Irrigation and Root Health in HLB-affected Citrus

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Outline

- Introduction on the current status of citrus production
- Importance of water management on HLB management and root density
- Effect of irrigation system (microsprinkler and drip) on root density
- Root distribution pattern as a function of irrigation and non-irrigated zone
- Summary
- Acknowledgements

Current Status of HLB

- Citrus accounts for ~$10 billion in economic activity
- Current citrus production ~437,000 acres
- Significant reduction in production area due to HLB
- Declined tree performance, root loss and significant defoliation
- Roots influence water and nutrient uptake in citrus and other crops

Irrigation strategies for managing HLB

- ***Preventative measures: HLB negative (healthy trees)***
  - Frequent irrigation (daily or multiple times a day)
  - Regulated deficit irrigation or CUPS
  - Exclusion of Asian citrus psyllids (ACP).

- ***Curative management of HLB positive trees (asymptomatic trees)***
  - Daily irrigation plus ACP control
  - Managing pH to optimum levels for nutrient availability (5.5 to 6.5)
  - Improved nutrition programs via fertigation and also controlled release fertilizers

- ***Remediation/Management of HLB affected trees (symptomatic trees)***
  - Daily irrigation plus Asian psyllid control
  - Managing pH to optimum levels for nutrient availability
  - Fertigation practices and controlled release fertilizers

Irrigation strategies for managing HLB (2)

Field studies on irrigation conducted in:

- Irrigation studies at 3 sites: Ave Maria, Avon Park, Arcadia (2013-2014)

➡ Comparison of Irrigation Schedules Daily, IFAS (irrigating every two days) and Intermediate (irrigating every 1.5 days) based on FAWN evapotranspiration

- Advanced Citrus Production Systems (ACPS) studies:

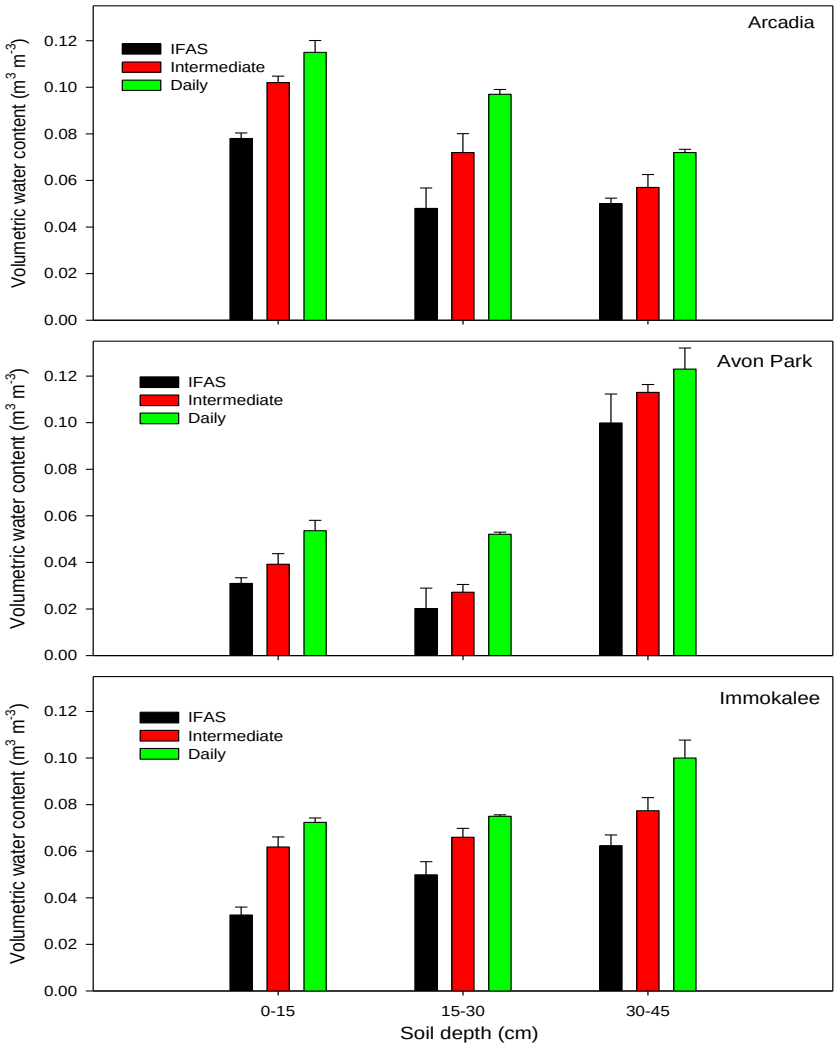
Two Sites: Immokalee at UF/IFAS, SWFREC, and Lake Alfred (2008 to 2012)

