Using 3D Printing Technology To Make A Better Asian Citrus Psyllid Trap

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Improving ACP Traps

- This project will result in enhanced mitigation capabilities of citrus greening through early detection of the ACP vector through improved trapping technologies:

- Psyllid testing is reliable means of early detection of HLB.

- Enhanced trap/lures = earlier pest complex detection

Current Standard “Trap”

Yellow sticky cards

- Expensive
- Not reusable
- Messy
- Lot of bi-catch
- Replace frequently
- <u>ACP not preserved for follow up PCR</u>

Project Details

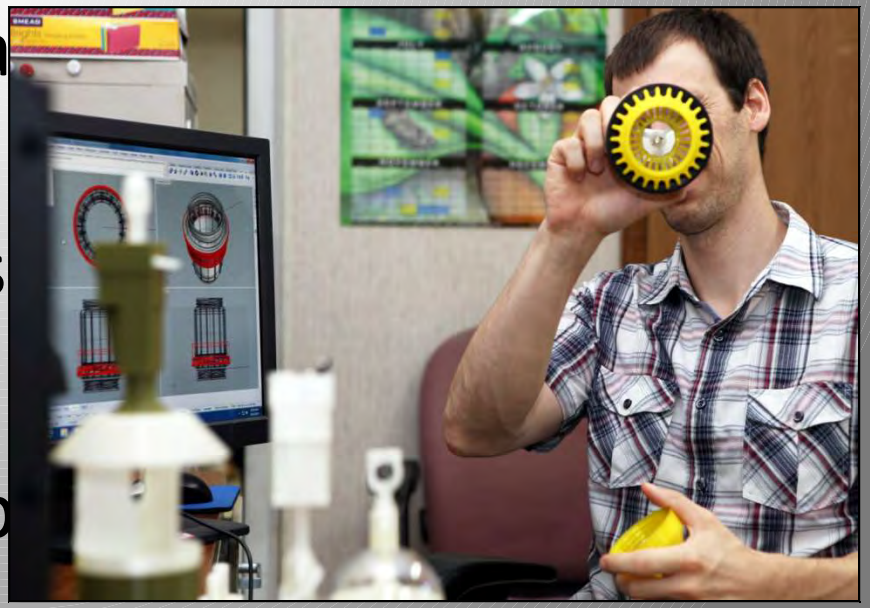
- National Institute of Food and Agriculture (NIFA) Specialty Crop Research Initiative (SCRI) 5 year grant. Year 1 of 5.

- Collaboration with University of California Riverside and other researchers in California, Texas and Hawaii.

- Two Components:

Strategy

- Use recent advancements in 3D printing systems to rapidly design, print, and lab/field test traps in CA, TX and FL.



