

# **SHORT TIME THERMOTHERAPY USING SUPPLEMENTARY HEAT**

**Reza Ehsani**

Associate Professor  
[ehsani@ufl.edu](mailto:ehsani@ufl.edu)



# Why Heat Treatment

---

- Heat treatment or thermotherapy is the application of heat at a specific time and temperature to kill a pathogen with minimum damage to the host.
- It is an old technique that has been successfully used to control several bacterial diseases in tomato, tobacco, rice, barley, cucumber and cotton.
- Parts of the plant such as the entire tree, scions, stalks, seedlings, seeds, even fruits have been heat treated.

# Methods of Heat Treatment

---

- Soaking in hot water
- Spraying hot water
- Hot air
- Steam
- Microwave
  - It has been used mainly for seed-borne pathogens.
  - It can kill by heat. It may disrupt pathogen cells.
  - Safety is a major concern for field application.

# Can It be Used for HLB Treatment

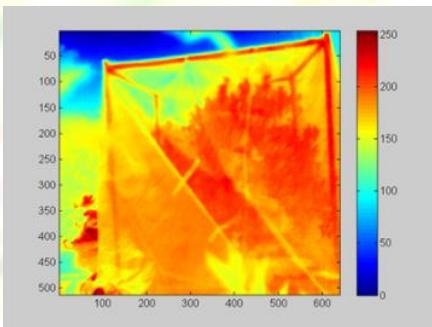
---

How does heat affect the bacteria?

- HLB bacteria is more susceptible than the plant cells to heat
- The bacteria population significantly decreases at  $\approx 42^{\circ}\text{C}$  ( $108^{\circ}\text{F}$ )



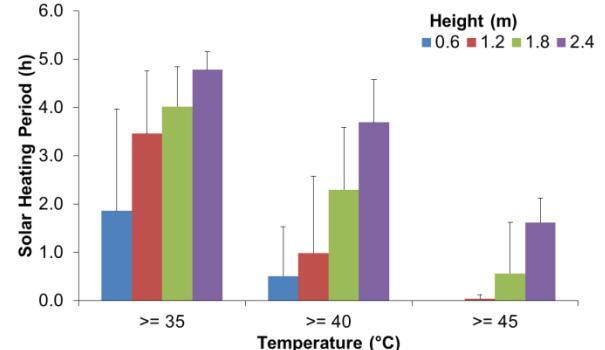
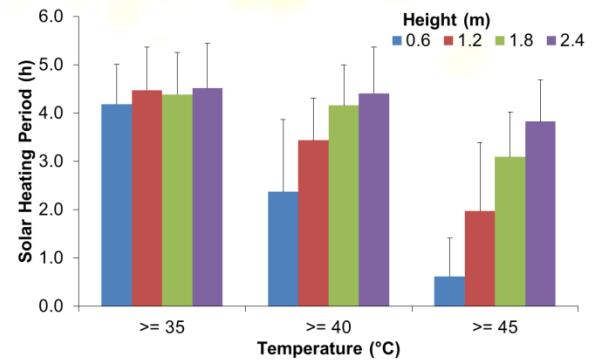
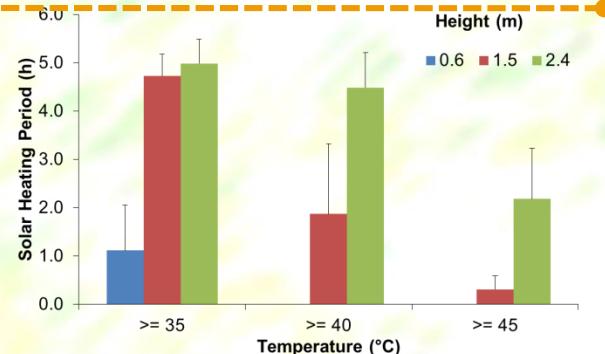
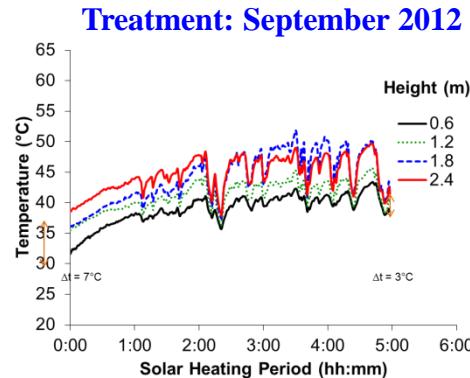
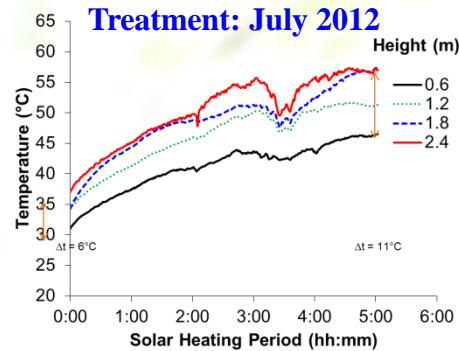
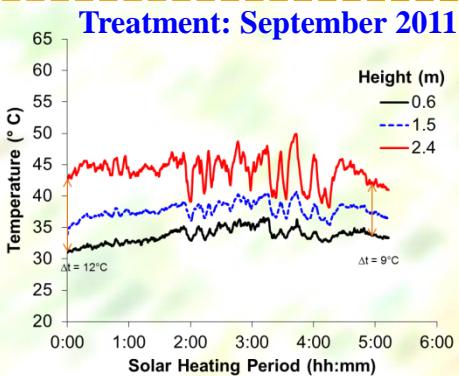
# Canopy Temperature Distribution