➡ Comparison of drip and modified microsprinkler irrigation with grower practices

- Greenhouse studies conducted at Immokalee, SWFREC (2014-2015)

➡ Comparison of HLB vs non-HLB affected citrus

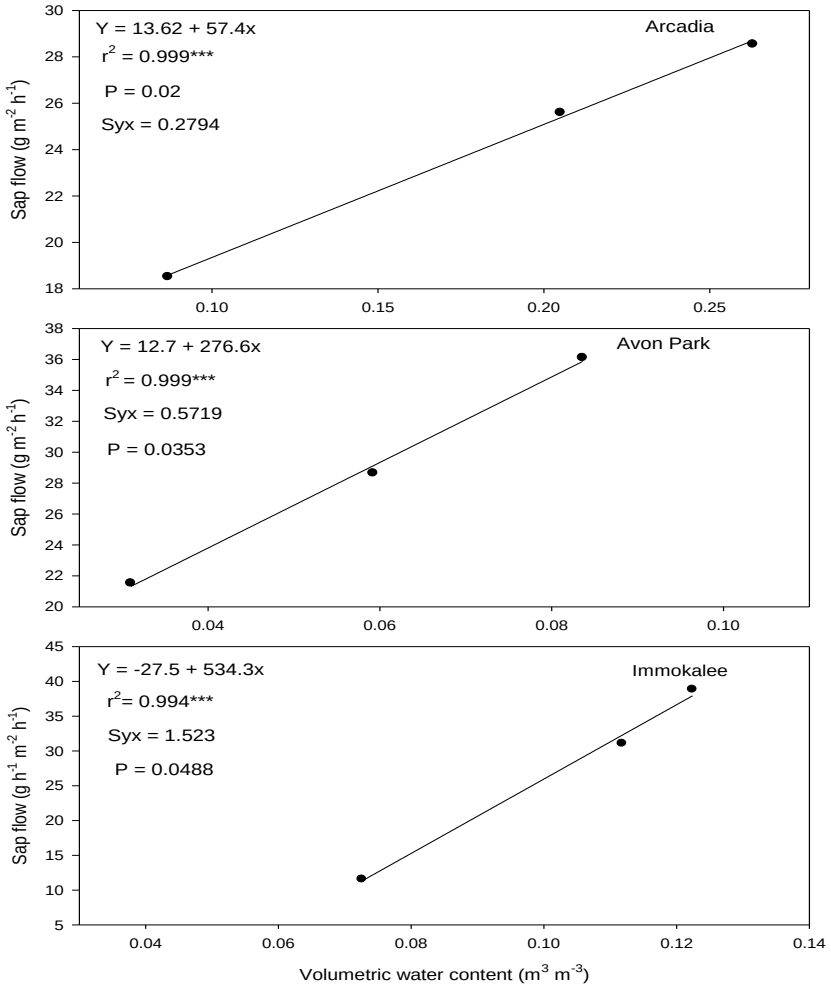
IRRIGATION STRATEGIES FOR MANAGING HLB (3)



Moisture contents (left) and significant relationships with sapflow (right)

Keeping water in the top 0-12 inches improved water use for HLB affected trees. Greater moisture content beyond the root zone (at 45 cm) in Immokalee could be due to capillary rise since the soils have a high water table and in Avon Park could be due to deep percolation because those soils are well drained.

More details: Hamido et al. 2017a. HortScience 52(6):916-921.



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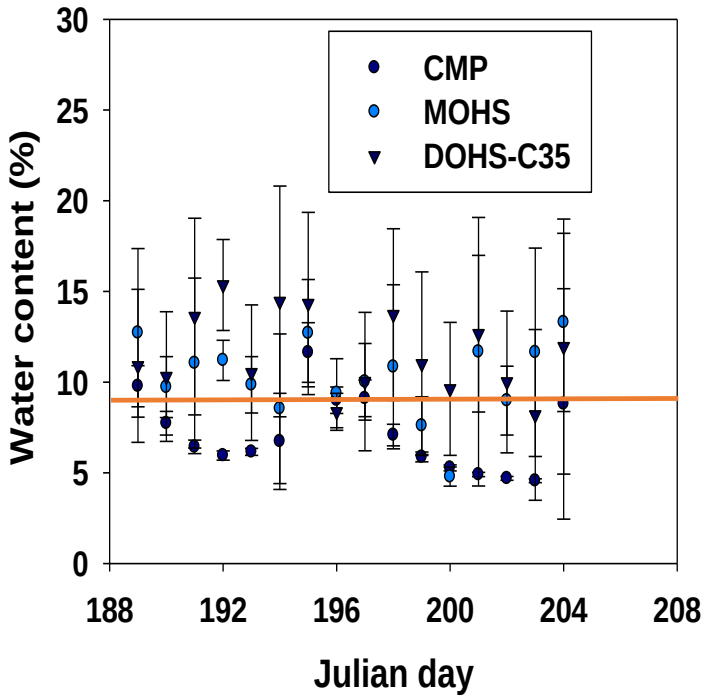
Irrigation strategies for managing HLB (4)

