UPDATE ON IRRIGATION AND NUTRIENT MANAGEMENT STUDIES OF HLB AFFECTED TREES

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Outline

- Status of HLB in FL: What we know now
- Irrigation studies for managing HLB: Examples
- Nutrition studies for managing HLB: Highlights
- Summary
- Acknowledgements

Current Status of HLB

- Citrus accounts for $10 billion in economic activity
- Pre-HLB 240 million boxes
- Current 80 million boxes, about 67% reduction in production
- Production costs up to $2100 per acre due to HLB
- Significant reduction in production area
- Declined tree performance, root loss and significant defoliation

Irrigation strategies for managing HLB

- Preventative measures: HLB negative (healthy trees)
  - Frequent irrigation (daily or multiple times a day) e.g. Citrus Under Cover Production System
  - Regulated deficit irrigation
  - Partial root zone drying

  Plus Asian psyllid control

- Curative management of HLB positive trees (asymptomatic trees)
  - Daily irrigation plus Asian psyllid control
  - Managing pH to optimum levels for nutrient availability
  - Improved nutrition programs via fertigation

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

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 Daily, IFAS and Intermediate Irrigation Schedules based on FAWN evapotranspiration

- Advanced Citrus Production Systems (ACPS) studies:

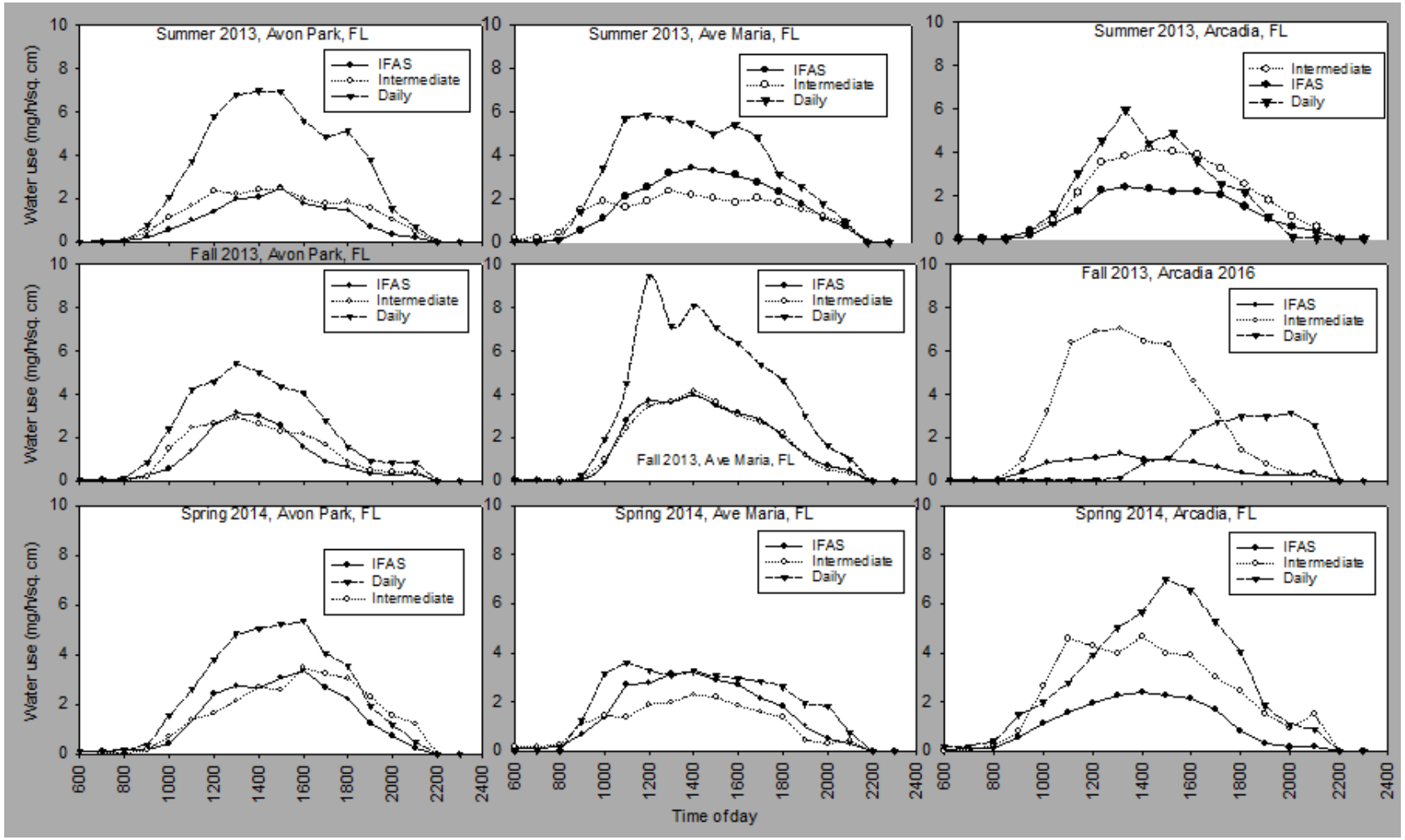
Two Sites: Immokalee at UF/IFAS, SWFREC, and Lake Alfred (2008 to 2011)