Temperature profiles of 5-h treatment period revealed that the upper section of the canopies ( $> 1.5$  m) heated much faster than lower section.

$$35^\circ\text{C} = 95^\circ\text{F}, 40^\circ\text{C} = 104^\circ\text{F}$$

$$45^\circ\text{C} = 113^\circ\text{F}$$



# Why Supplemental Heat?

## Benefits of using Supplemental Heat

- To reduce heat treatment time
- To increase the heat treatment season beyond summer
- To improve uniformity and better control



# Field Experiments

- 36 trees
- 3 temperature settings (113,122,131 °F )
- 3 time durations for each temperature setting
- Each combination was repeated 4 times
- Experiment was evaluated based on specific physiological markers I
- Harvest yield, fruit quality, and juice quality was measured



# Field Experiments

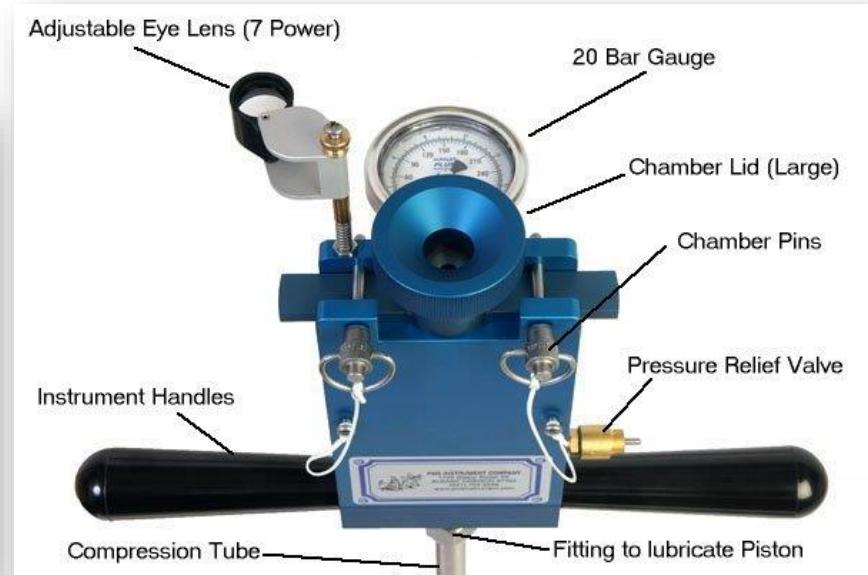
- Heating Tunnel Prototype
- 2 Infrared Radiant Heaters
- 4 fans at top corners of tent to circulate the air inside the tent
- A thermostat connected to control the temperature in the tent
- 10 thermocouples are placed within the tree at varying heights
- 2 thermocouples are placed in the ground to measure the change in soil temperature