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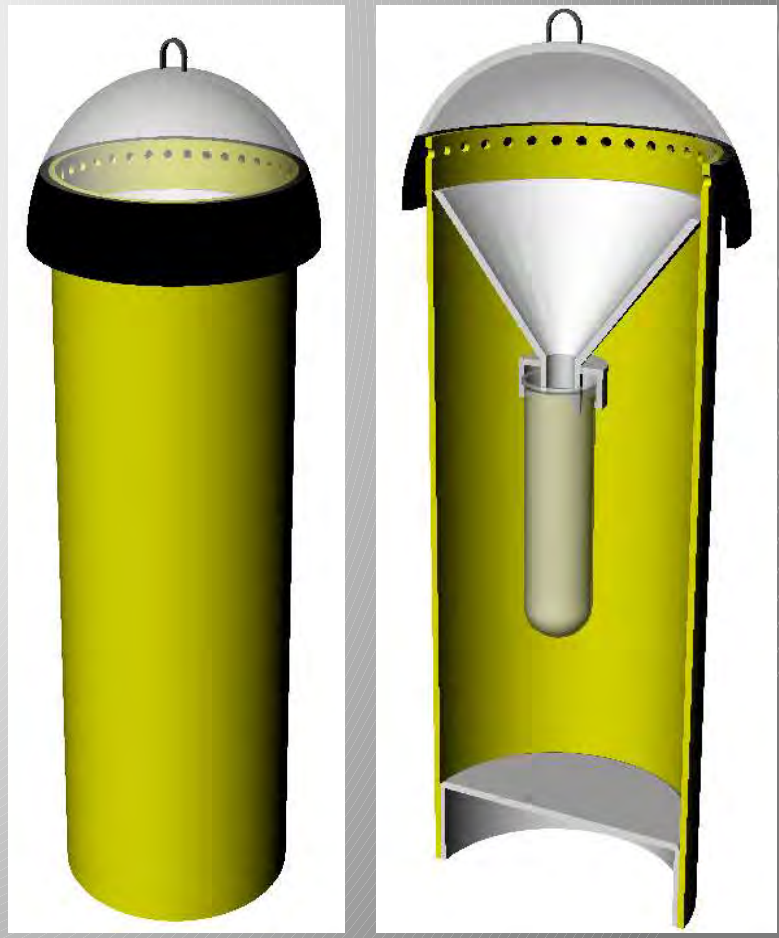
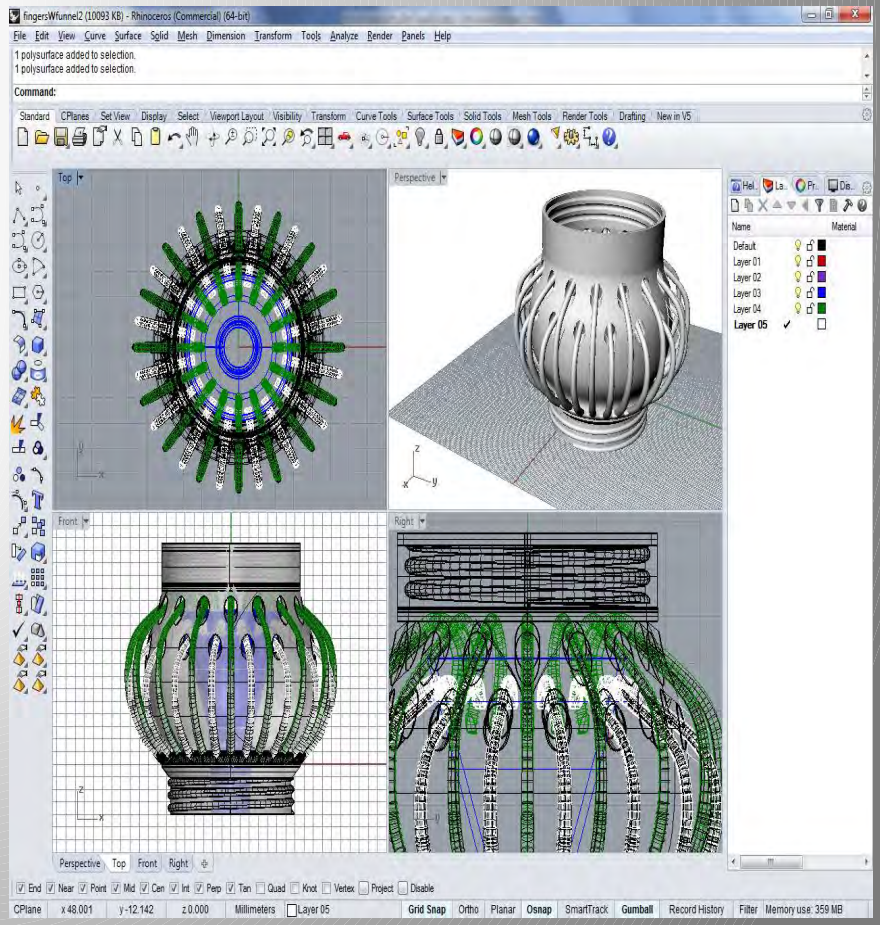
Original Prototype

- Designed by Dr. Russell Mizell (UF) and our laboratory.
- Hollow yellow cylinder, shaded holes at top, clear dome to allow light to shine into the cylinder and out the holes.



Trap Production

- Models are created and modified using Rhinoceros 5 3D design software.
- Concepts are derived from careful observation of the behavior of psyllids and reaction to the designs.
- Focus on shape, color, lighting.



Trap Testing in Lab then Field

- New designs tested against each other, yellow sticky cards and against the prototype.

- 40 psyllids in a test cage for 24 hours. Rearing cages vary in size between .256 m^3 and .120 m^3.