➡ 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 studies



Water use of HLB affected trees in south west and central Florida

- Daily > Intermediate > IFAS irrigation scheduling
- Daily irrigation could help in managing HLB affected trees, reduce tree water stress

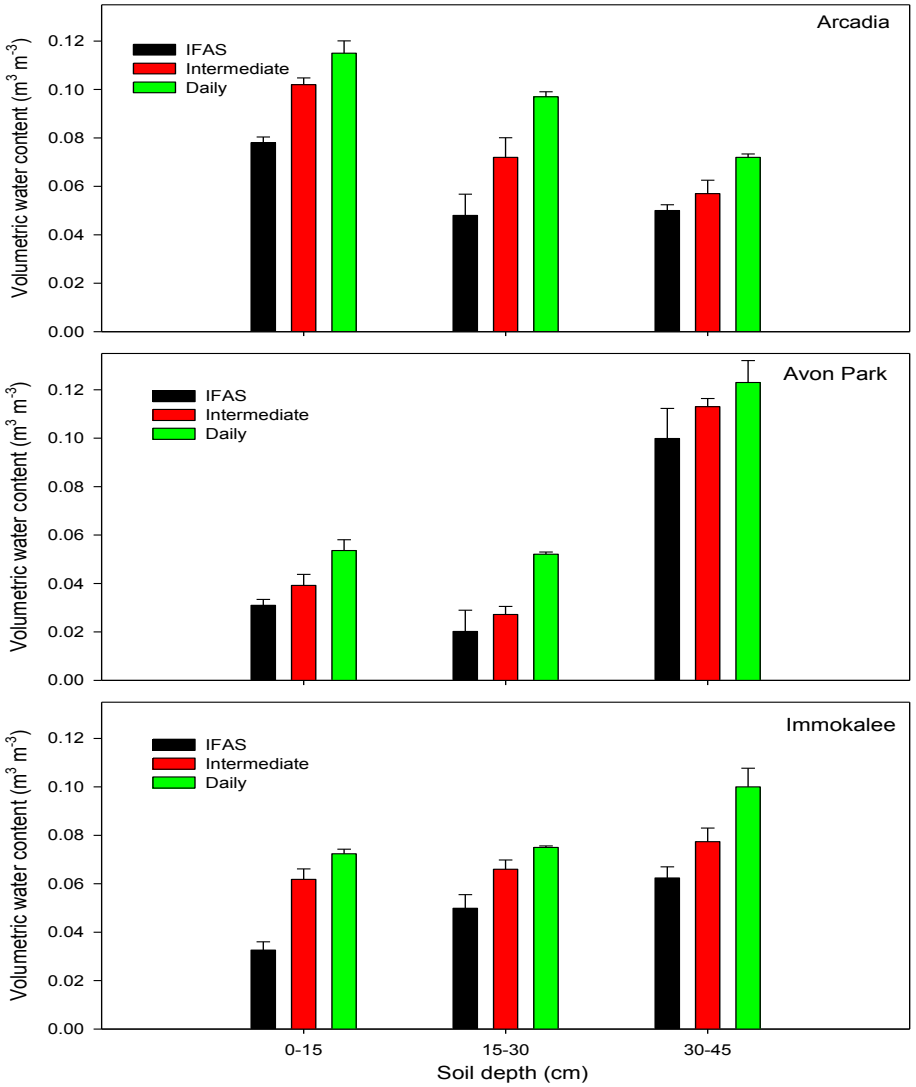
Irrigation studies (2)