- **Increasing total available water (TAW) with depth, greater uptake in the top 6 inches due to constant availability of water in the root zone.**

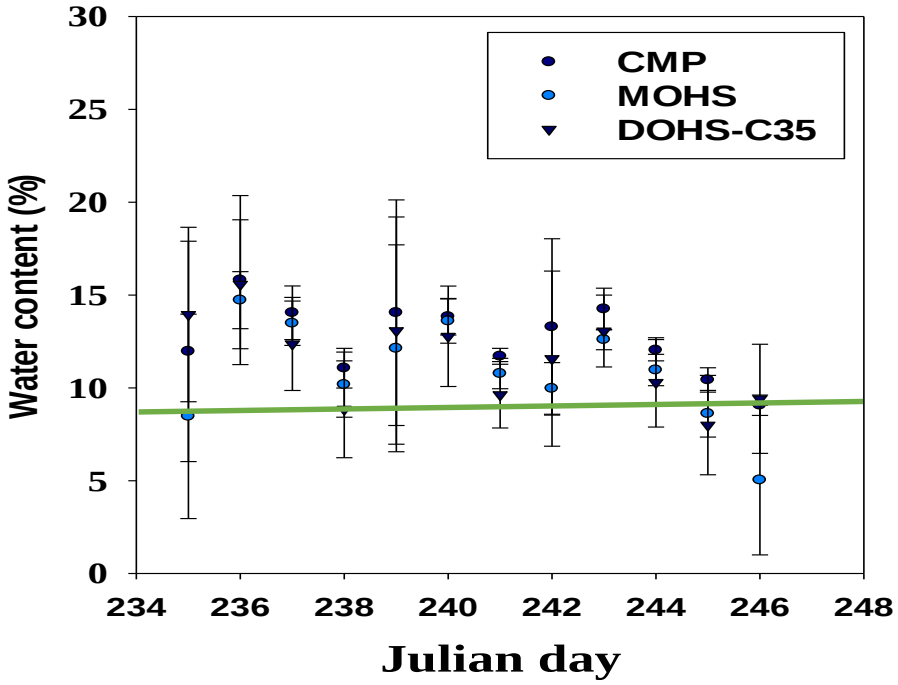
- **Greater TAW in top 6 inch than lower 6-18 inches for Daily than Intermediate and IFAS irrigation schedule.**

- **Increased root density in wetted zones**

Irrigation strategies for managing HLB (5)



July 2010



Aug-Sept 2011

CMP-Conventional microsprinkler irrigation
MOHS-Microprinkler open hydroponic system with daily irrigation and weekly fertigaton.
DOHS-C35-Drip open hydroponic system with daily irrigation and fertigation

Soil moisture at 4-inch depth was close to or slightly above field capacity in the range of 7 and 15%.

Kadyampakeni et al. 2014a, b. Soil Science Society of America Journal 78:645–654; 78:1351–1361