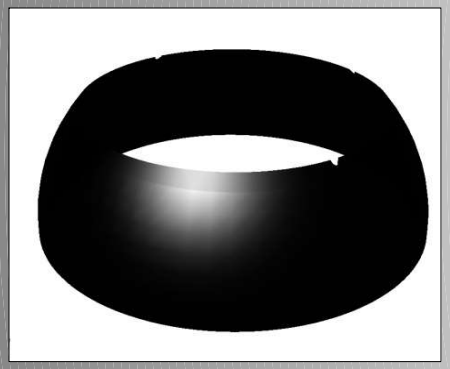
- A florescent light is placed above the cage and two traps to be tested against each other are hung on the inside.

- Trials are repeated in two's so that traps run on both sides of cage to factor out positional effects. Multiple replications.

- The number of psyllids caught in each trap are counted at the end of each trial.

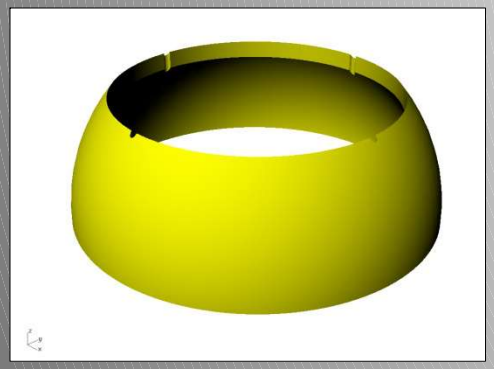
- Designs that perform well in cage trials are sent to various citrus groves in FL, TX, and C

Trap Components - Awnings



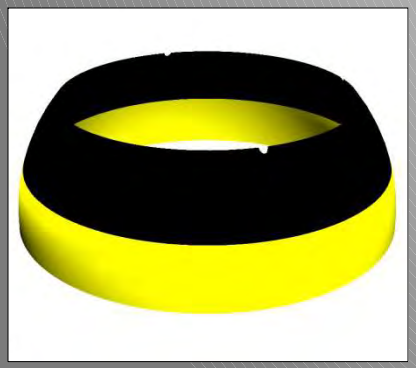
All black: Provides shade without attracting psyllids to the wrong part of the trap.

Problem: It is too dark, and psyllids were hesitant to go beneath it.



Yellow: All yellow still provides shade and psyllids were likely to go beneath.

Problem: Not dark enough, psyllids would go under and come back out.



Half and Half: This combination proved to be most effective. The lower yellow rim was welcoming to psyllids while the upper black part provided enough darkness.

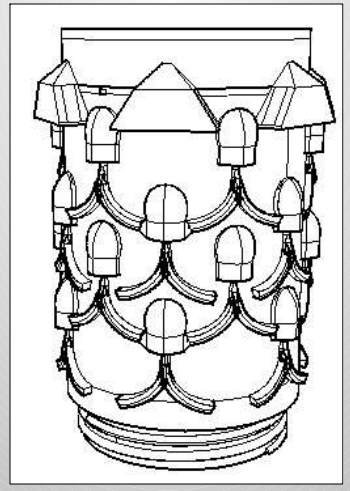
Entrance Hole Number, Shape, and Size

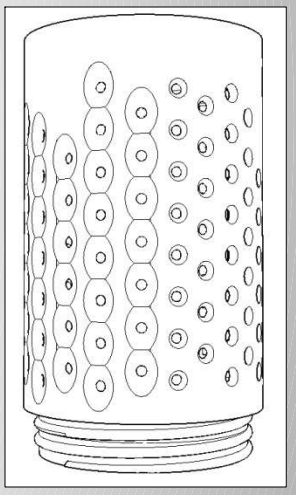
-Do more holes = more catch?
Only up to a certain point.

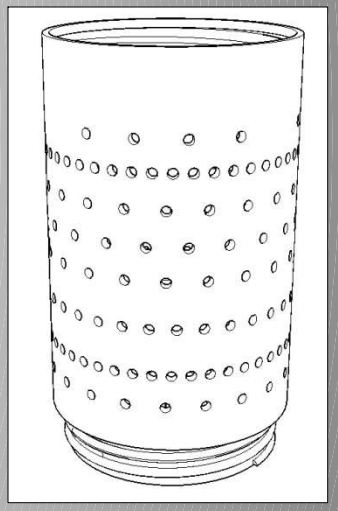
-Instead of an awning on top to keep psyllids inside, a coat of Fluon was used to create a slippery interior surface.
But without an awning, psyllids simply perched on the exterior rim of the hole and did not go in.