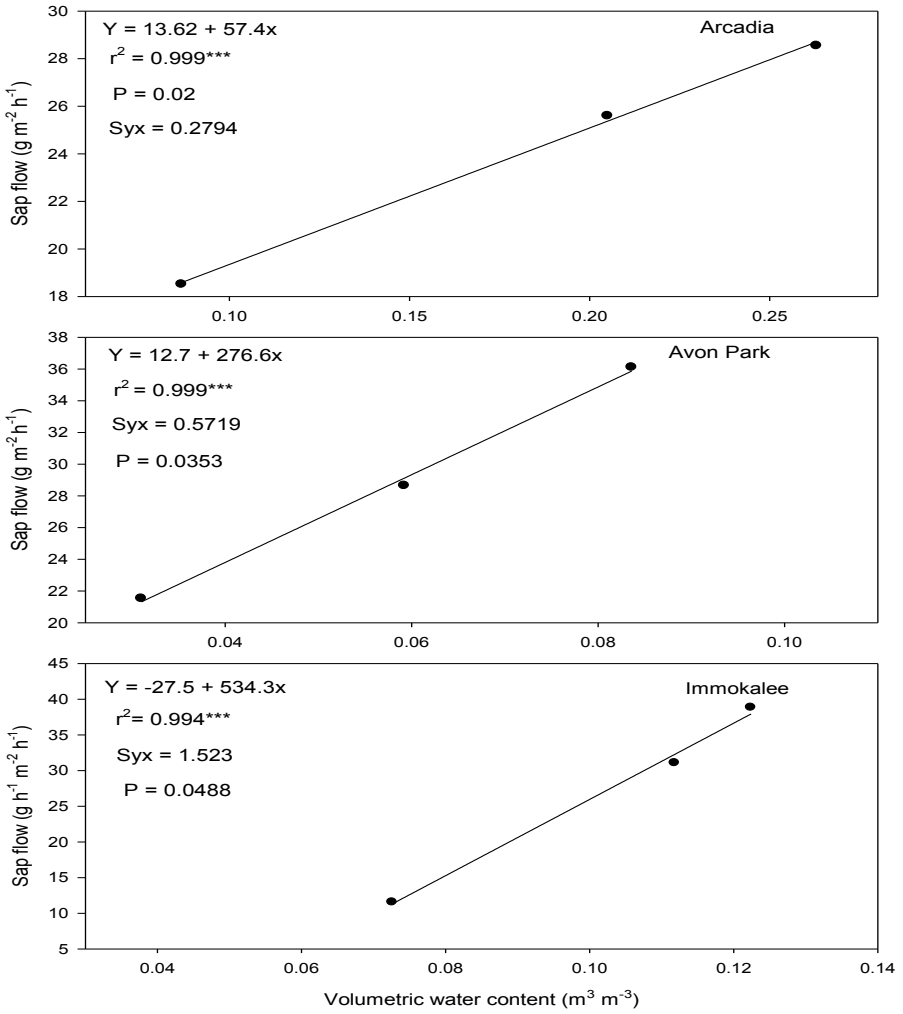
Total available water (%) in southwest and central Florida

Irrigation treatment	Soil depth (cm)	Commercial site		
		Arcadia	Avon Park	Immokalee
Daily				
	0-15	68.9dc	80.7b	68.1bc
	15-30	72.2c	58.7c	75.3b
	30-45	98.2a	87.8a	97.9a
Intermediate				
	0-15	52.2fg	56.3cd	64.5c
	15-30	58.9ef	61.4c	46.6d
	30-45	98.8a	74.3b	42.3d
IFAS				
	0-15	48.1g	49.7d	46.6d
	15-30	80.9b	50.4d	32.1e
	30-45	62.3de	61.9c	69.3bc
		ANOVA		
		Arcadia	Avon Park	Immokalee
Source of variation		Pr > F	Pr > F	Pr > F
Irrigation treatment		<.0001	<.0001	<.0001

- Increasing TAW with depth, greater uptake in the top 6 inches.
- Greater TAW in in top 6 inch than lower 6-18 inches for Daily than Intermediate and IFAS irrigation schedule.