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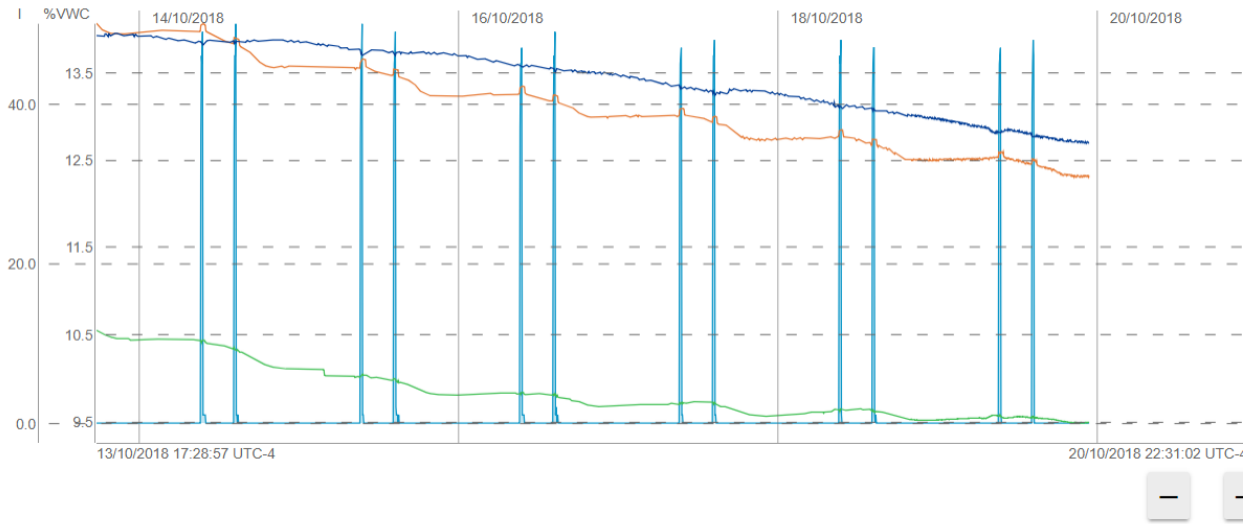
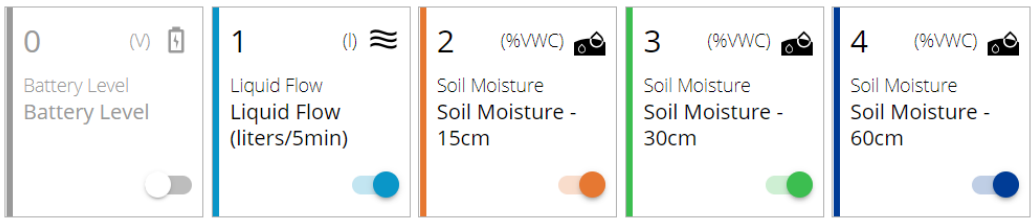
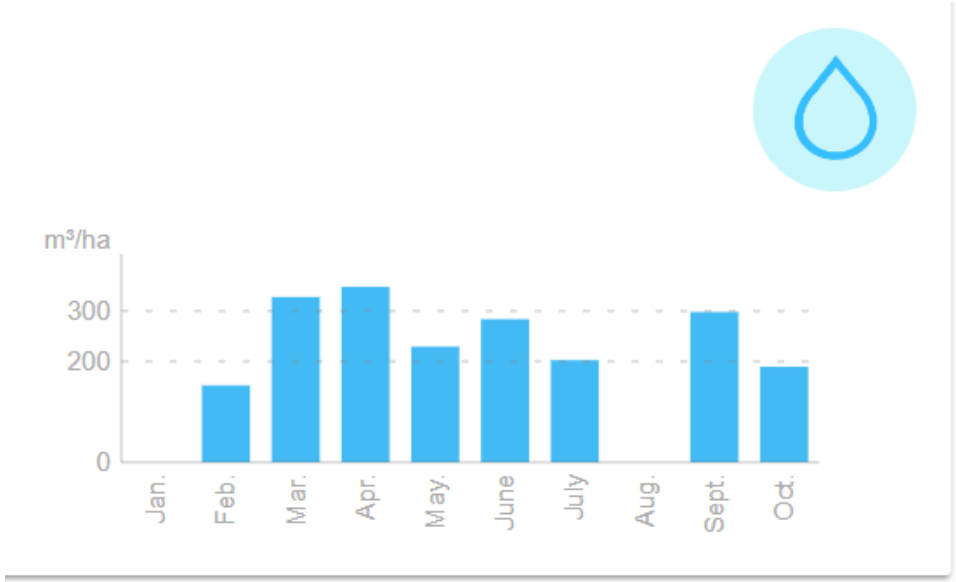
IRRIGATION STRATEGIES FOR MANAGING HLB (5)

Water monitoring at grove scale and soil moisture distribution at 6-, 12 and 24-inch soil depth







~217,238 gal/acre since Feb. 2018

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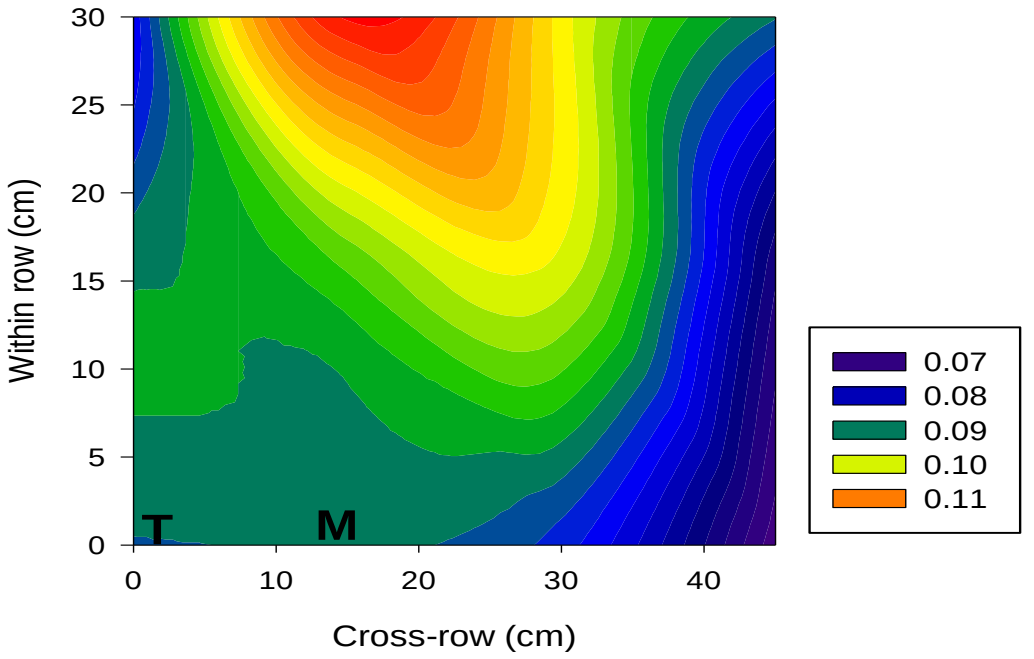
EFFECT OF CONVENTIONAL MICROSPRINKLER IRRIGATION SYSTEM ON ROOT DENSITY

