chemical Ecology?

- Behavior-modifying compounds

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- **Pheromones**: volatile organic molecules that cause a behavioral response in individuals of the same species

Chemical Ecology?

- Behavior-modifying compounds
- Incorporated into many IPM programs

- **Pheromones**: volatile organic molecules that cause a behavioral response in individuals of the same species

- May reduce broad-spectrum insecticide usage
- Protect non-target organisms
- Relatively low cost
- Reduced toxicity

Chemical Ecology?

- **Pheromones**
  - Monitoring
  - Mating disruption
  - Mass trapping
  - Attract-and-kill

Chemical Ecology?

- Pheromones
- ***Attractive effect can be enhanced***
- Combining pheromone lures with host plant volatile blends

Boll weevil, *Anthonomus grandis*

- Cotton industry → early 20th century

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- Breakthrough in Boll weevil management
- Release of synthetic aggregation pheromone
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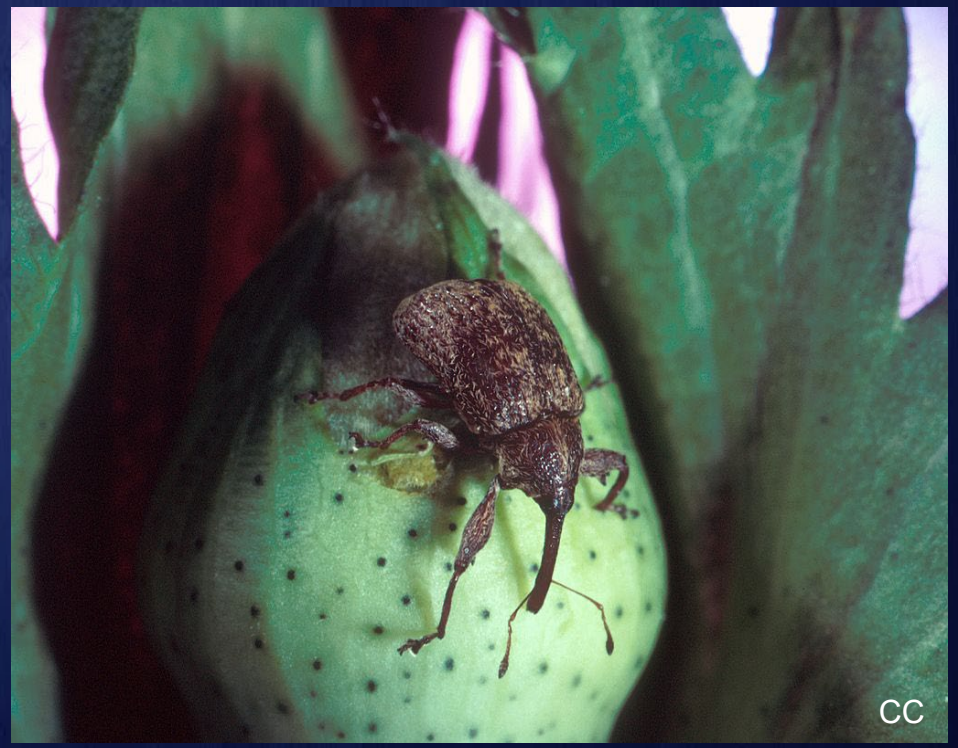

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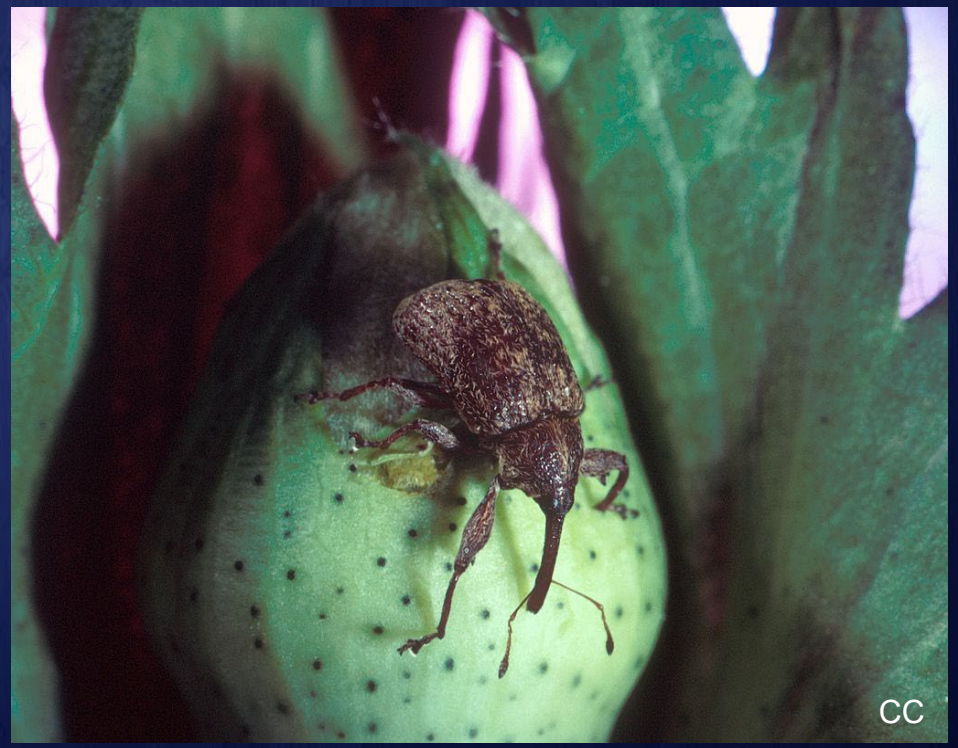
- Breakthrough in Boll weevil management
- Release of synthetic aggregation pheromone
  - ‘grandlure’
- Grandlure→ pheromone traps
  - In eradication trials



Overall goal: Develop an effective lure and trap design for use in HBW monitoring programs

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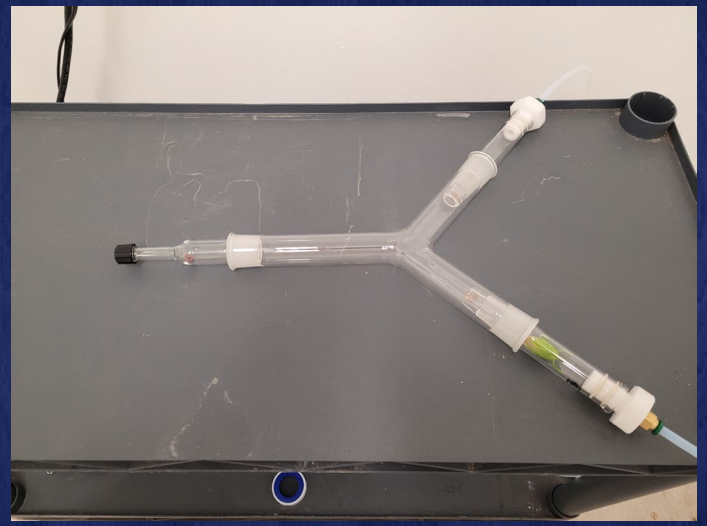
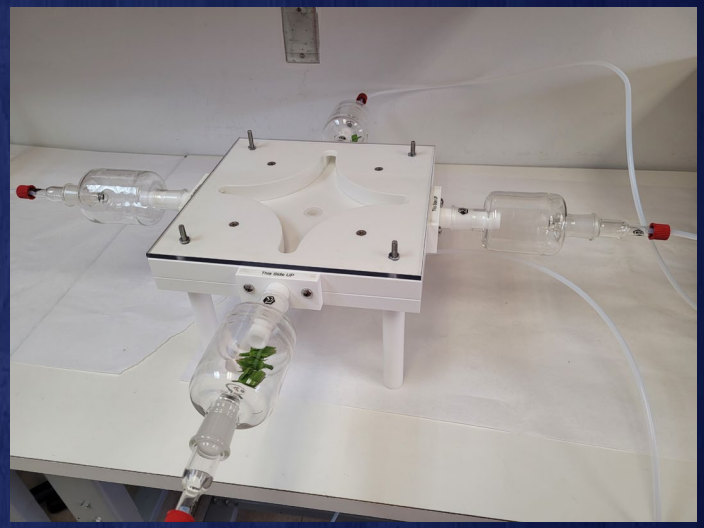
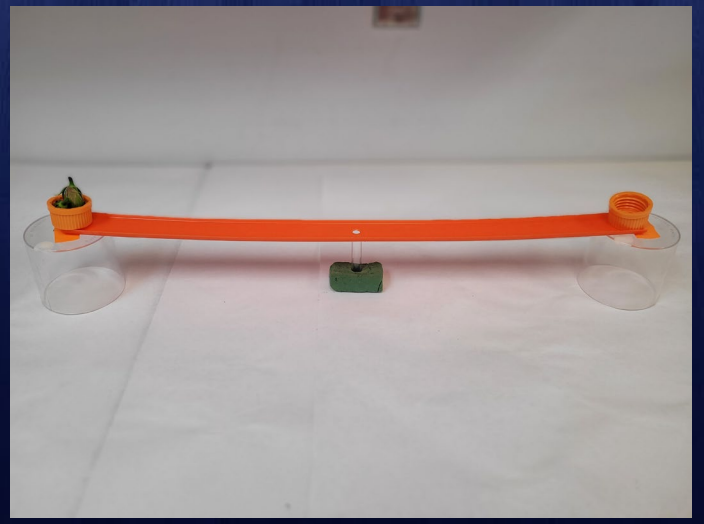
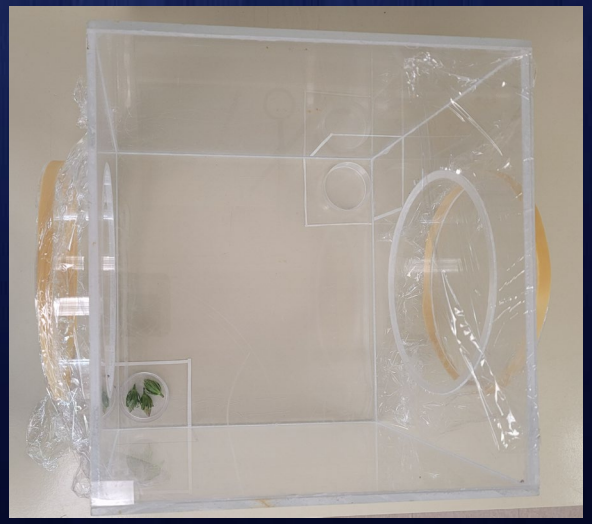
Step 1: Identify an appropriate bioassay system to test HBW attraction to lures and volatiles









Overall goal: Develop an effective lure and trap design for use in HBW monitoring programs

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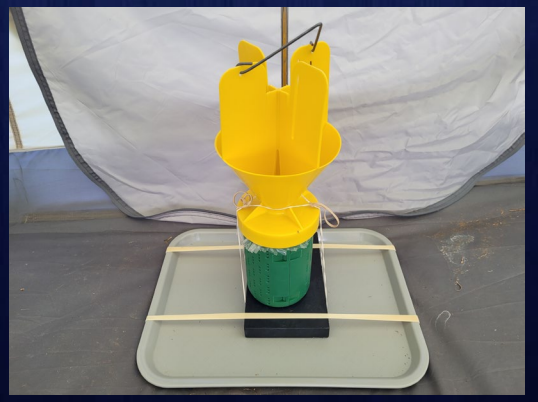
Step 1: Identify an appropriate bioassay system to test HBW attraction to lures and volatiles

Step 2: Test lures, volatiles, and traps in semi-field settings



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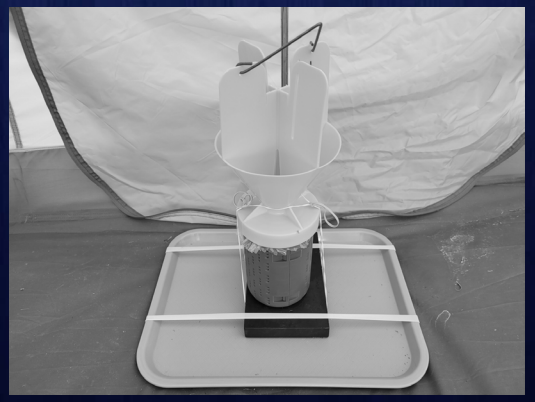

Step 1: Choosing a bioassay system

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- What we know: HBW can feed and complete development on hibiscus buds