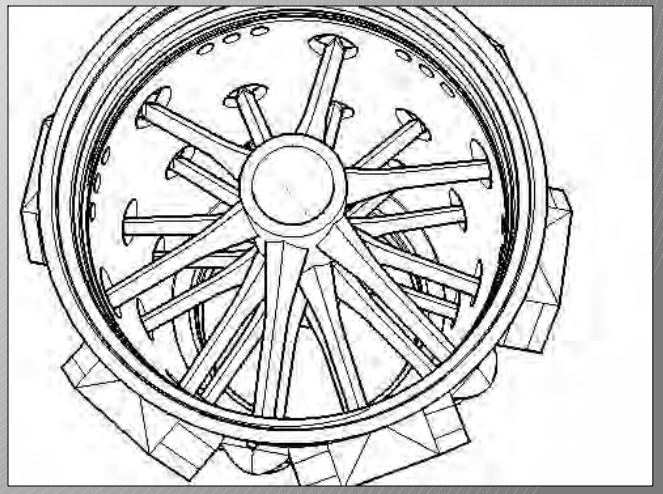
-Small individual awnings over each hole improved catchment slightly, especially when combined with an internal stem structure, but were still outperformed by the original design.

Top awning + Floun = best combo

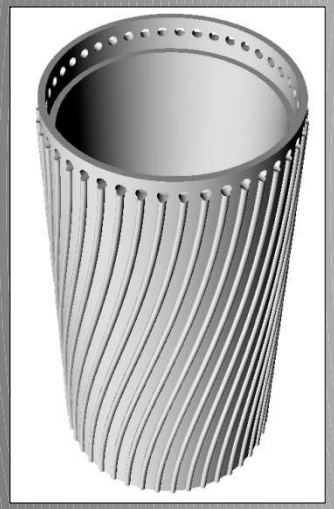


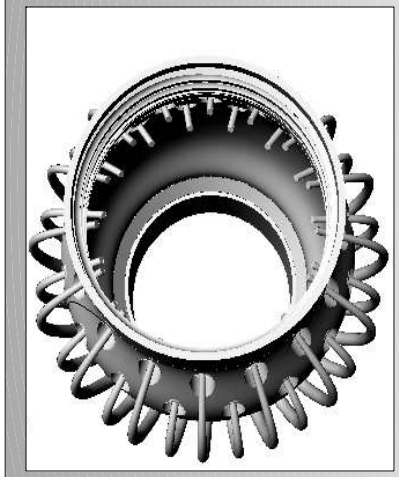


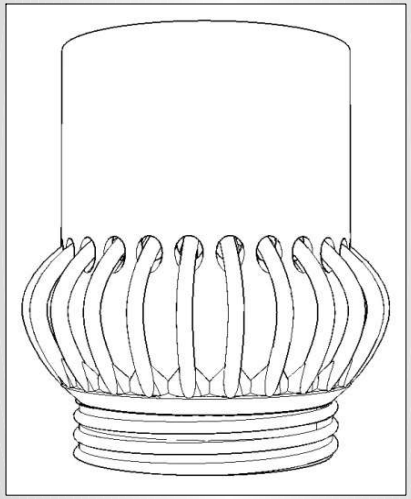


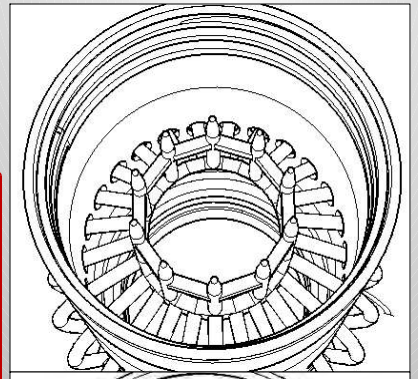


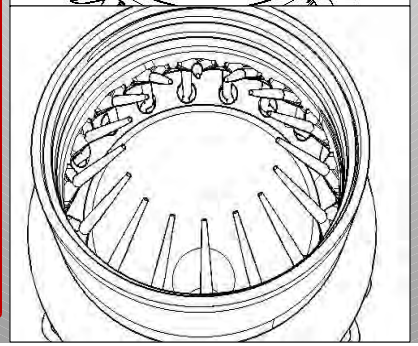
Ridges and Stem Guides









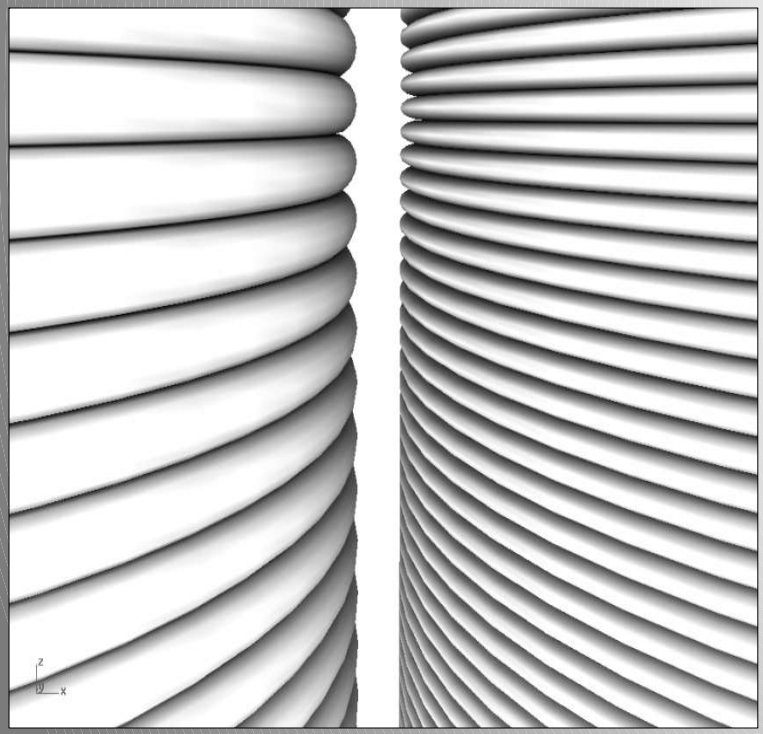


- ACP typically climb upwards upon landing, but were observed veering off course before reaching the holes so stems and ridges incorporated to direct ACP to the holes.

- Psyllids observed following grooves, but designs that include vertical and slanted ridges have not increased trap yield.

- Stems have proven to be effective. The challenge is to keep the psyllids from taking the stem route back out. This has been abated through the use of a Fluon interior coat and stems that connect to an interior funnel. This has repeatedly outperformed all other traps in the lab or field.

Texture



Low quality print – High quality print

The 3D printer lays down plastic layer by layer, leaving a textured surface.

The higher the print quality setting, the thinner these layers.

- We found this texture to hamper the psyllids mobility, regardless of quality.
- A rubberized clear coat (Flex Seal) applied to the 3D printed surface has improved the catch.