Lateral root density distribution using conventional microsprinkler irrigation

Positions in the irrigated zones of a conventional microsprinkler showed moderate root density distribution. The root density was about a third or quarter of the density observed with drip or linear microsprinkler irrigating system.



T=tree, M=microsprinkler
Roots uniformly distributed around the tree

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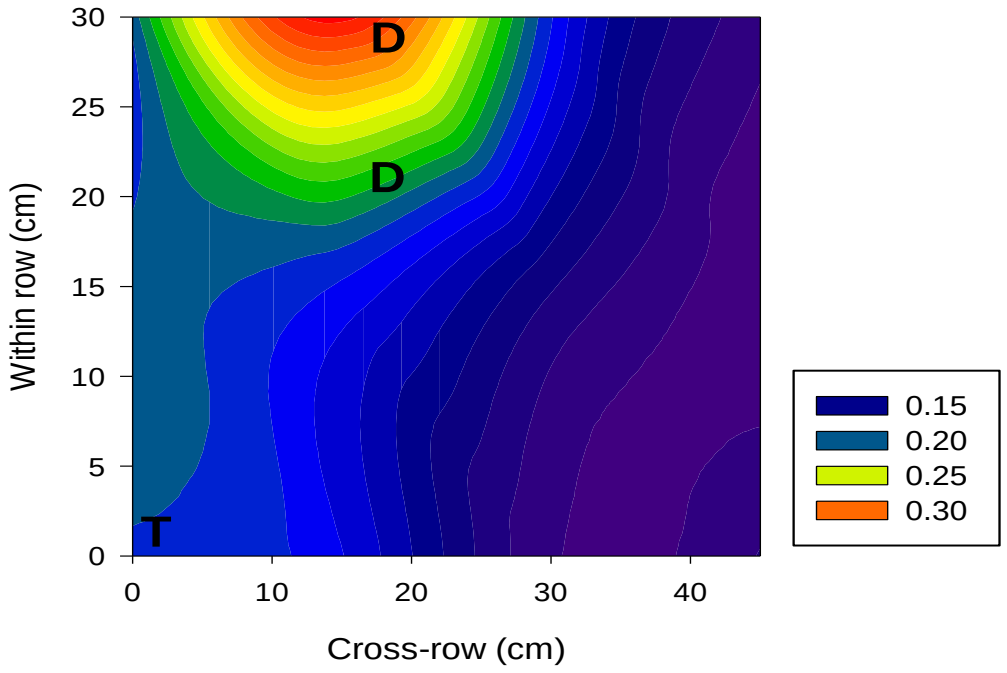
EFFECT OF IRRIGATION SYSTEM (MICROSPRINKLER AND DRIP) ON ROOT DENSITY

Lateral root density distribution using drip irrigation.

Positions in the irrigated zones of drip irrigation systems showed higher root density (2 to 3x greater) than non-irrigated zones.