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- What we know: HBW can feed and complete development on hibiscus buds
- What don't we know: Which *Anthonomus* spp. lures and hibiscus volatiles are HBW attracted to?
- Used 'Painted Lady' variety hibiscus buds as the lure

Step 1: Choosing a bioassay system

- Need a system to measure HBW attraction to *Anthonomus* spp. lures and hibiscus volatiles
- **How do we know if our system works?**
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Anthonomus spp. aggregation pheromones

Boll weevil
A. grandis

Cranberry weevil
A. musculus

Pepper weevil
A. eugenii

Strawberry blossom weevil
A. rubi

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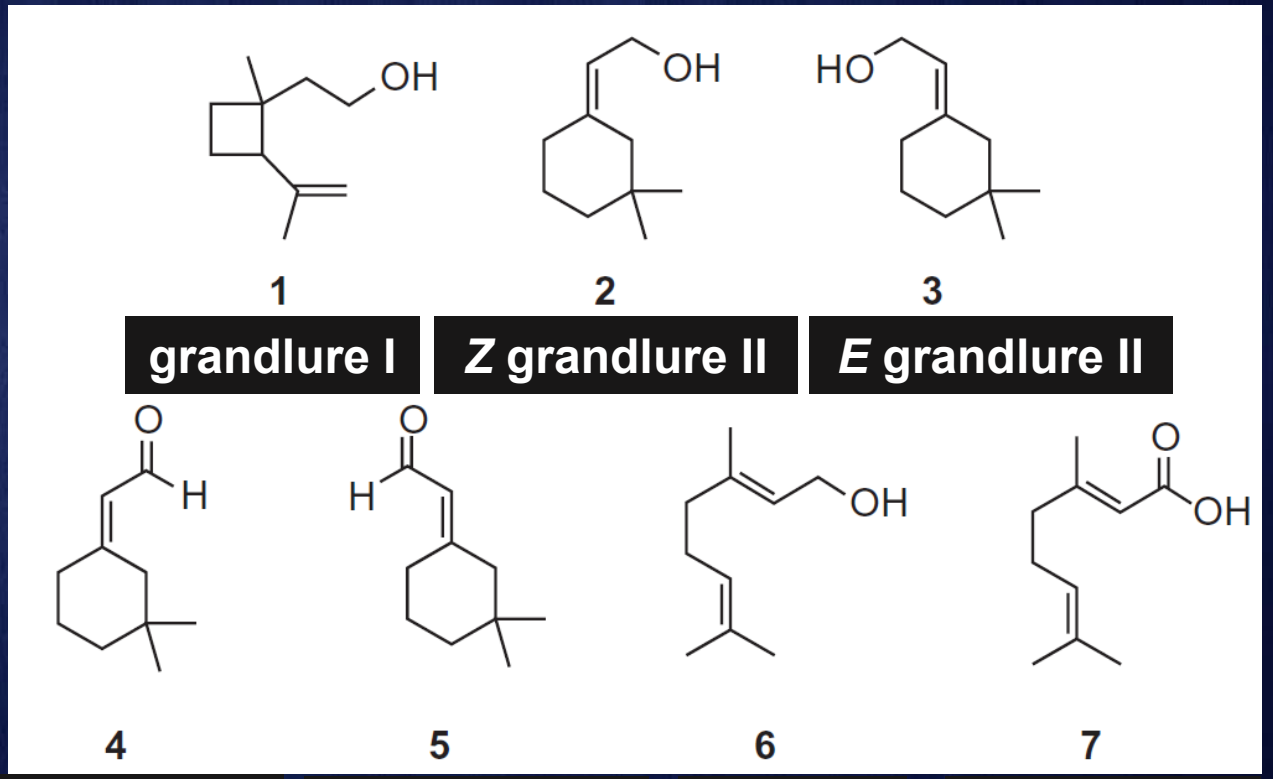
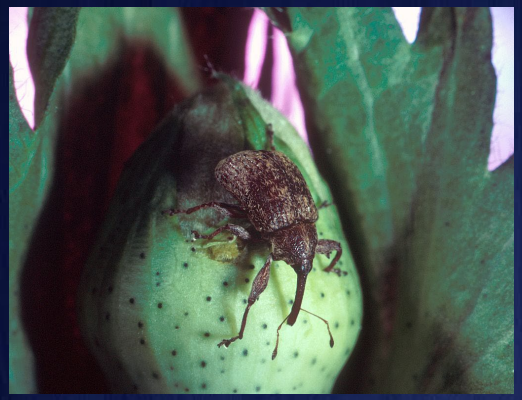


Anthonomus spp. aggregation pheromones



Boll weevil
A. grandis

- *Z* grandlure II

Cranberry weevil
A. musculus

- *Z* grandlure II

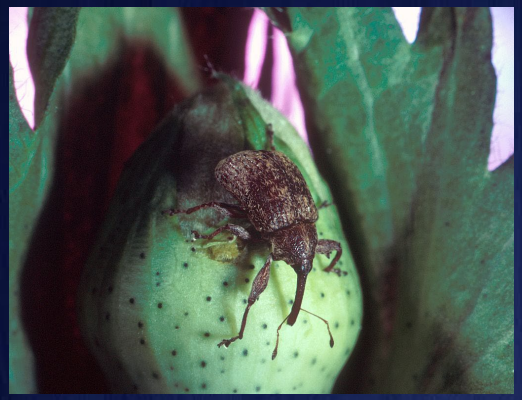
Pepper weevil
A. eugenii

- *Z* grandlure II

Strawberry blossom weevil
A. rubi

- *Z* grandlure II

Anthonomus spp. aggregation pheromones



Boll weevil
A. grandis

- *Z* grandlure II
- grandlure III
- grandlure IV

Cranberry weevil
A. musculus

- *Z* grandlure II
- grandlure III
- grandlure IV

Pepper weevil
A. eugenii

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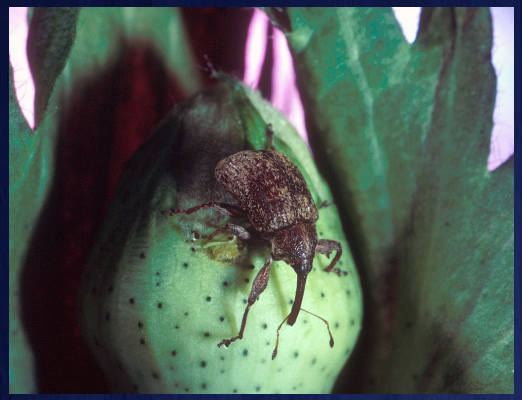
- grandlure IV

Strawberry blossom weevil
A. rubi

- *Z* grandlure II

Anthonomus spp. aggregation pheromones



Boll weevil
A. grandis

- *Z* grandlure II
- grandlure III
- grandlure IV
- grandlure I

Cranberry weevil
A. musculus

- *Z* grandlure II
- grandlure III
- grandlure IV
- geraniol

Pepper weevil
A. eugenii

- *Z* grandlure II
- grandlure III
- grandlure IV
- *E* grandlure II
- geraniol
- geranic acid

Strawberry blossom weevil
A. rubi

- *Z* grandlure II
- grandlure I
- lavandulol

Step 1: Choosing a bioassay system

- Three olfactometer types

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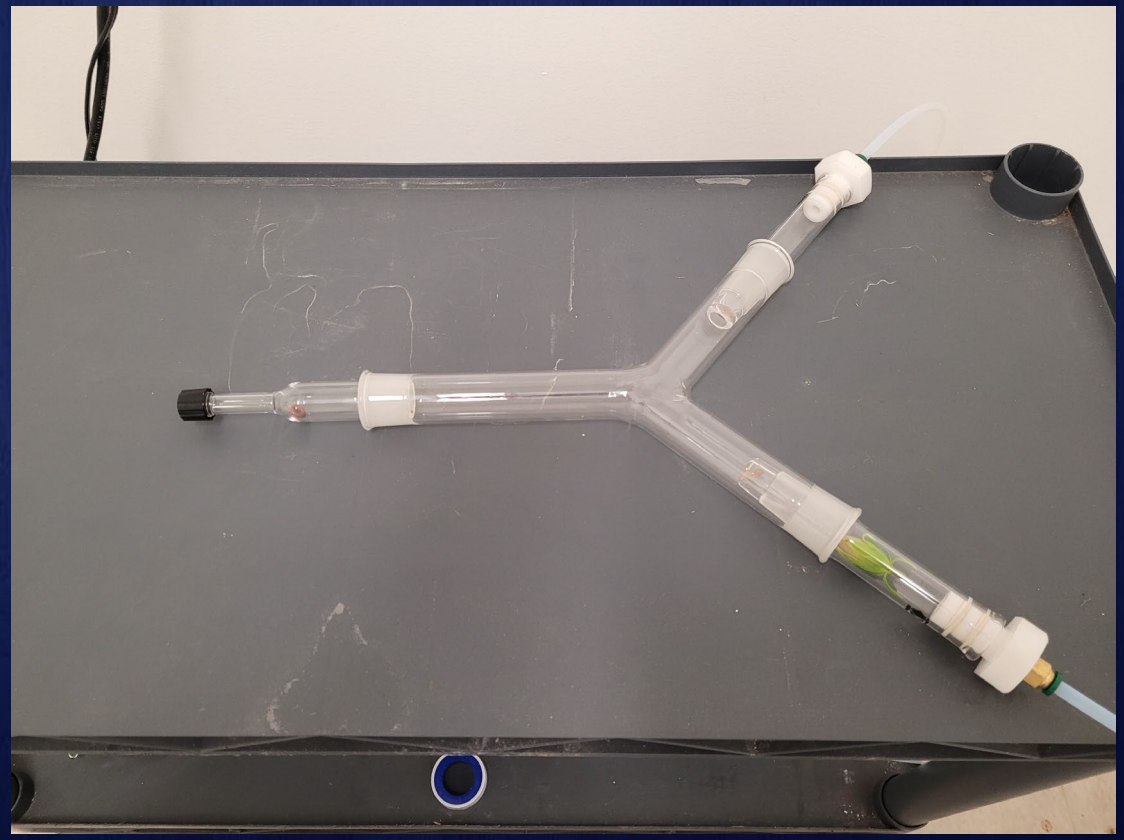
  - Y-tube



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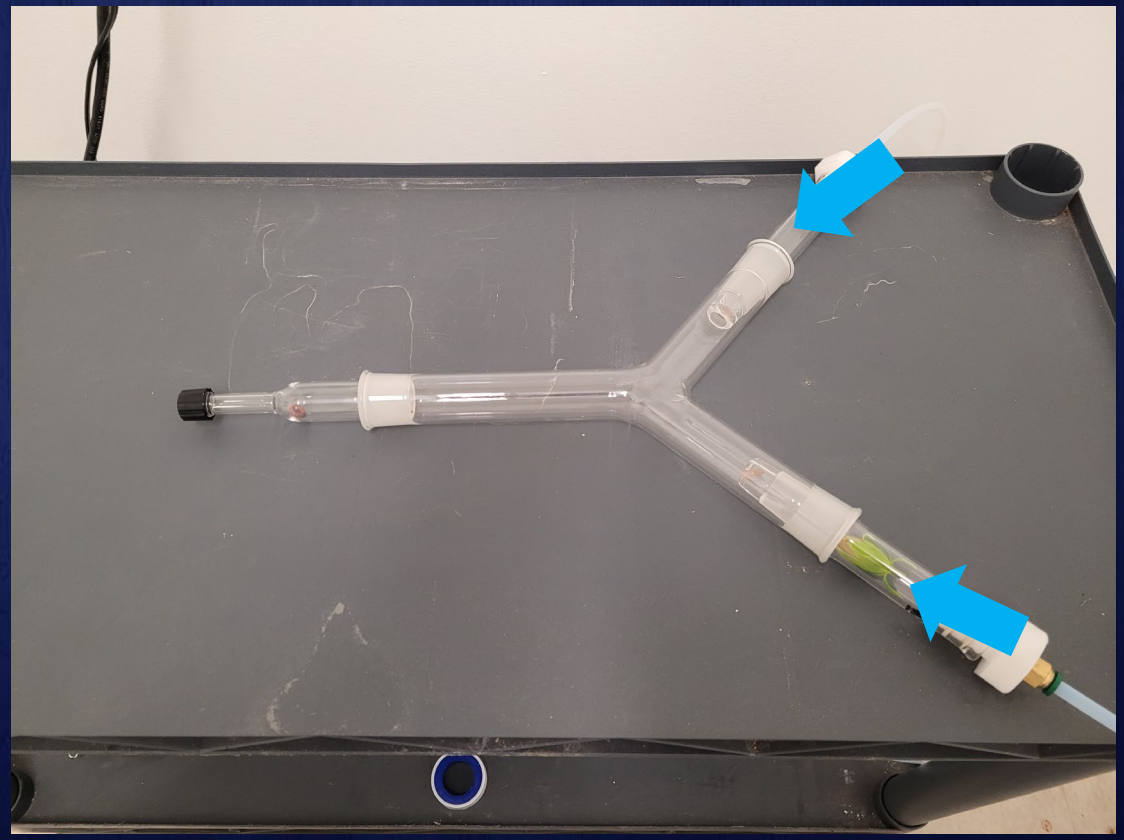