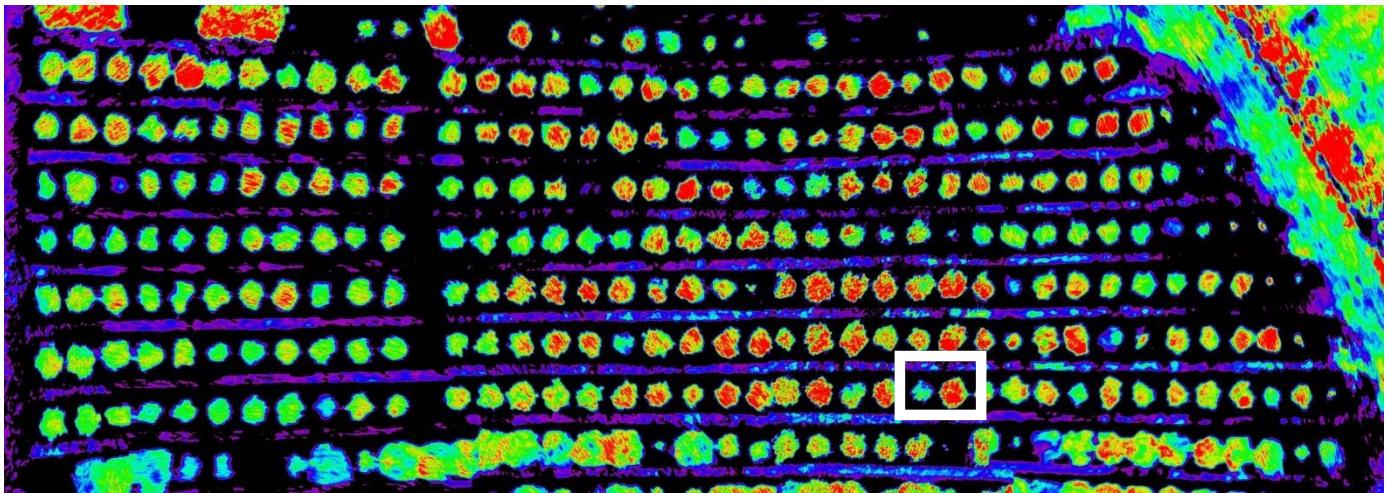
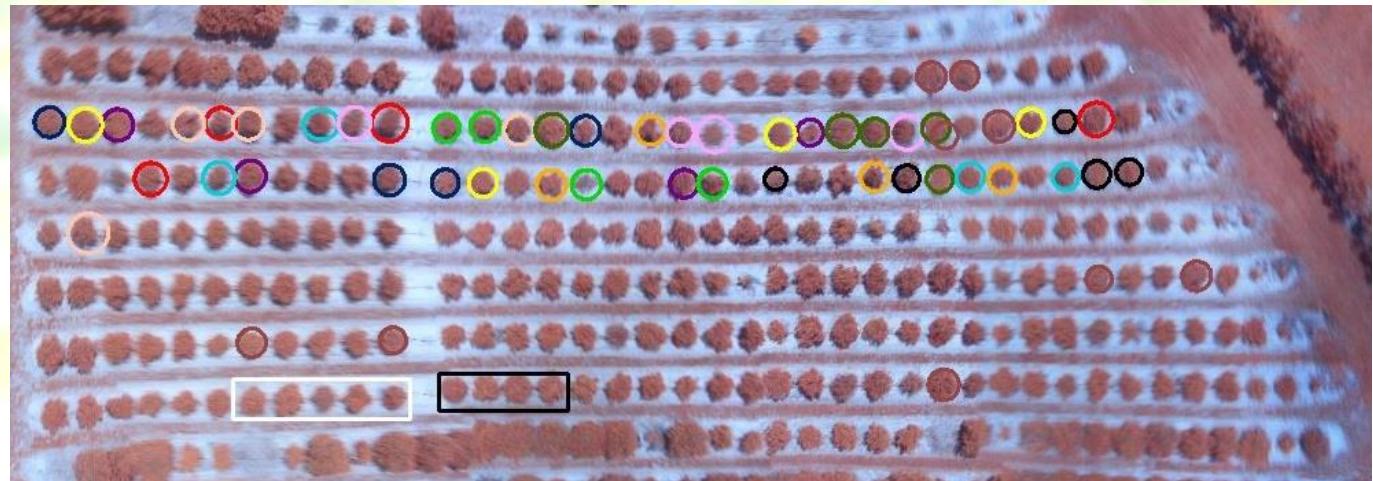
# Physiological Tests