T=tree, D=dripper, Roots concentrated below the drippers

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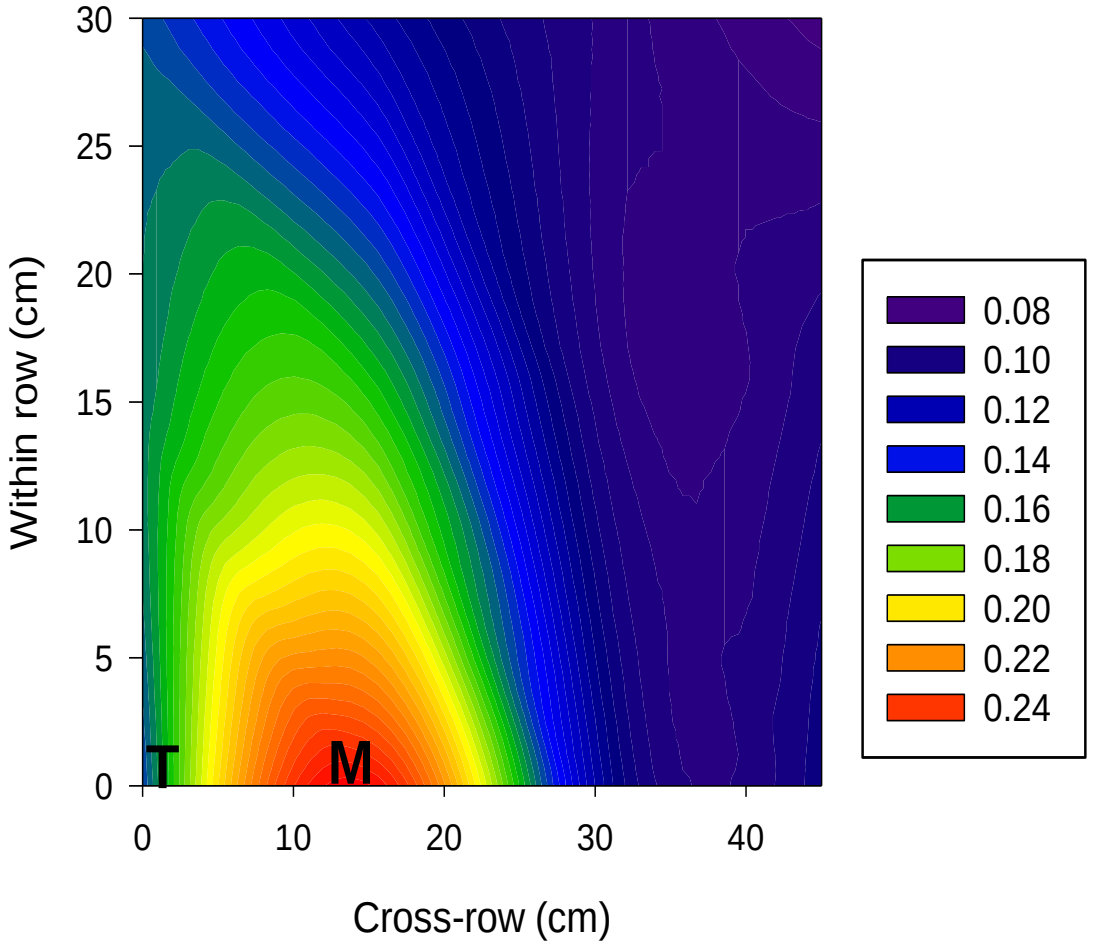
EFFECT OF LINEAR MICROSPRINKLER IRRIGATION SYSTEM ON ROOT DENSITY

Lateral root length density (cm cm^{-3}) distribution using modified microsprinkler irrigation

Positions in the irrigated zones of linear microsprinkler showed higher root density than non-irrigated zones