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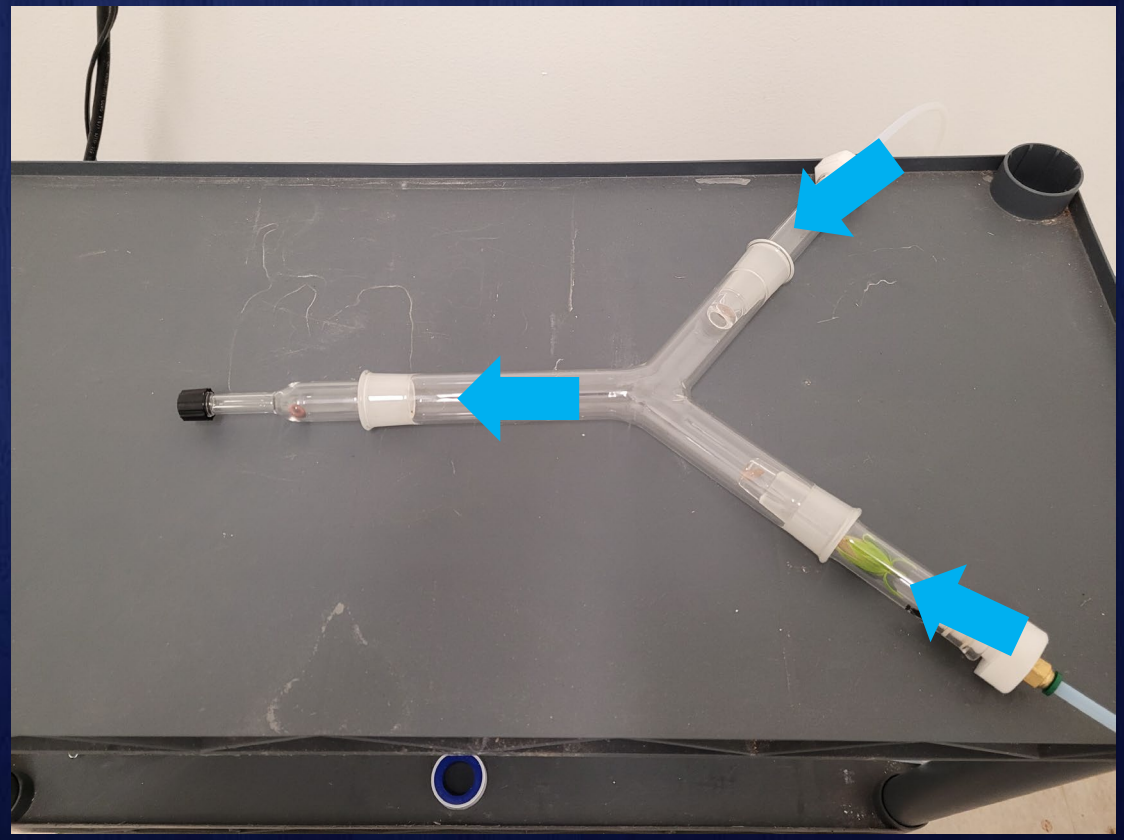

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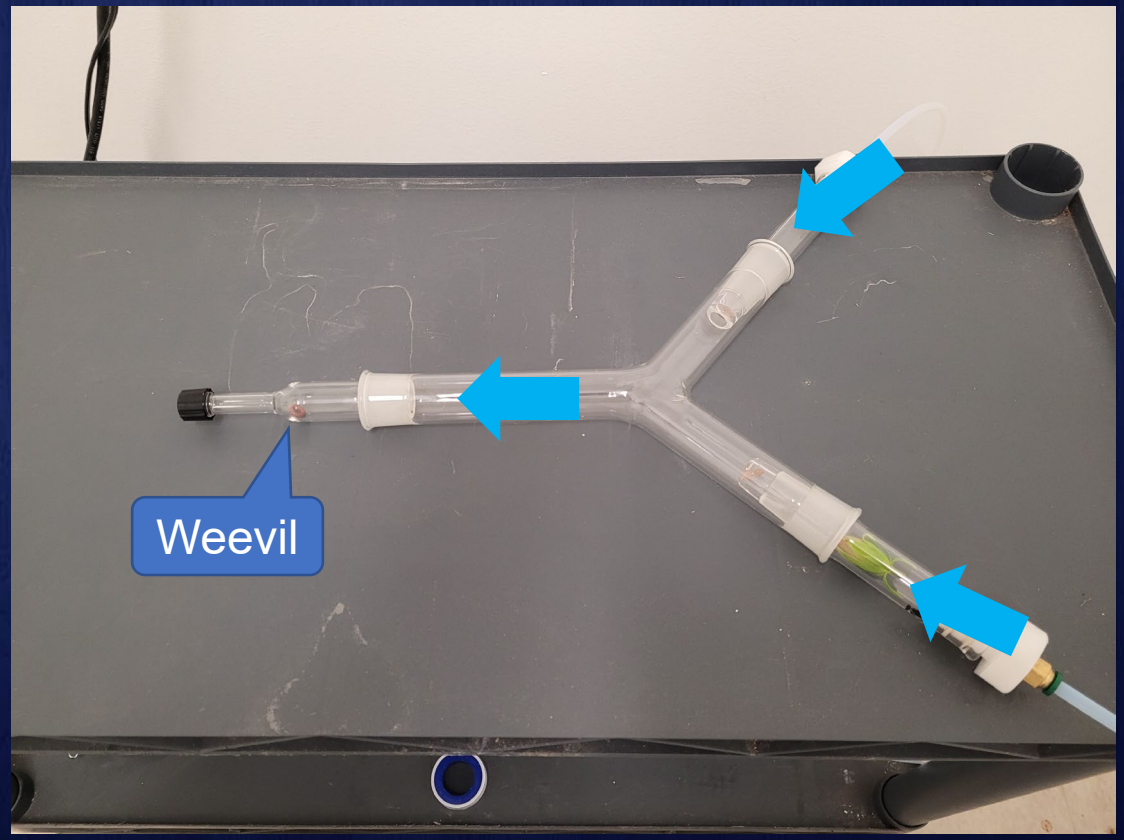
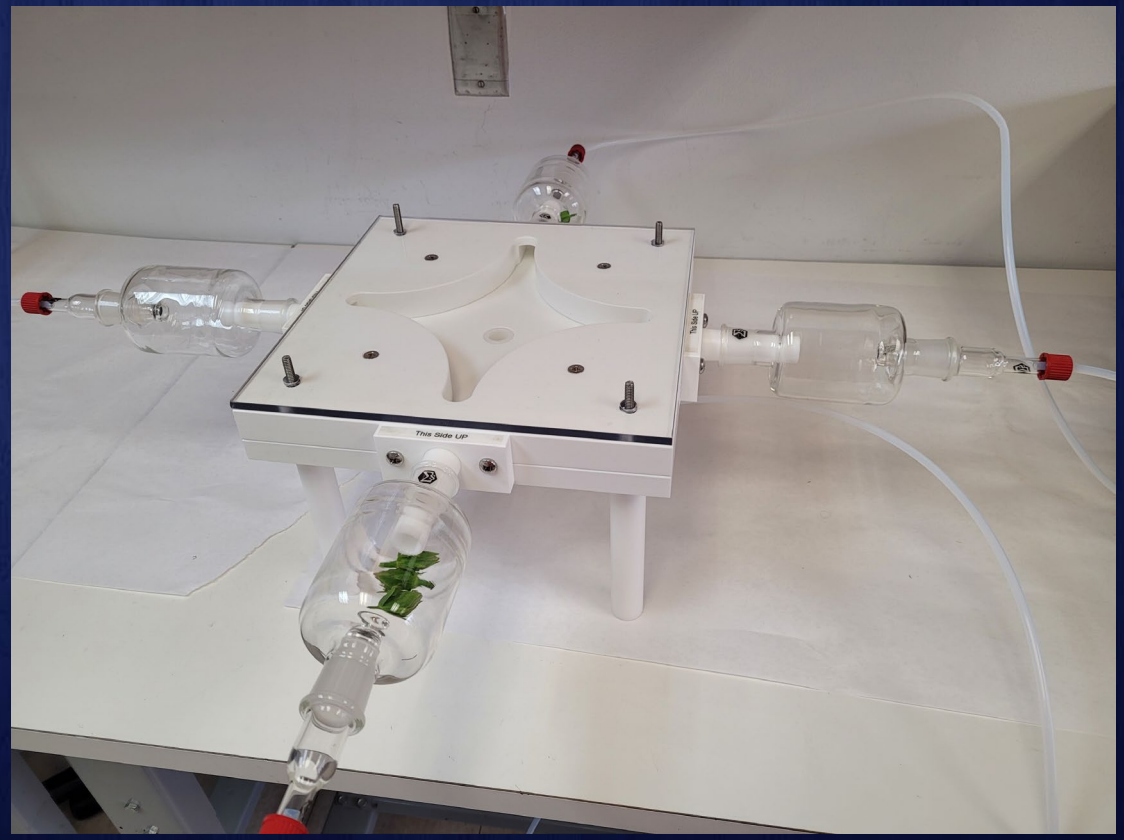


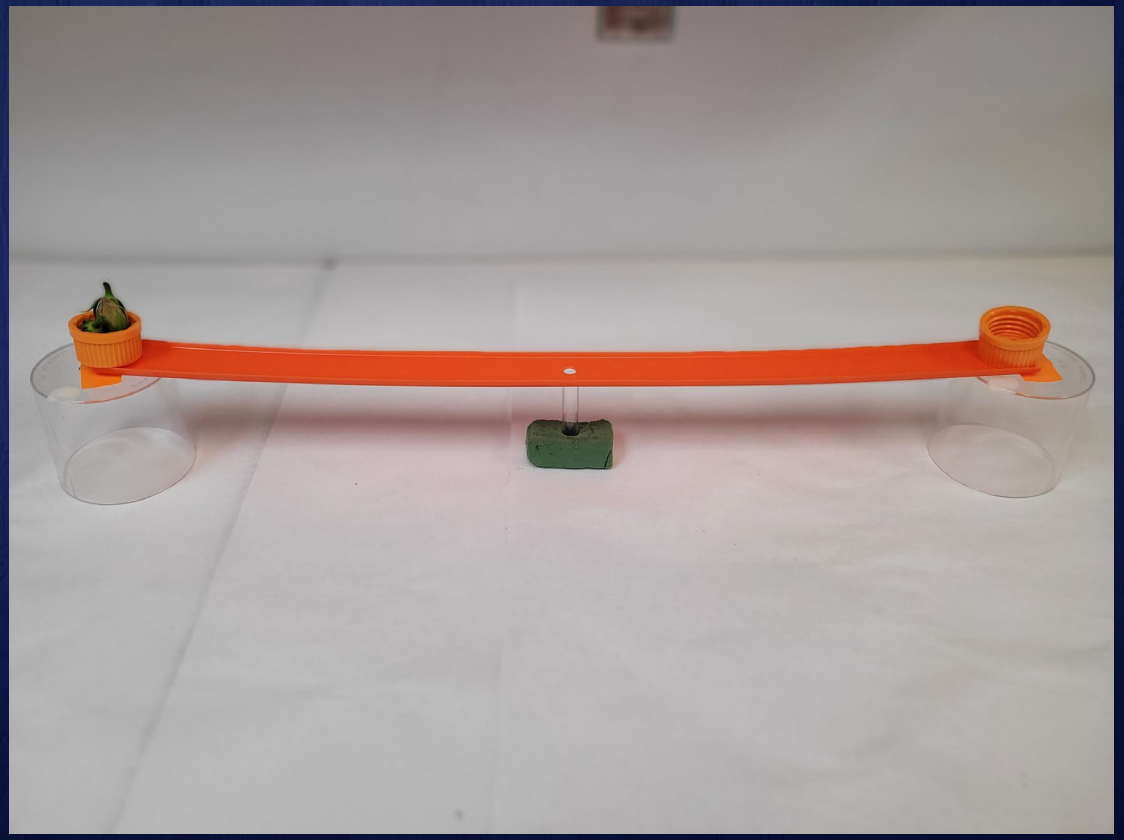
Step 1: Choosing a bioassay system

- Three olfactometer types
  - Y-tube
  - Four-way



Step 1: Choosing a bioassay system

- Three olfactometer types
  - Y-tube
  - Four-way
  - Linear



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- Open design, static arena
- Long experimental period