Irrigation studies (3)





Moisture contents and significant relationships with sapflow

ACPS studies

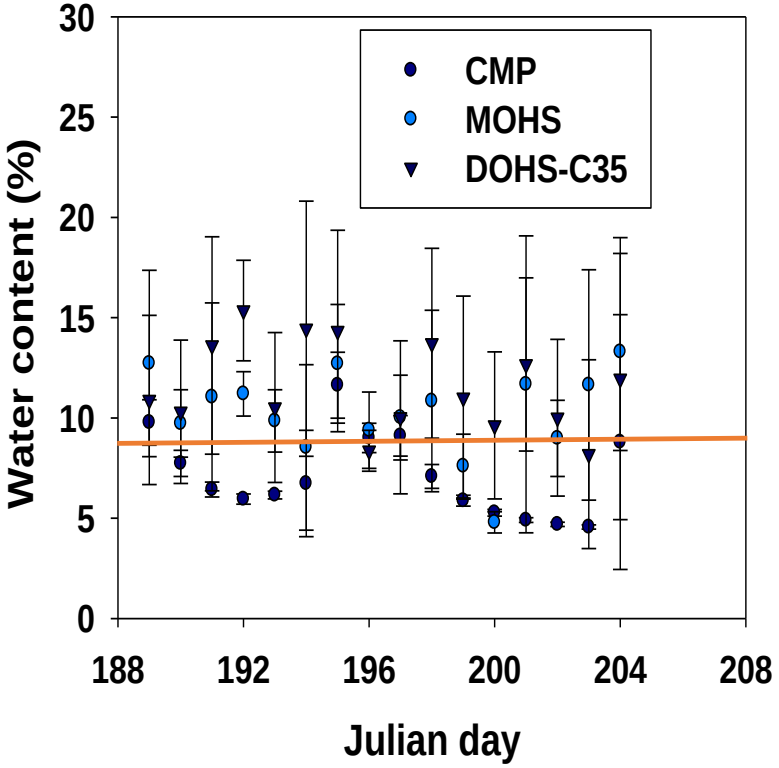
Irrigation method	HLB	Site	Water use per canopy vol. lbs/ft^3/d	Water use per leaf area lbs/ft^2/d
Conventional	-	Ridge	0.28±0.13a	0.35±0.20a
Drip	-	Ridge	0.24±0.01a	0.24±0.01a
RM	-	Ridge	0.20±0.18a	0.23±0.20a
Conventional	+	Flatwoods	0.19±0.05a	0.24±0.04a
Drip	+	Flatwoods	0.28±0.10a	0.29±0.08a
RM	+	Flatwoods	0.19±0.09a	0.46±0.19a

RM=Restricted microsprinkler.

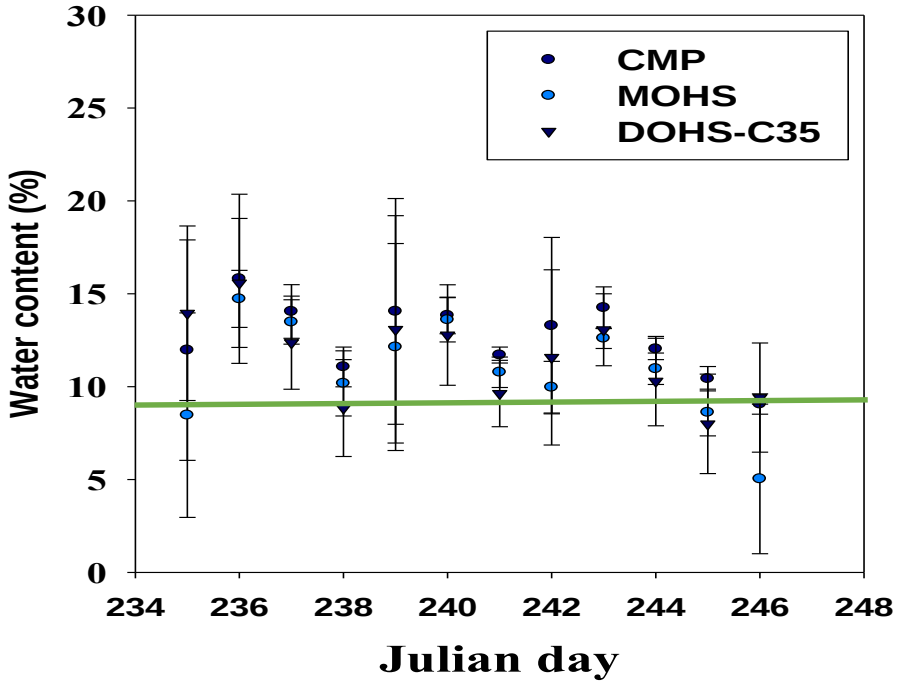
- Daily water use was not statistically different between the ACPS irrigation methods compared with the Conventional grower practices even though irrigated area is smaller.