M = microsprinkler
T = tree

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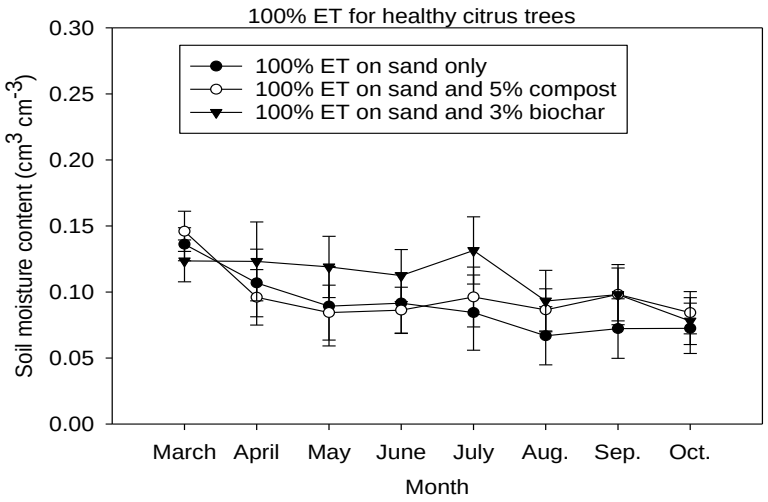
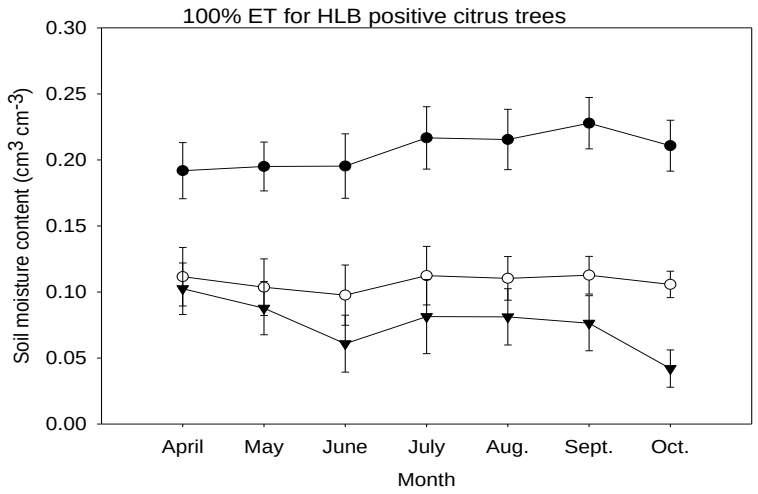
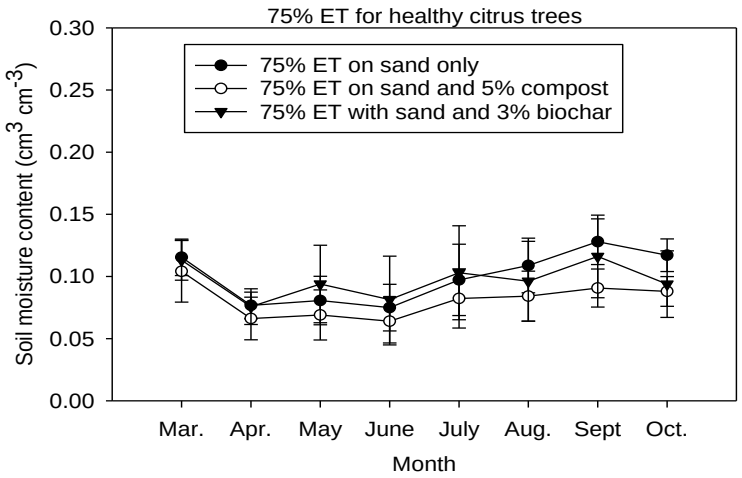
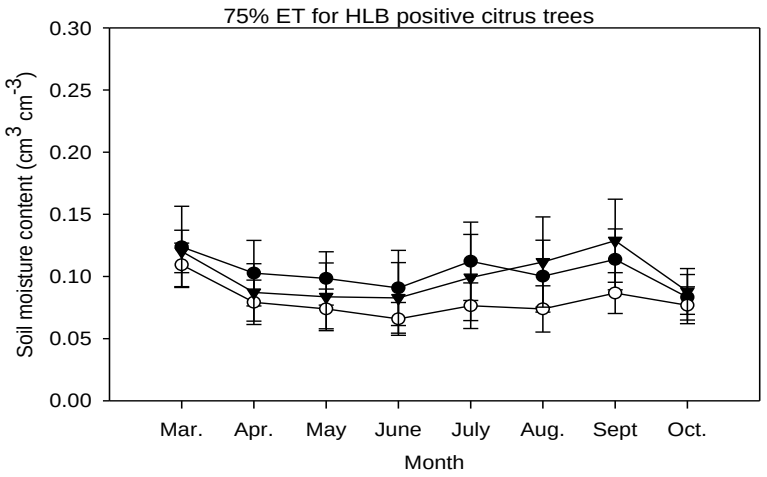
SOIL MOISTURE AVAILABILITY AMONG HLB AFFECTED AND NON-AFFECTED TREES









Soil moisture in the soil without any amendment showed 40 to 52% greater soil moisture than those HLB-affected trees grown on sand amended with compost and biochar at 100% ET irrigation signaling greater water uptake for the latter.

Frequent irrigation at 100% evapotranspiration (ET) was recommended for HLB affected trees due to limited growth at 75% ET.