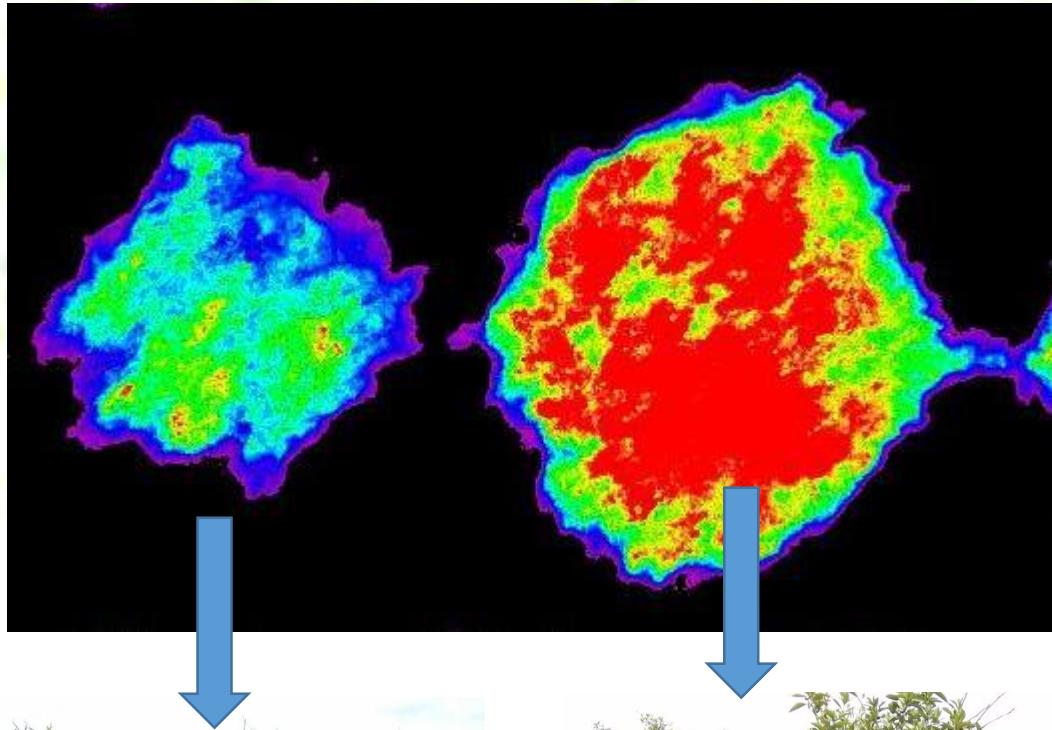


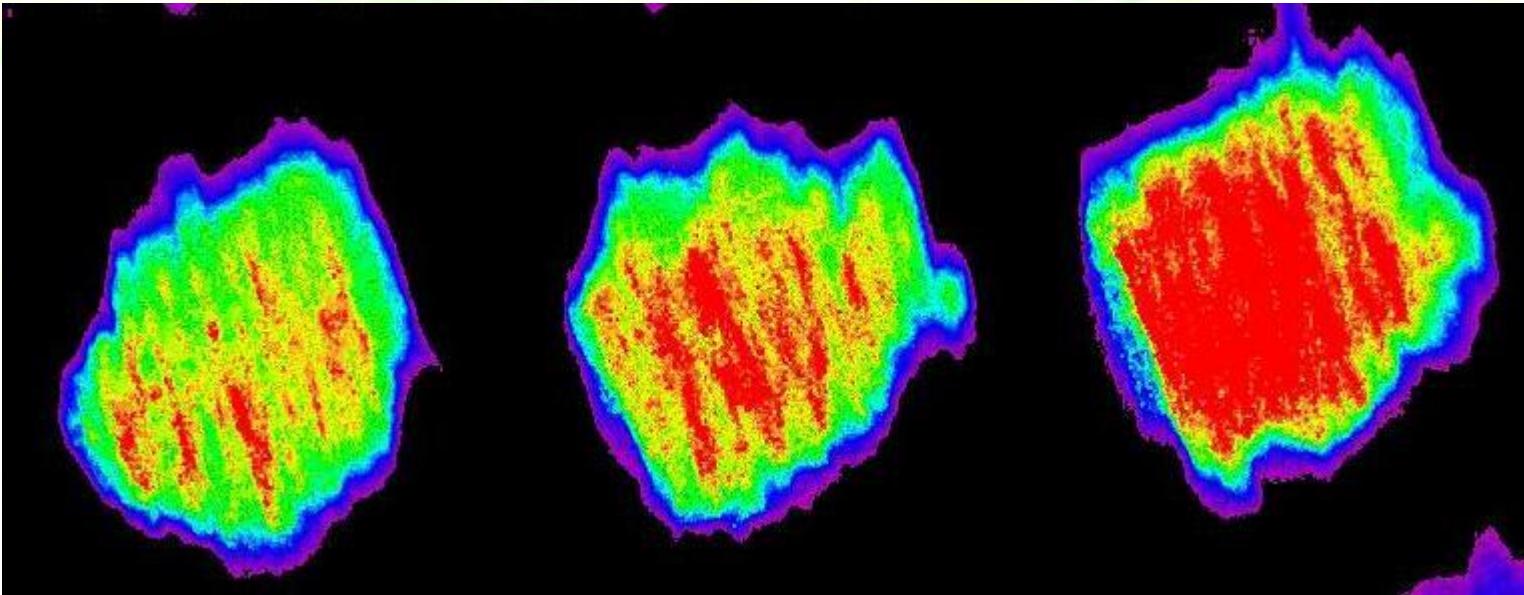
- Physiological measurements are taken to evaluate the overall health of the tree
- Leaf porosity, water potential, and leaf anatomy samples are taken to better quantify the health of the tree throughout the process of thermotherapy