ACPS (2)

Soil moisture at 10 cm was close to or slightly above field capacity in the range of 7 and 15%



July 2010



Aug-Sept 2011

Greenhouse studies (1)

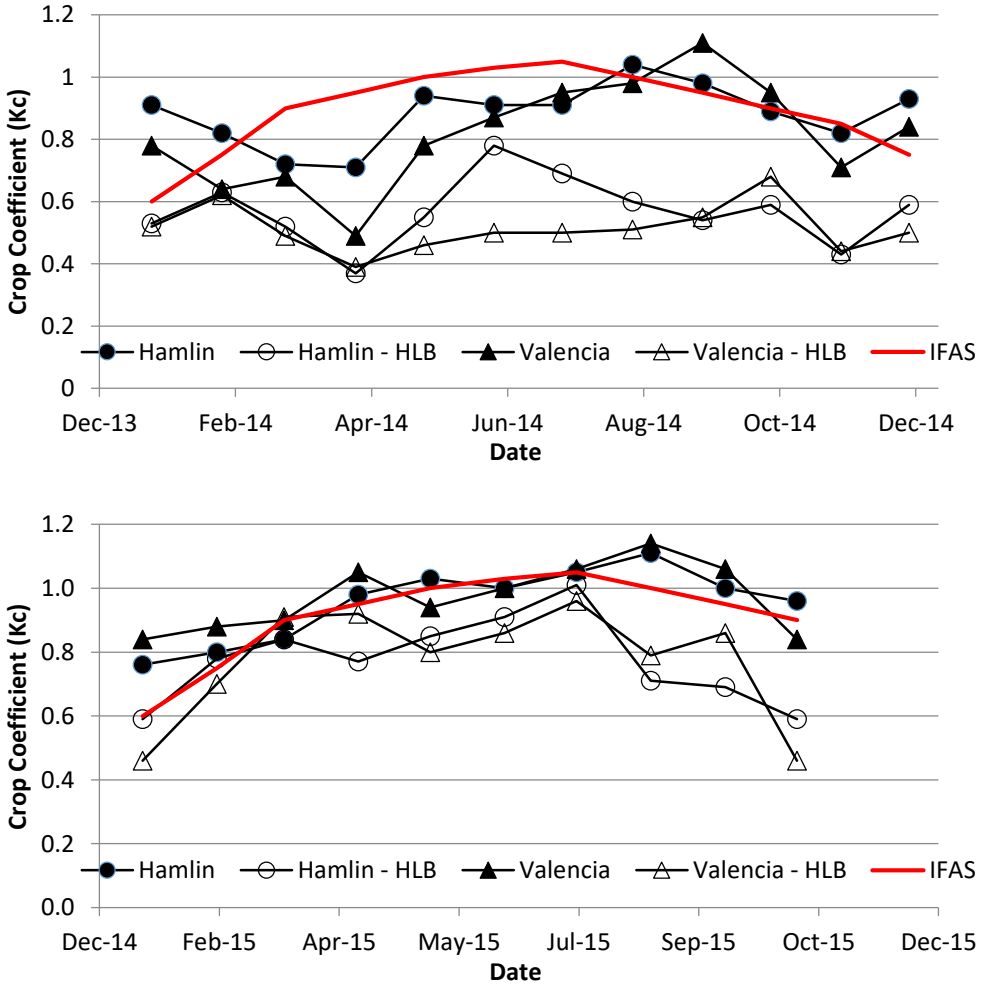
Water use of HLB affected trees in southwest Florida under greenhouse conditions

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

Greenhouse studies (2)

- Patterns of K_c similar for HLB affected and non-affected trees
- Non-affected tree K_c similar to those found to field trees prior to greening
- Infected trees consistently with lower K_c
- 35.2% in 2014 and 20.8% in 2015



Crop coefficient (Kc) for HLB affected trees in southwest Florida under greenhouse conditions