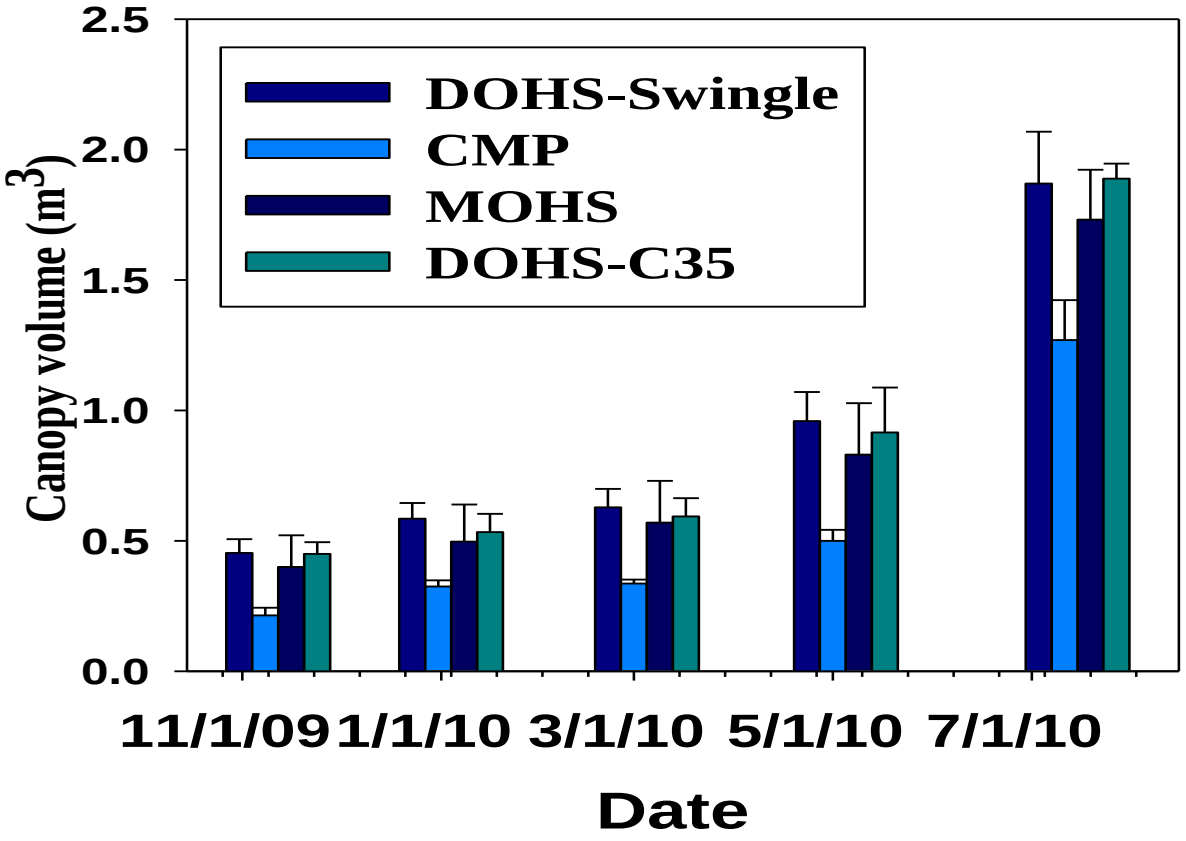
Temporal soil moisture distribution as a function of citrus greening disease and irrigation rate under greenhouse conditions.

WATER USE OF HLB AFFECTED TREES IN SOUTHWEST FLORIDA UNDER GREENHOUSE CONDITIONS

Month -year	ET_o (mm d^{-1})	ET_c (mm d^{-1})		ET_c diff. (%)‡
		Hamlin-Non HLB	Hamlin-HLB	
Jan-Jun-14	3.57	2.97	2.23	23.73
Jul-Dec-14	4.42	4.16	2.63	34.82
Jan-Jun-2015	3.38	4.08	2.83	29.82
Jun-Oct-15	3.73	4.94	3.18	35.20
Overall Average	3.79	4.00a**	2.69b**	30.75
		Valencia-Non HLB	Valencia-HLB	
Jan-Jun-14	3.57	2.83	2.22	22.28
Jul-Dec-14	4.42	3.97	2.83	28.85
Jan-Jun-2015	3.38	3.85	2.69	30.98
Jun-Oct-15	3.73	4.79	3.56	26.42
Overall Average	3.79	3.82a**	2.80b**	26.99**

- 22 to 35% greater water use for Non-HLB affected trees
- Inter-season and annual variability in water use
- Comparable water use between varieties

Effect of irrigation practices on canopy size



Canopy volume as a function of irrigation practice at the Lake Alfred site

Treatments:
DOHS is the drip open hydroponic system on Swingle or C-35 rootstock
CMP is the conventional microsprinkler practice
MOHS is a microsprinkler hydroponic system applying water linearly in the tree row.

Advanced citrus production system (ACPS) fertigation had greater tree size than conventional practice

Summary

- Daily, frequent irrigation critical for improved tree performance, soil moisture distribution and water use
- HLB affected trees use 22 to 35% less water than the non-affected trees, thus irrigation amount could be reduced without affecting yield. This needs to be validated at field scale since this was a greenhouse study.
- Intensive irrigation practices could be adapted to grower practices for vigorous tree growth, water use, greater root density and nutrient accumulation.

Acknowledgements

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  - Orange Co., Arcadia, FL
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Questions/Comments