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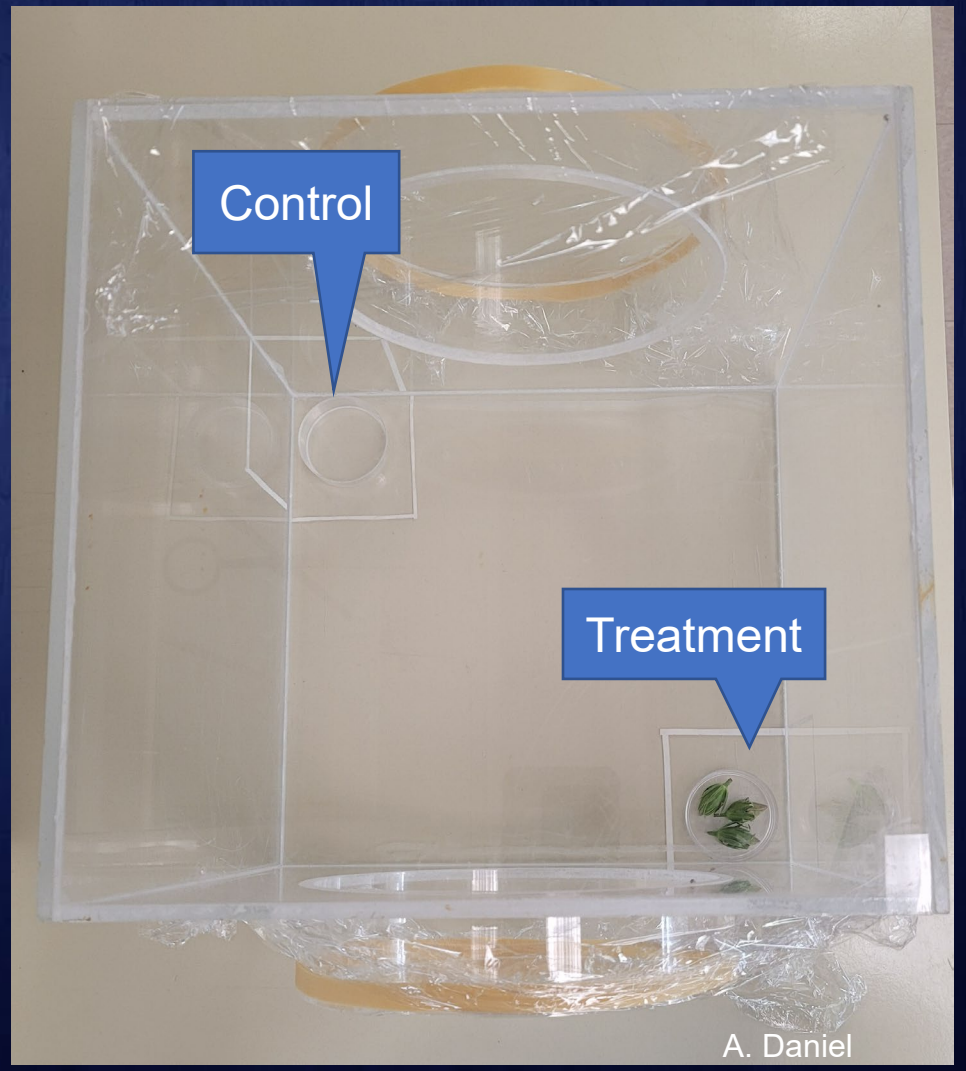
- Constricted systems
- Open design, static arena
- Long experimental period
- Cage olfactometer
  - Acrylic
  - 1 x 1 x 1 feet

Step 1: Choosing a bioassay system

- Treatment and control
  - Diagonal corners



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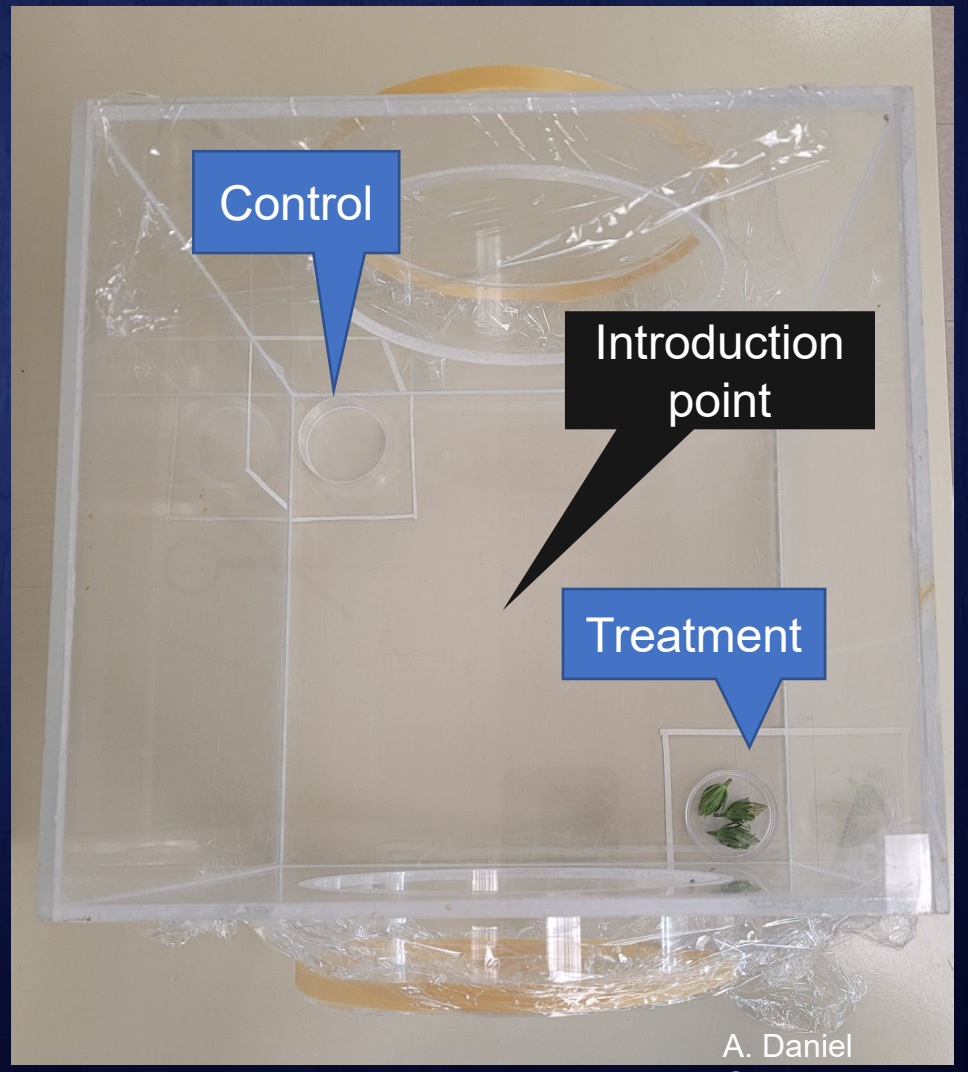
Step 1: Choosing a bioassay system

- Treatment and control
  - Diagonal corners
- 10 adult weevils
  - Introduced in the middle of the cage
- Openings sealed with polyvinyl film



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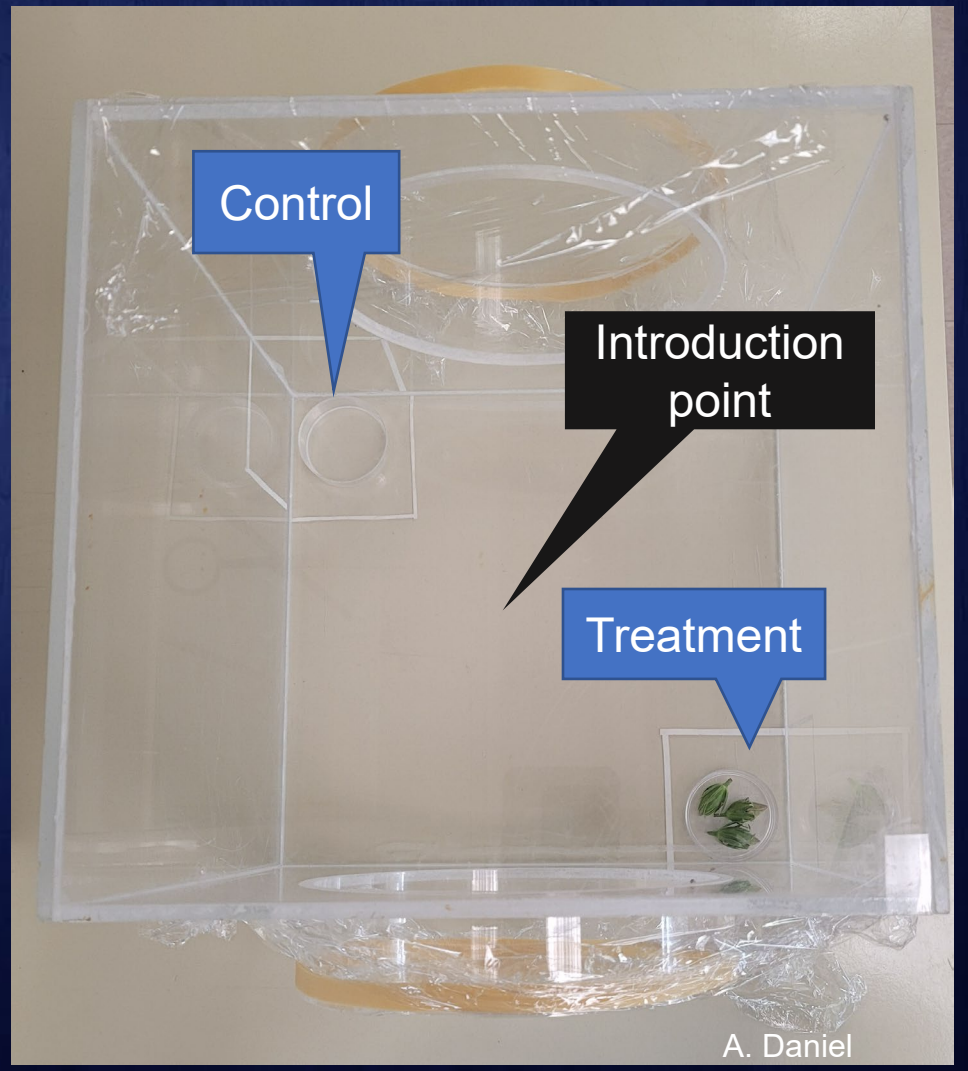
Step 1: Choosing a bioassay system

- Post-experimental time point
  - 15 min
  - 30 min
  - 1 hour
  - 2 hours
  - 4 hours
  - 6 hours
  - 24 hours