Nutrition studies for managing HLB: Highlights

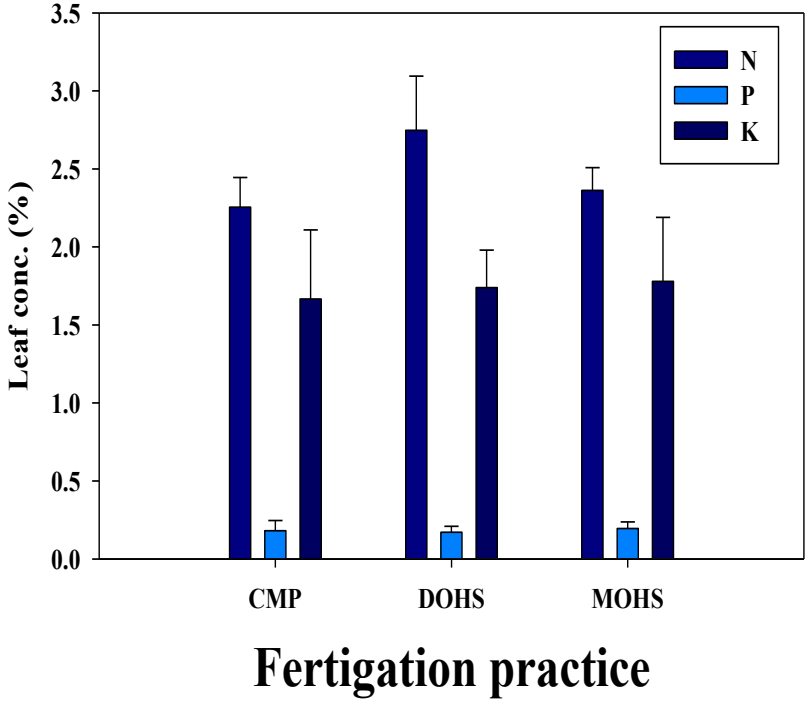
- Advanced Citrus Production Systems (ACPS) studies:

→ Two Sites: Immokalee at UF/IFAS, SWFREC, and Lake Alfred (2008 to 2011)

→ Comparison of drip and modified microsprinkler fertigation systems with Conventional grower practices

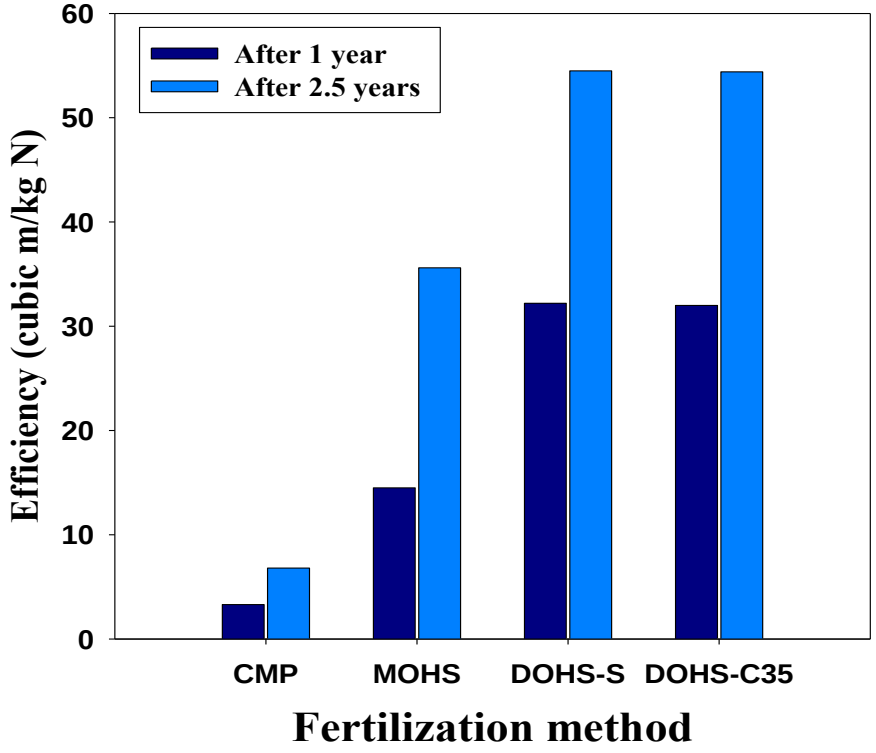
→ Two ACPS systems: drip (DOHS) and microsprinkler (RM, MOHS), and conventional microsprinkler practice (CMP)

ACPS Nutrition Studies



Leaf NPK concentration

Leaf NPK conc. were in optimum or high range.