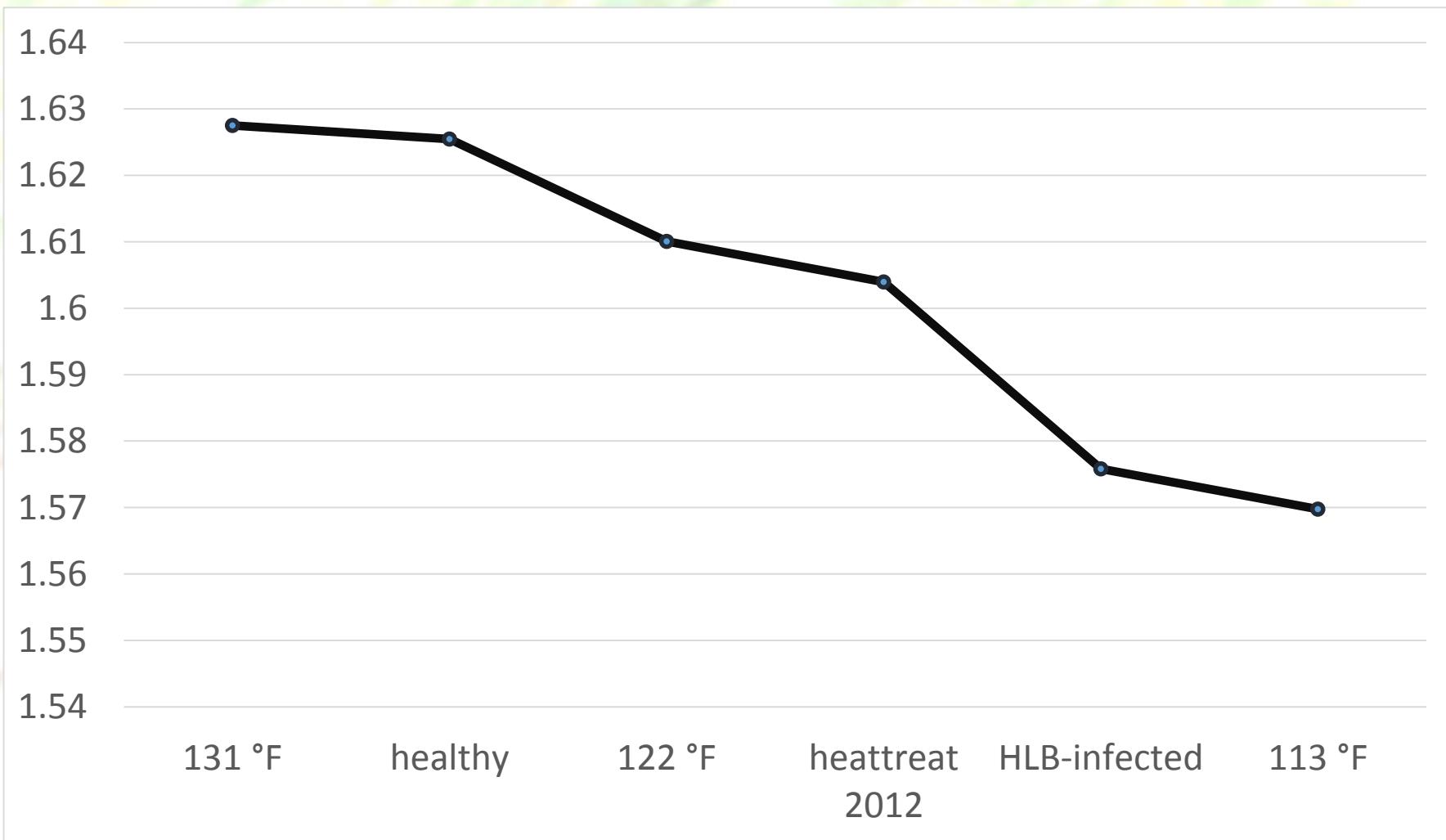


# Aerial Imaging to Access Heat Treatment





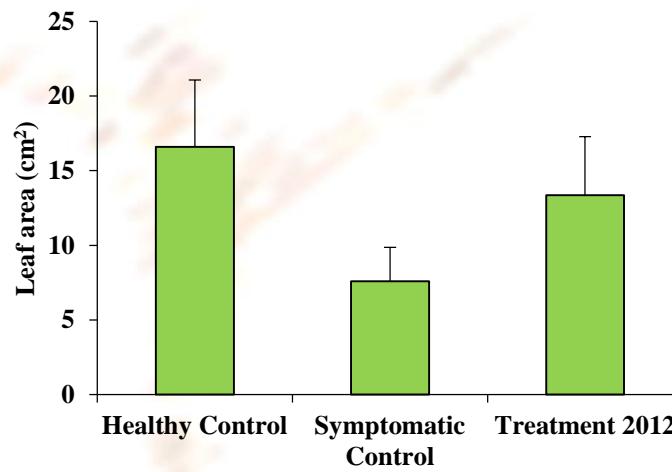




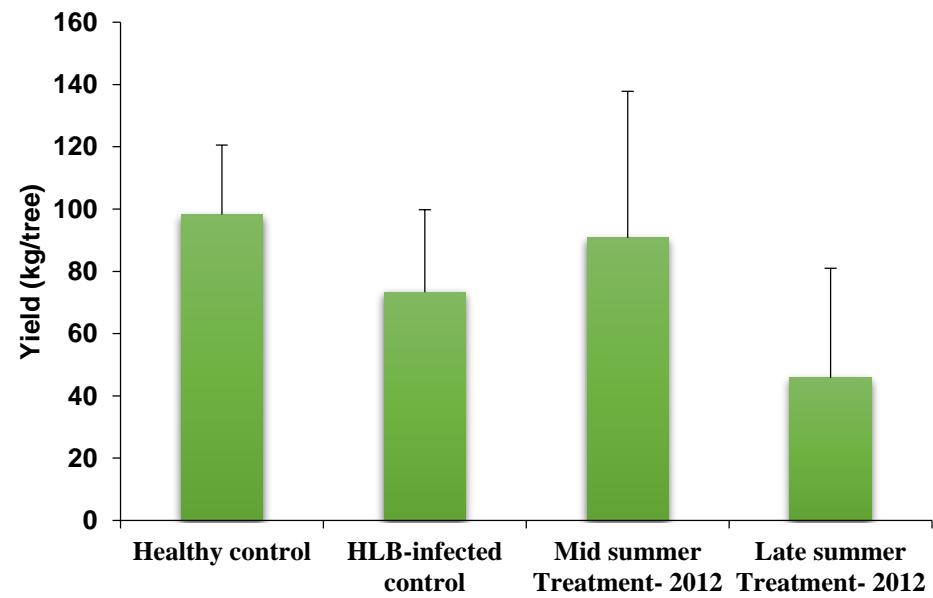
# Canopy Health Monitoring



HLB-infected (July 2012 treatment)



HLB-infected control



# Juice Quality

Treatment	Acid		Total SSC ( $^{\circ}$ Brix)		Ratio	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Healthy Control	0.8	0.1	<b>12.0</b>	<b>0.6</b>	<b>14.6</b>	<b>1.2</b>
HLB-infected Control	0.8	0.1	11.3	1.0	13.6	2.1
Mid summer Treated-2012	0.8	0.1	<b>12.0</b>	<b>0.5</b>	<b>16.1</b>	<b>1.6</b>
Late summer Treated -2012	0.8	0.1	11.0	1.1	13.8	2.3

# Damage to Lower Branches



Progression of heat-treated Valencia orange tree