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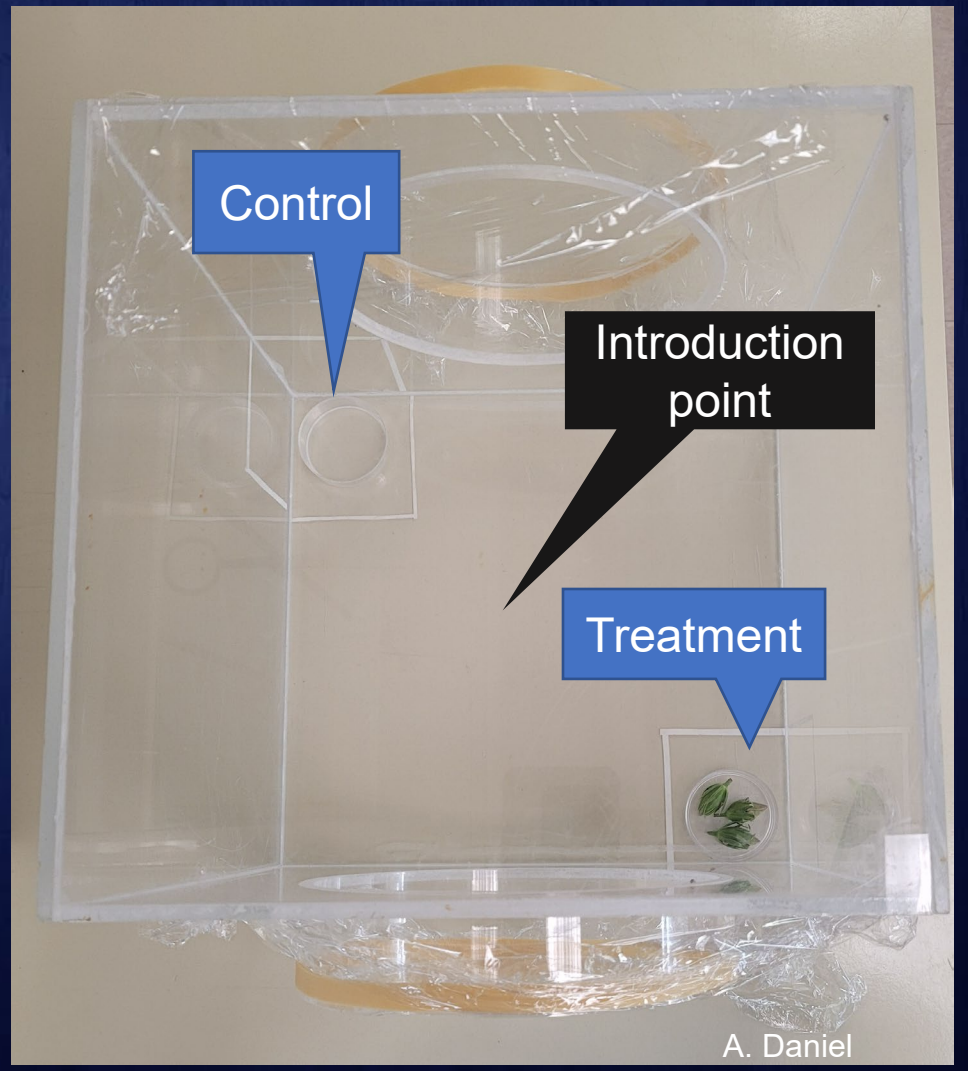
Step 1: Choosing a bioassay system

- Post-experimental time point
  - 15 min
  - 30 min
  - 1 hour
  - 2 hours
  - 4 hours
  - 6 hours
  - 24 hours
- Weevils within treatment and control areas were counted



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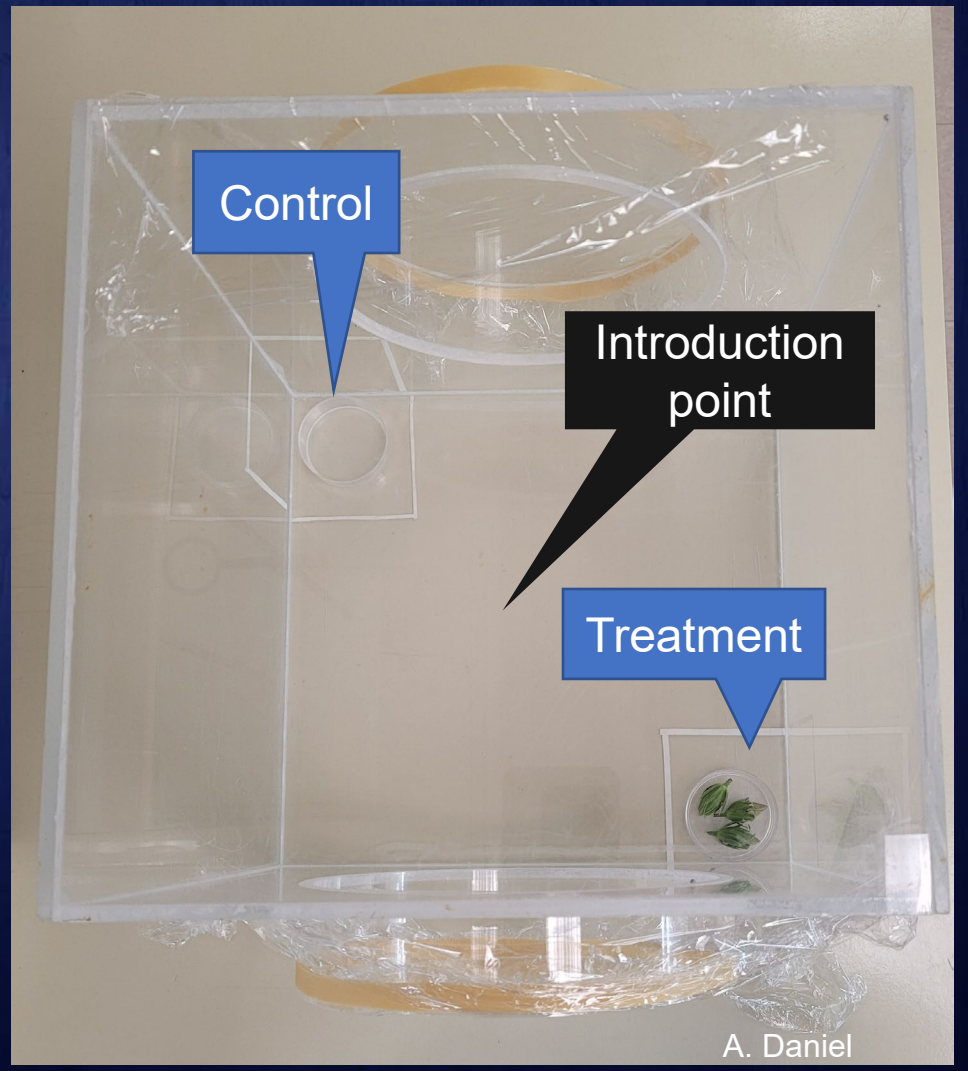
Cage olfactometer experiments

- Three HBW groups
  - 10 ♀
  - 10 ♂
  - 5 ♀, 5 ♂



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HBW response to hibiscus buds

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HBW response to hibiscus buds

- Y axis = Average number of weevils within each area
- X axis = hours post-experimental setup

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Treatment mean — Control mean

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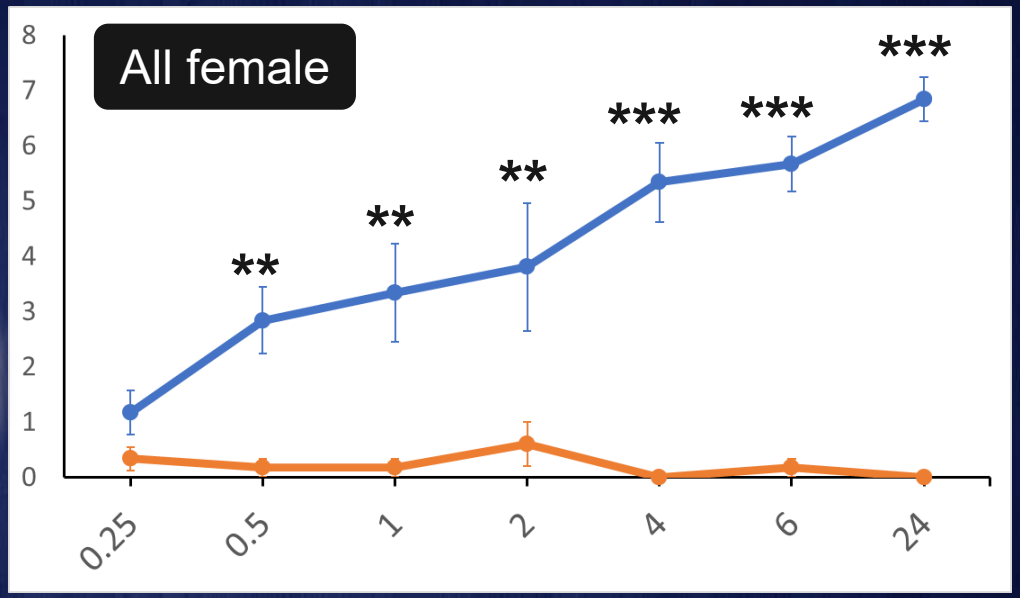

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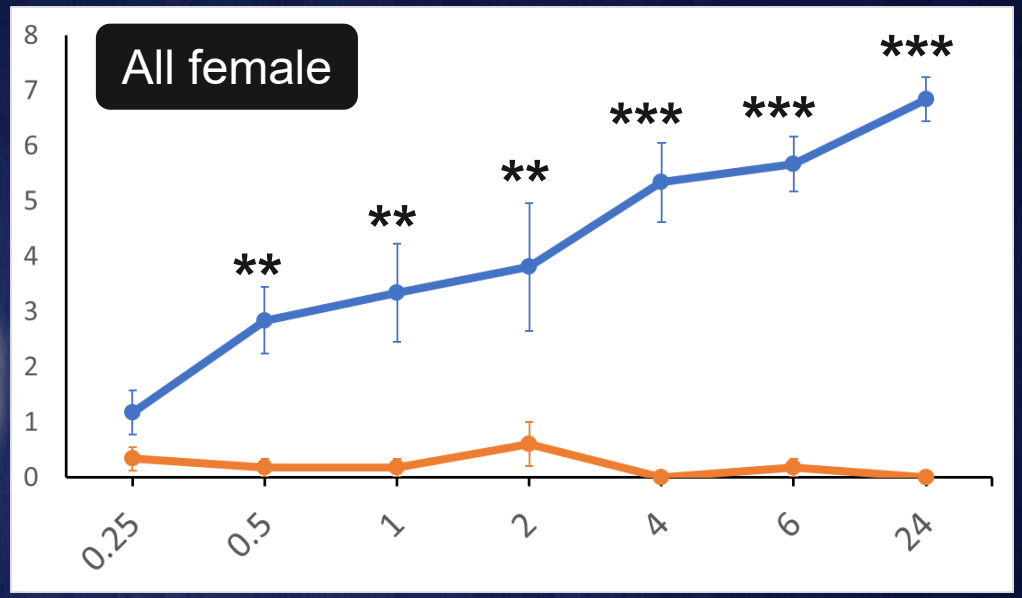