Nutrient efficiency (m^3/kg N)

CMP needs more fertilizer and water per ha at 1 to 2.5 years than ACPS (Schumann et al. 2010)

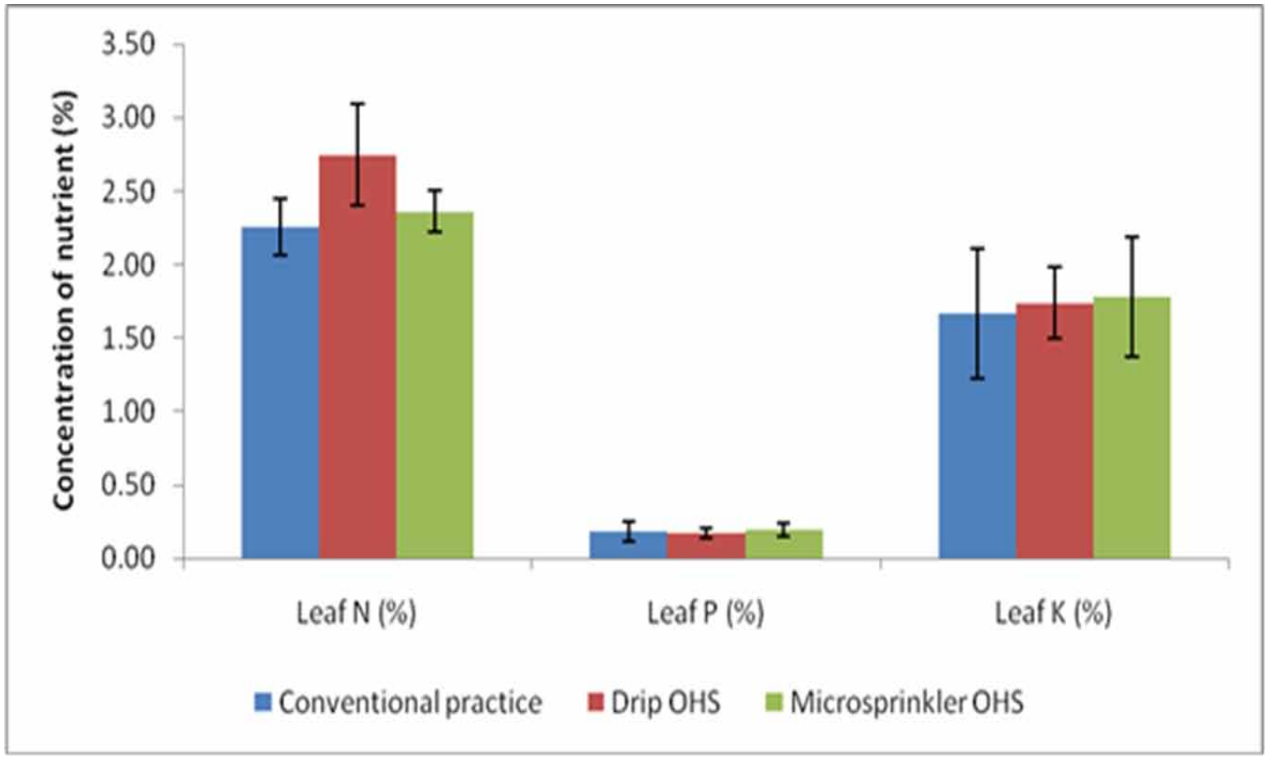
ACPS Nutrition Studies (2)

N and P accumulation on Immokalee sand

Fertigation method	CMP	Drip	RM	CMP	Drip	RM
Tissue	N (kg ha^{-1})			P (kg ha^{-1})		
Leaves	24.00	49.78	37.10	1.34	1.69	1.48
Fruits	22.40	15.78	29.98	2.68	1.03	2.28
Branches/trunk	20.70	28.38	26.44	4.76	3.80	4.22
Roots	11.60	20.82	20.20	2.85	2.98	2.96
Total	78.70	114.78	113.72	11.64	9.52	10.95

High N accumulation with ACPS than CMP but P accumulation similar for all practices.