# Psyllid Problem

---



# Covering Rows With Plastic



# Portable Diesel Indirect Forced Hot Air Heater

---



380,000 BTU  
20" Duct  
4,120 CFM output  
192 lbs  
56" L x 24" W x 33" H

# Heat Treatment in Late November

---



11-26-2013



12-20-2013



1-18-2014









# Summary

---

- Overall, thermal treatment seems effective in mitigating the progress of the disease.
- In systems that rely solely on heat from sun, there is a large amount of temporal and spatial temperature variability. A series of fans can reduce the amount of variability.
- Trees that were subjected to 122-131°F have shown signs of improvement.
- The duration of treatment depends on the tree size and age.
- Steam duration is much less than dry heat and it should be limited to 1-4 minutes depending on the size of tree.
- It seems the best time for heat treatment is after harvest April –November.

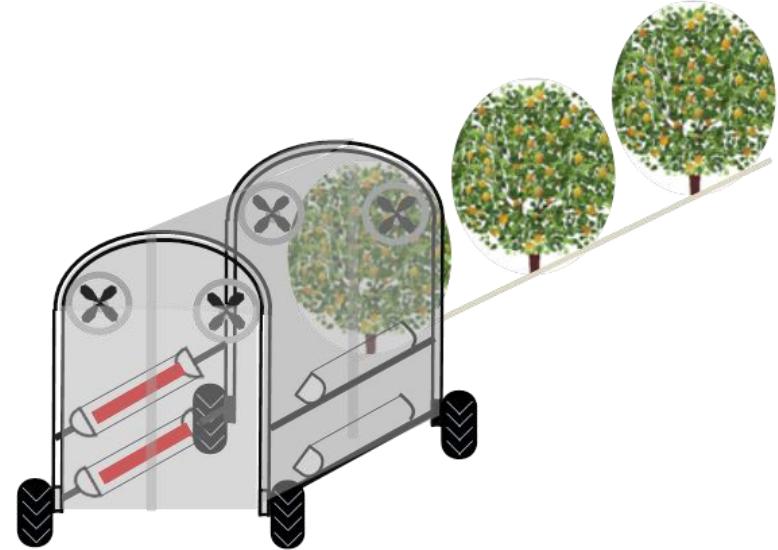
## FUTURE WORK

---

Improve the model to better predict the heat distribution for different size of trees.

Conducting more field trials

Heat treating the root system.



# Acknowledgements



- Dr. Jose Reyes
- Ms. Cininta Pertiwi
- Ms. Stefani Leavitt
- Ms. Luba Polonik
- Ms. Sherrie Buchanon
- Mr. Roy D. Sweeb



**THANK YOU**

Reza Ehsani,  
[ehsani@ufl.edu](mailto:ehsani@ufl.edu)

**UF | IFAS**  
UNIVERSITY *of* FLORIDA