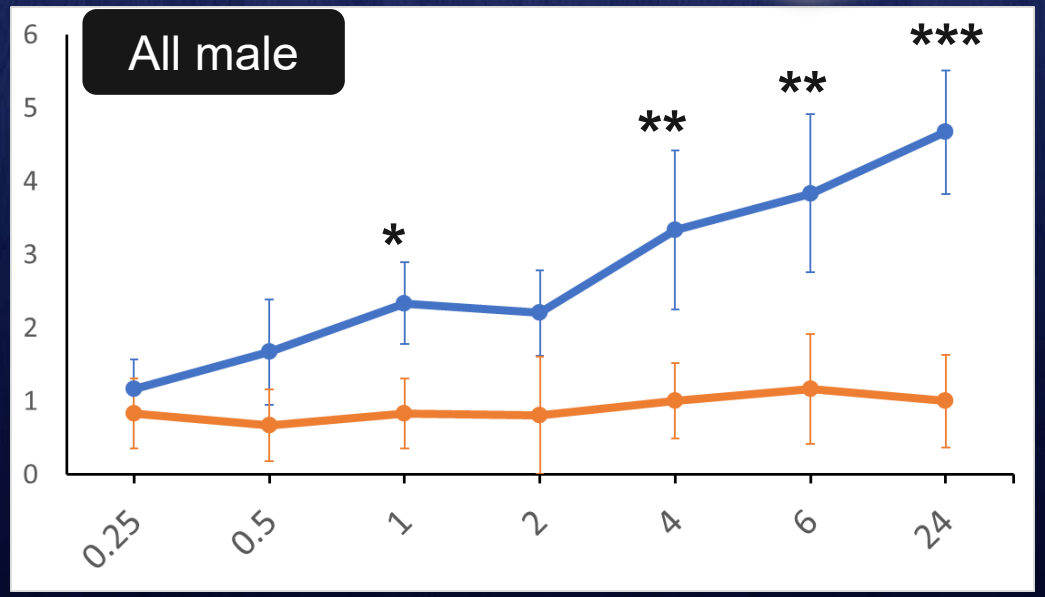

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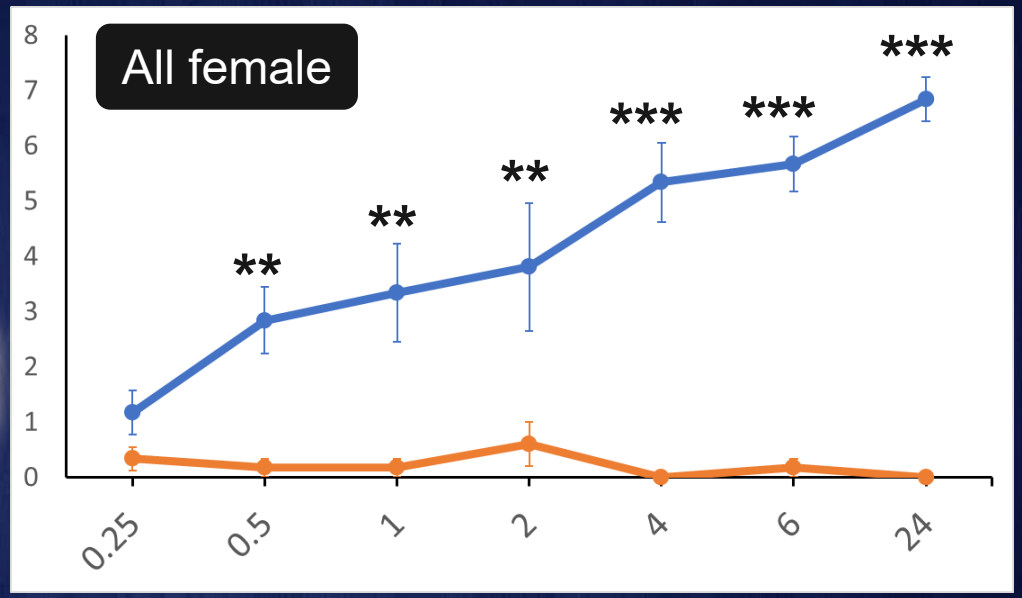
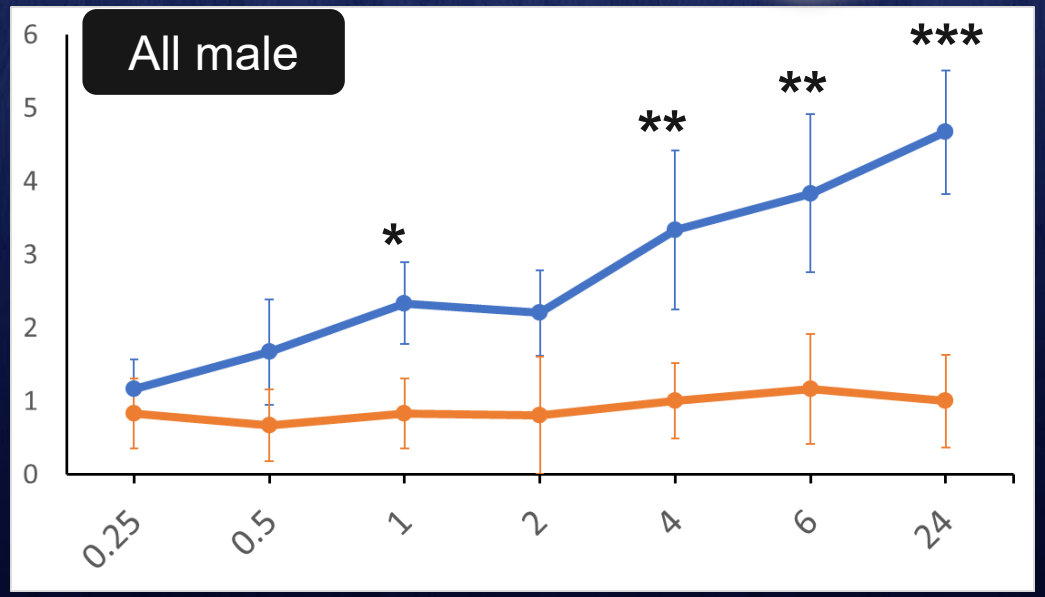
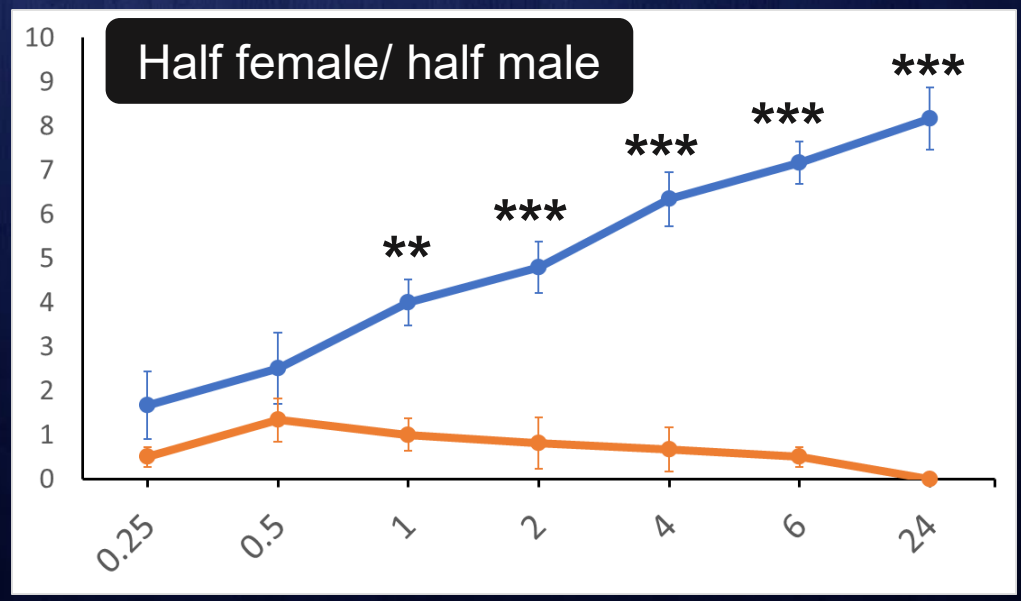






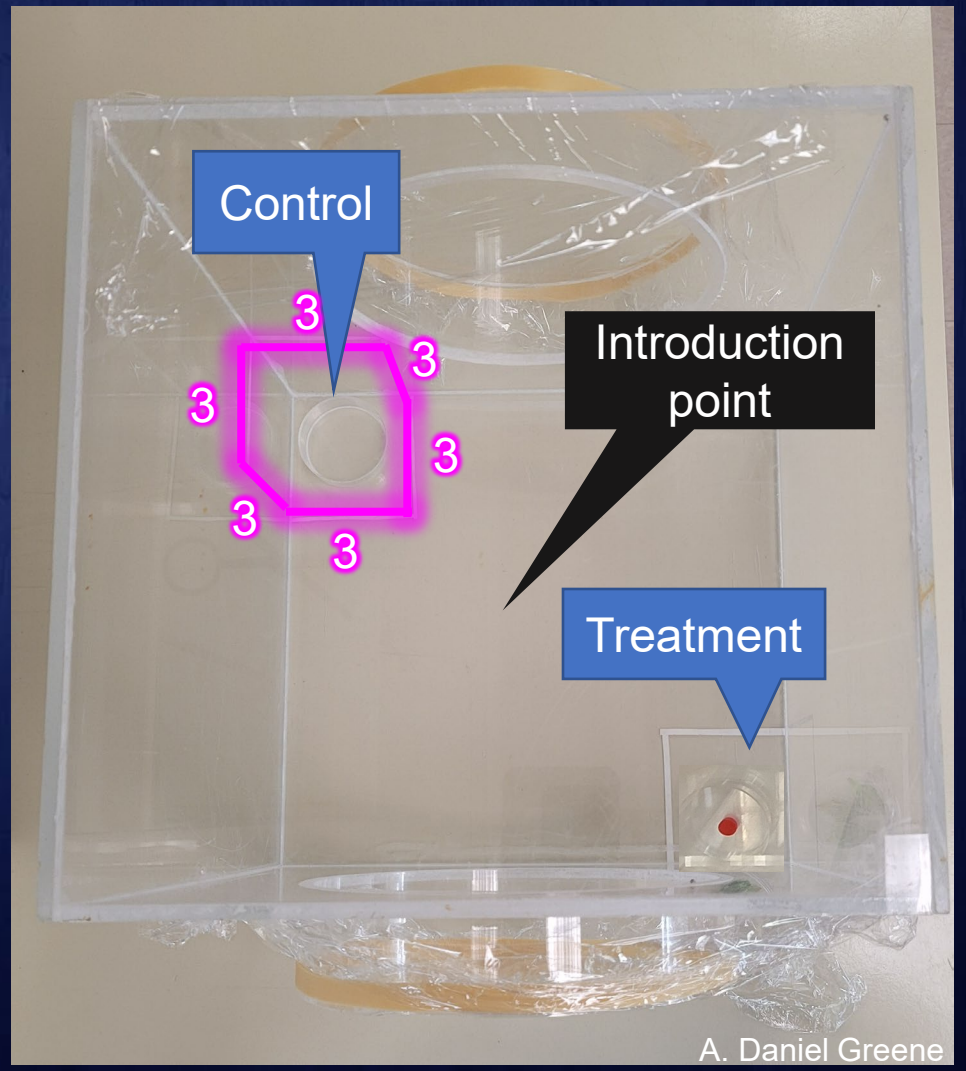
HBW response to hibiscus buds: Summary

- Cage olfactometer was a success→ weevils responded to hibiscus buds
- Use half female/ half male group→ HBW response to *Anthonomus* spp. pheromone lures

HBW response to commercial *Anthonomus* spp. pheromone lures

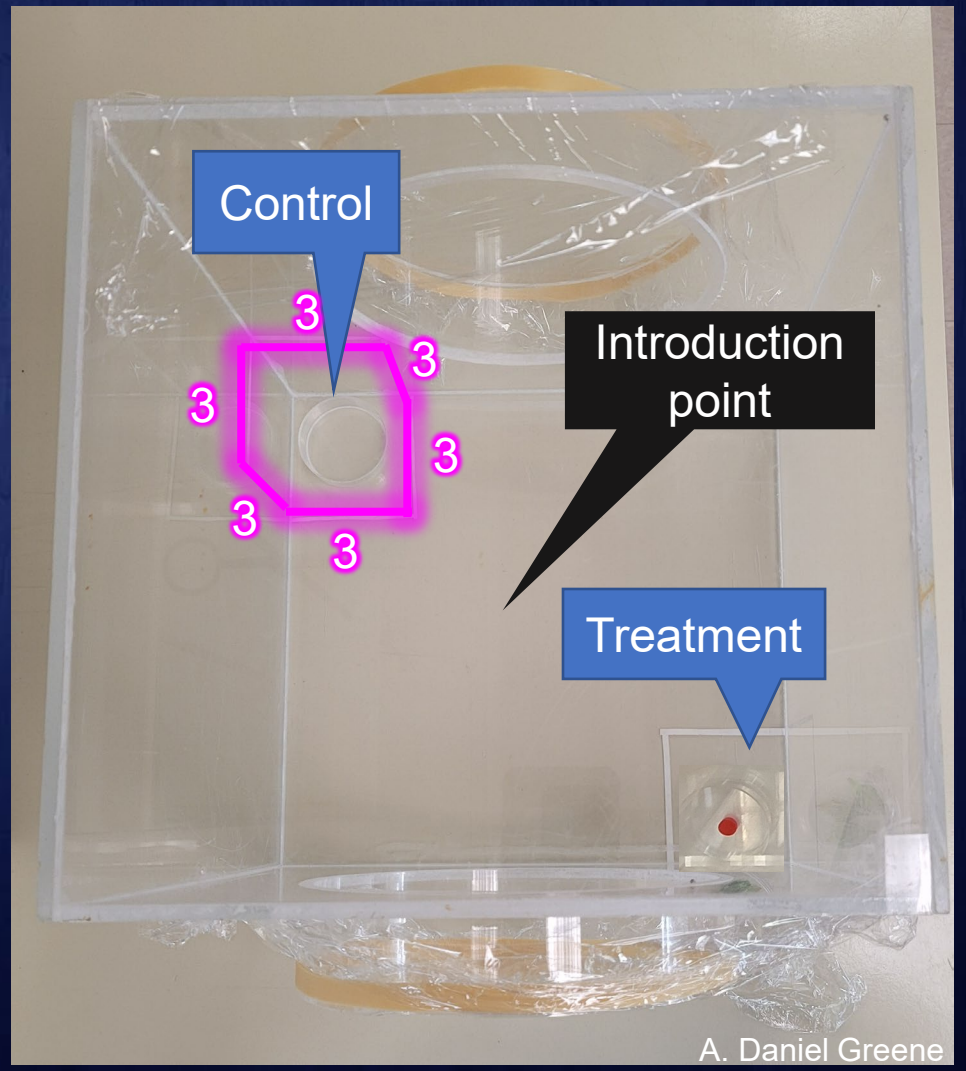
- Three species

- Three lure sizes (in diameter)