LED’s

LEDs attracted more psyllids in lab tests. Similar results in the field have yet to be achieved.

- Comparing light wavelength and intensity.
- Run during day or night or both. Yes in lab, field ?
- Powering LED’s for long periods in field problematic (battery size and life). Solar may be an option.
- Battery adds weight, increases maintenance and cost.

Field Results

- < 6 months of field trapping in FL, CA, TX.
- Adjust for rainfall (overflow psyllid collection vial). Modified trap body and seals.
- Catches variable, low overall. Must improve.
- Florida catches low compared to yellow sticky cards under high psyllid pressure. Comparable catches under low psyllid pressure (when sticky cards catch under 10 psyllids).

Lure (Volatiles)

- Hope to collaborate with others to investigate the use of ACP lures in 3D traps to improve catch.
- Plant or insect volatiles.

Conclusion

Development and testing continue. Guide stems, the right balance of color in the awnings, surface texture improvements, Fluon coated interiors, and LEDs are areas where we have recorded improvements on catchment. Further advancement in trap design will come from adjustments to these concepts as well as new ideas inspired by observation and research of psyllid behavior. Ultimately, a combination of all of the most effective features will be shaped into a single trap. This trap will catch and preserve psyllids while reducing the mess and bi-catch associated with yellow sticky traps.