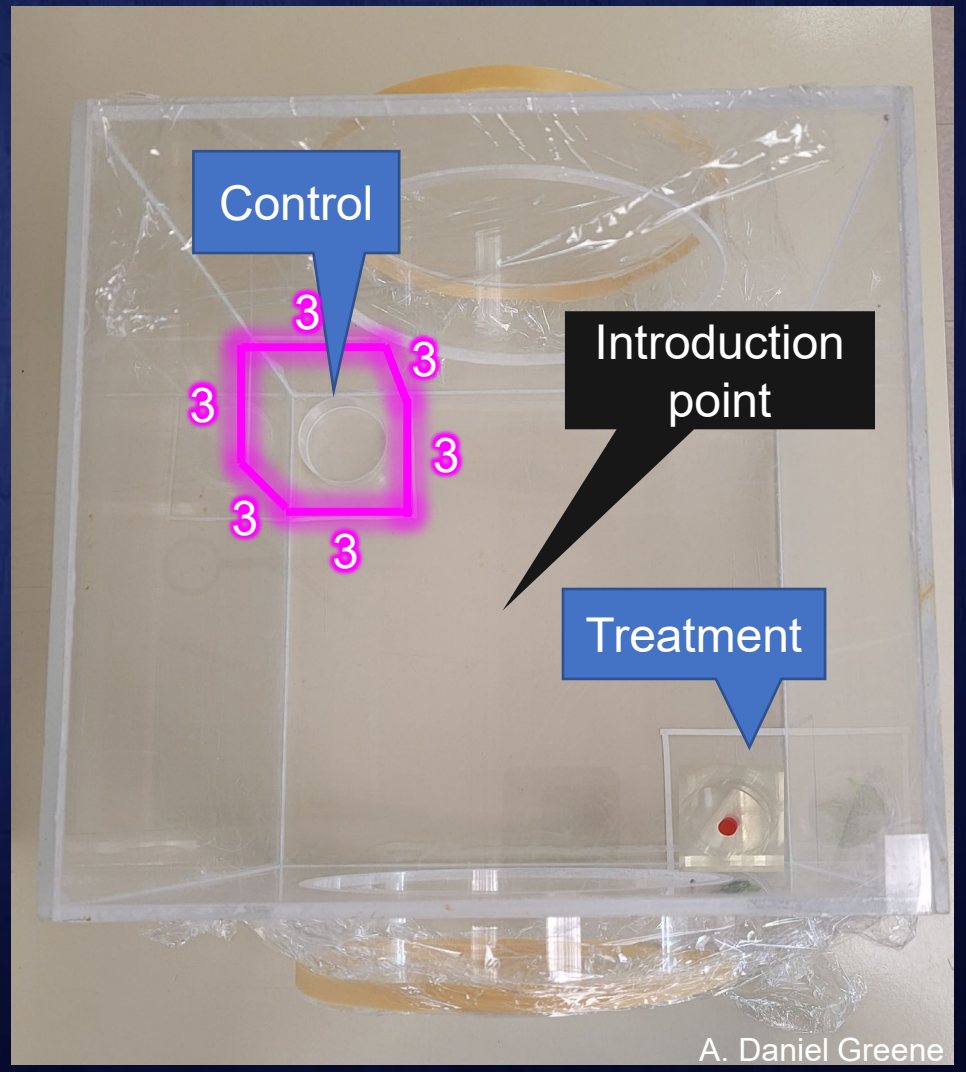
HBW response to commercial *Anthonomus* spp. pheromone lures

- Three species
  - Boll weevil
  - Cranberry weevil
  - Pepper weevil
- Three lure sizes (in diameter)



HBW response to commercial *Anthonomus* spp. pheromone lures

- Three species
  - Boll weevil
  - Cranberry weevil
  - Pepper weevil
- Three lure sizes (in diameter)
  - 0.15 inch
  - 0.4 inch
  - Full size
    - Boll & Pepper weevil = 1.2 inches
    - Cranberry weevil = 0.67 inches



HBW response to commercial *Anthonomus* spp. pheromone lures

- **What was the effect of lure species on the selection of treatment materials?**

HBW response to commercial *Anthonomus* spp. pheromone lures

- What was the effect of lure species on the selection of treatment materials?
- What was the effect of lure size on the selection of treatment materials?

HBW response to *Anthonomus* spp. pheromone lures

- **What was the effect of lure species on the selection of treatment materials?**
- **What was the effect of lure size on the selection of treatment materials?**
- Weevils did not significantly choose treatment materials for any lure species*size combination

HBW response to commercial *Anthonomus* spp. pheromone lures

- Y axis = Average number of weevils within each perimeter
- X axis = Lure Size

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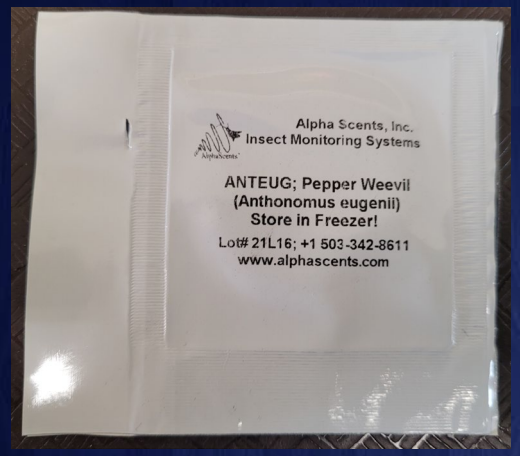

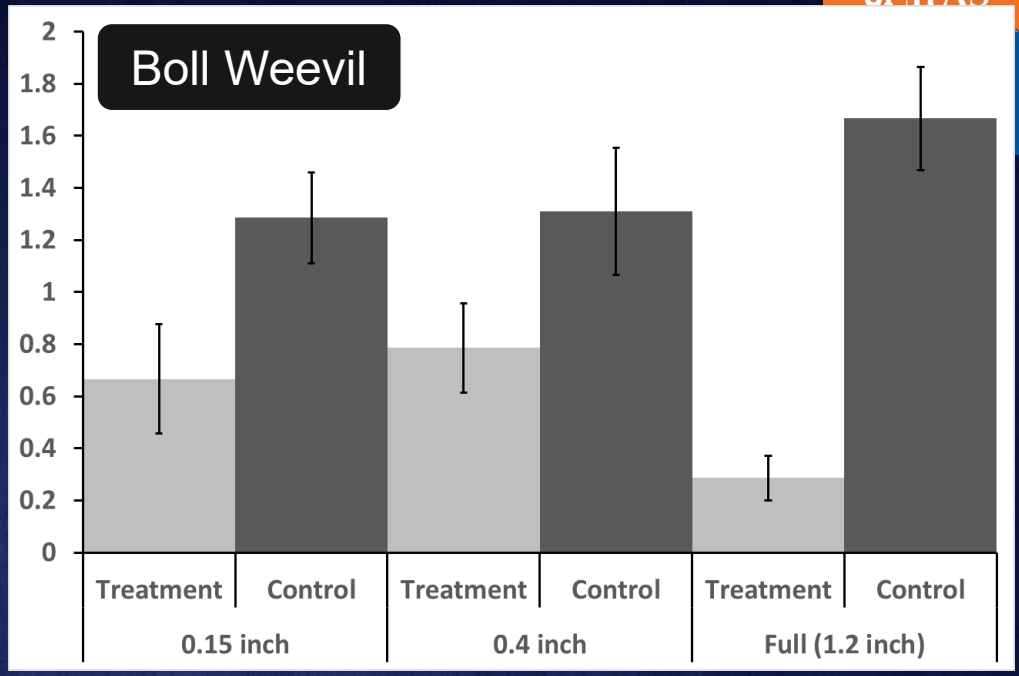

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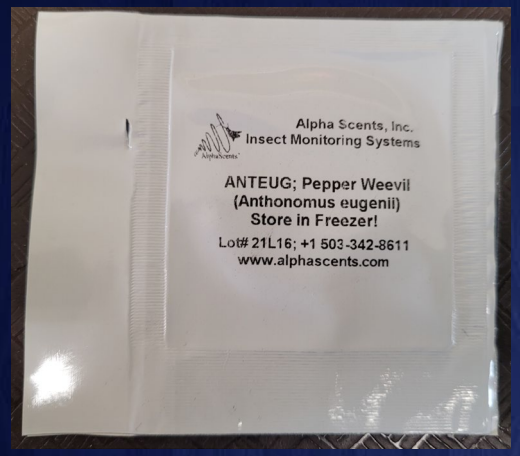

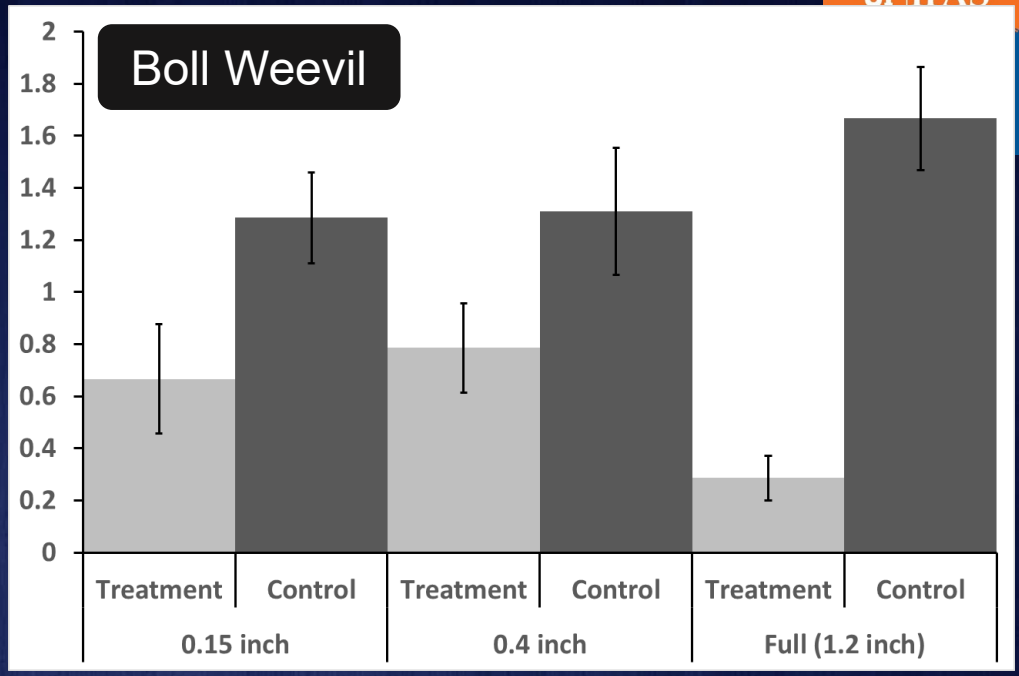

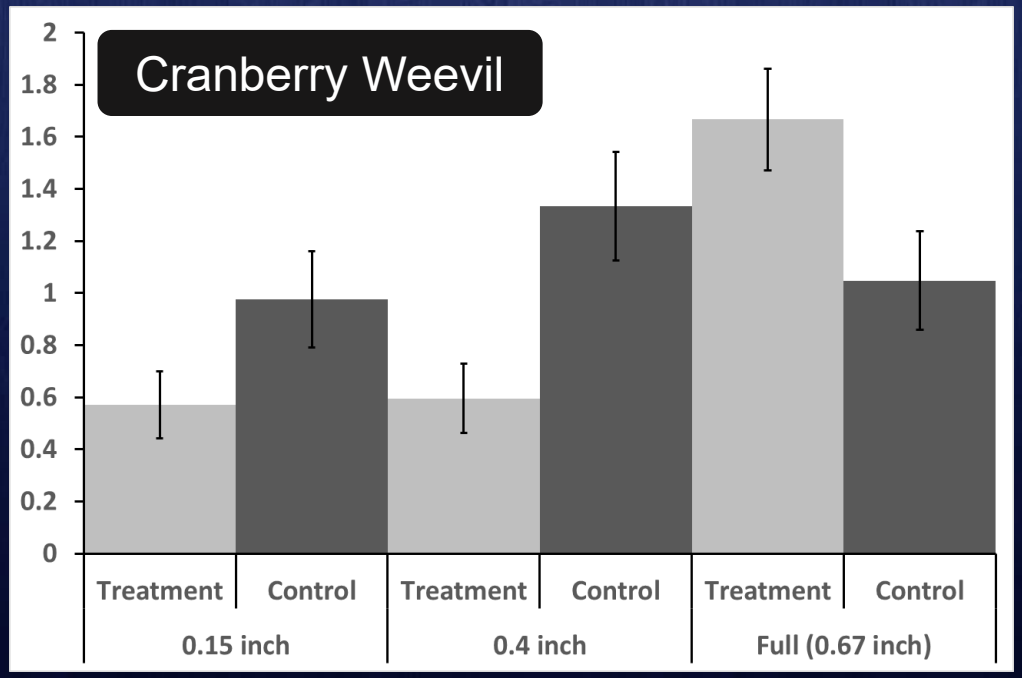

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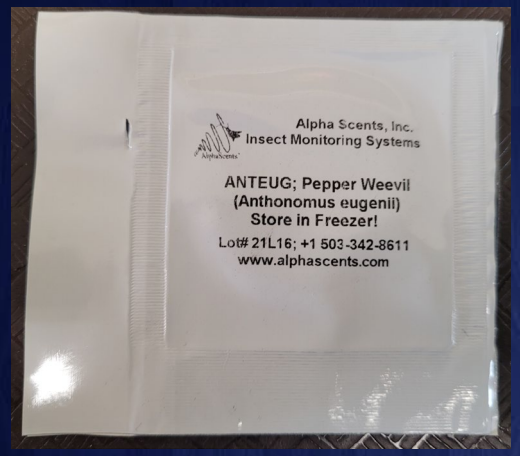
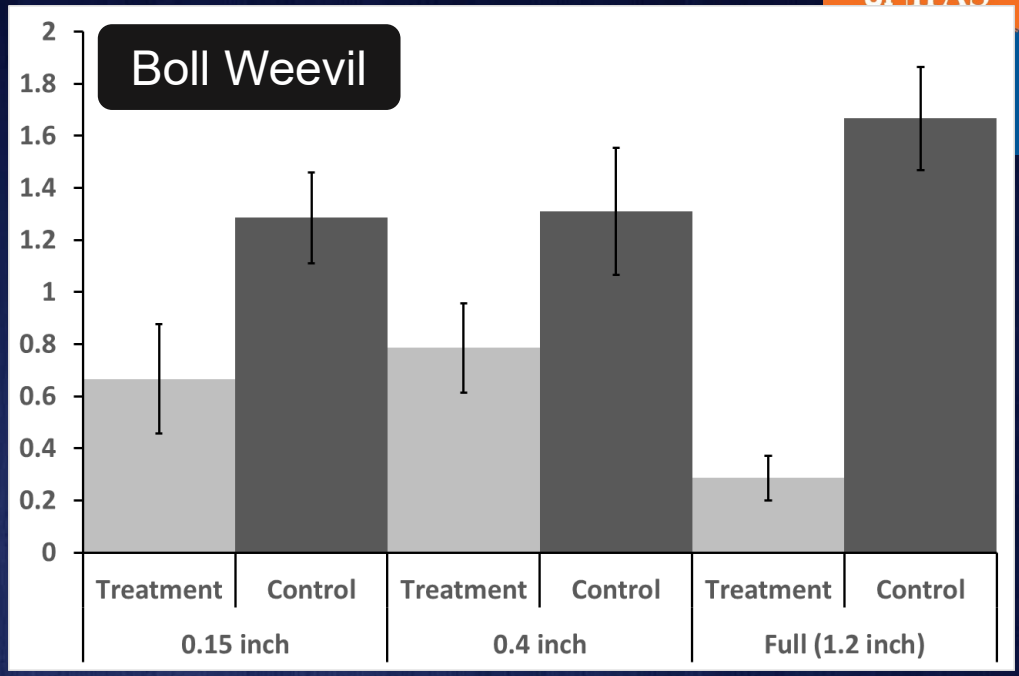
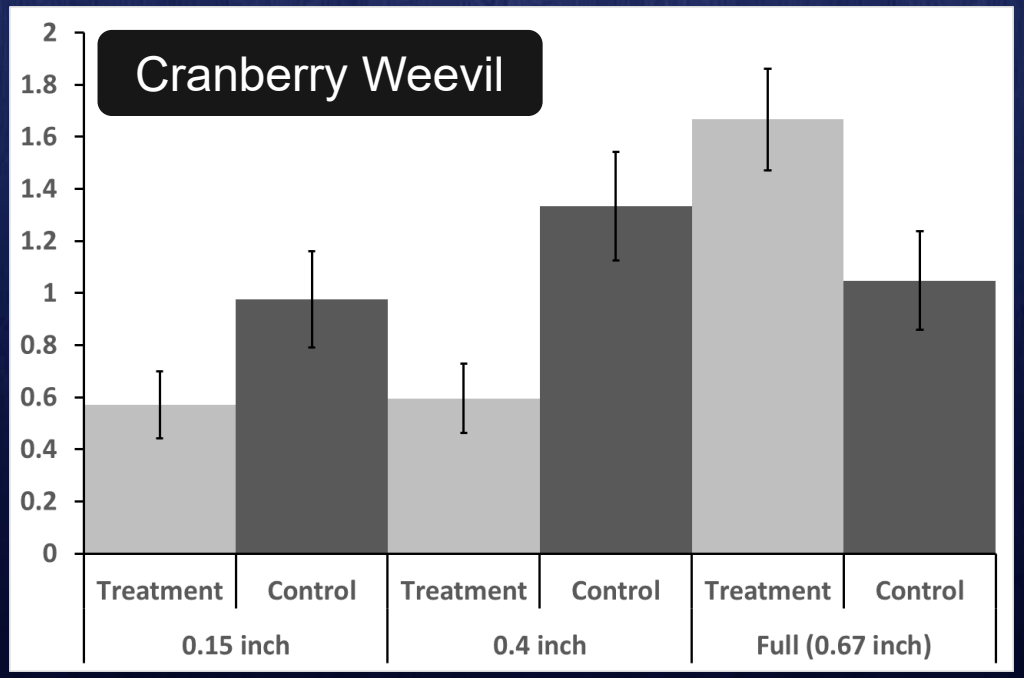
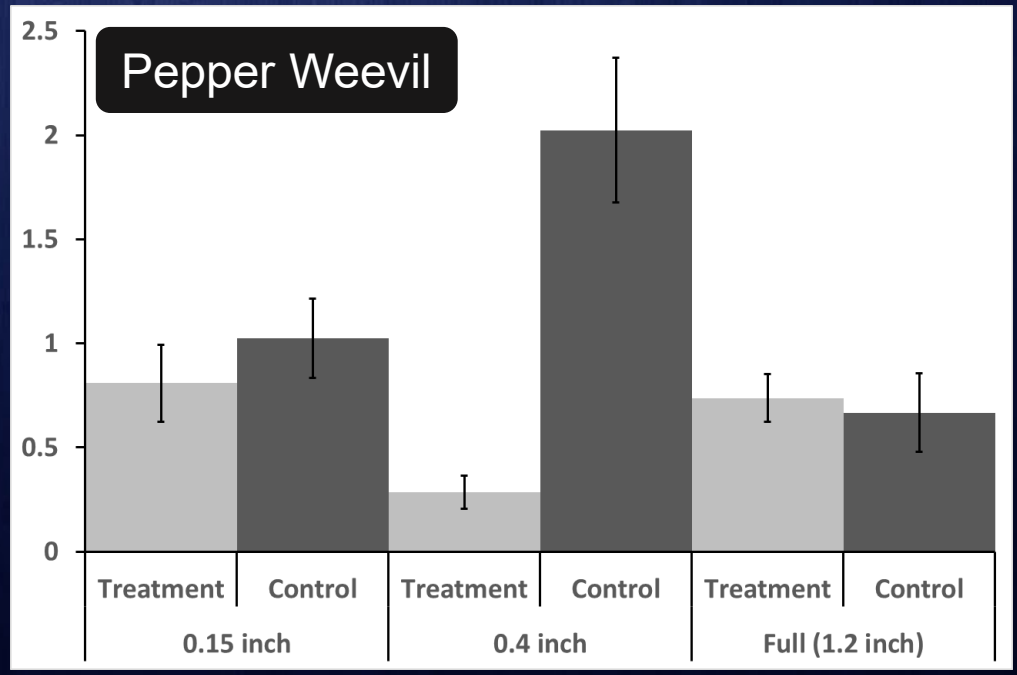






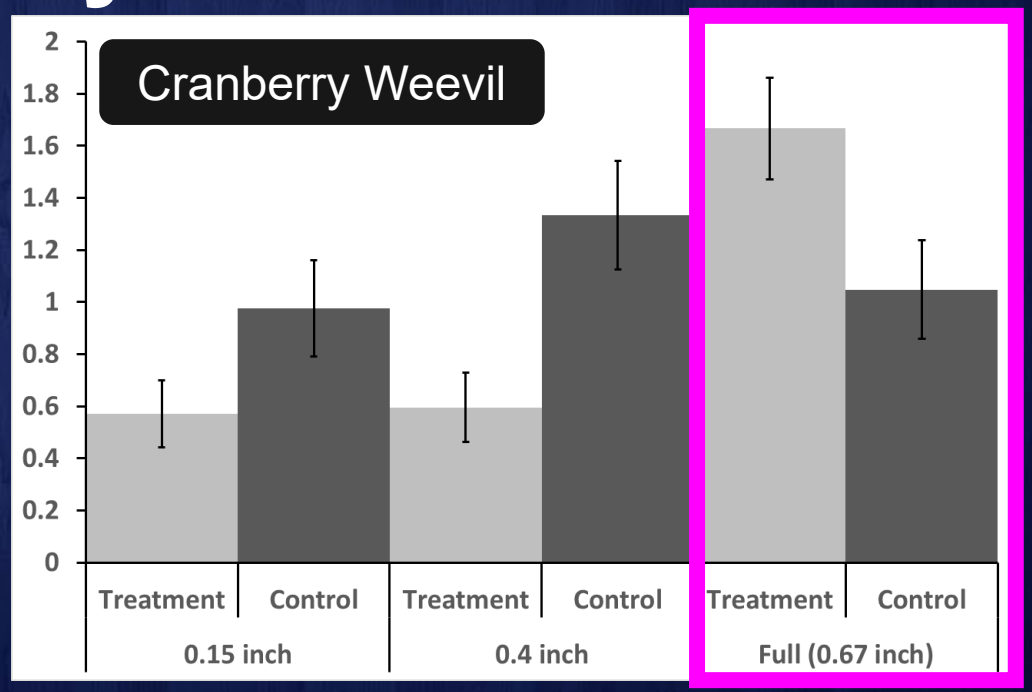


HBW response to commercial *Anthonomus* spp. pheromone lures: Summary

- Weevils did not significantly respond to *Anthonomus* spp. pheromone lures

HBW response to commercial *Anthonomus* spp. pheromone lures: Summary

- Weevils did not significantly respond to *Anthonomus* spp. pheromone lures
- Use full size cranberry weevil lures in trap experiments



Y axis = Average number of weevils within each perimeter

X axis = Lure Size

Next step

- Hibiscus volatiles

A. Daniel Greene

Next step

- Hibiscus volatiles
- Odors that are emitted

Next step

- Volatiles of ‘Painted Lady’ variety hibiscus
  - Buds (n=3)
  - Flowers (n=3)
  - Leaves (n=3)
- Distillation

Volatile collections

- Over 40 compounds were identified

Volatile collections

- Over 40 compounds were identified
- Nine selected for use in behavioral bioassays
- All 9 found in each plant part (buds, flowers, and leaves)

- linoleic acid
- linolenic acid
- myristic acid
- palmitic acid
- pentacosane
- phytol
- tetracosane
- trans,trans-2,4-decadienal
- tricosane

Overall Goal

Develop and implement a species-specific pheromone trap for the Hibiscus bud weevil

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Questions?

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