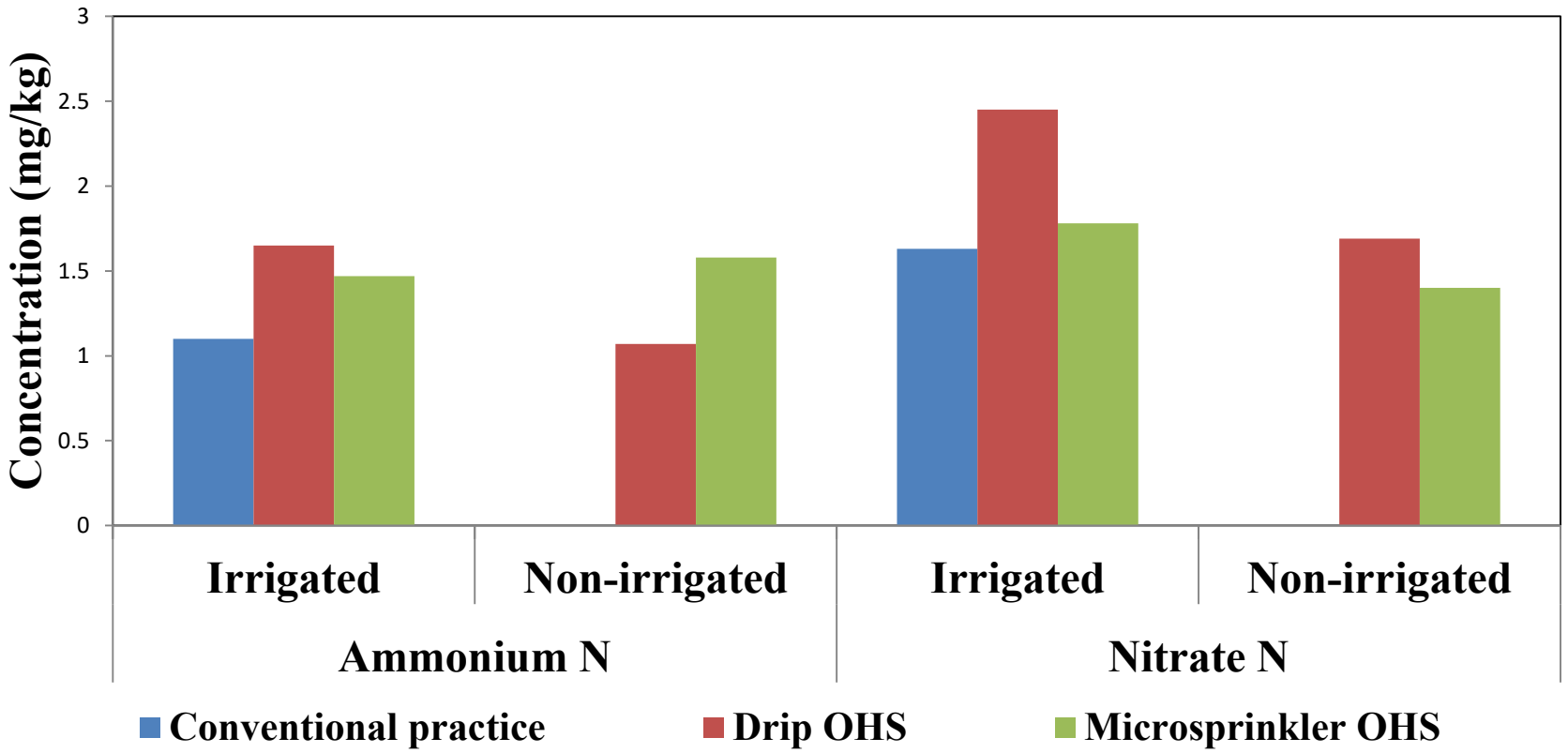
ACPS Nutrition Studies (3)



Leaf NPK concentration (%) determined in June 2009 at Immokalee.

- Sufficient NPK concentrations.
- Drip OHS was effective in enhancing N uptake compared with the other two irrigation methods studied.
- Leaf P concentration was high (0.17-0.30%) in all treatments
- Leaf K concentration was within optimum and high ranges (1.2-2.4%) suggesting
- No significant differences between ACPS and Conventional method.

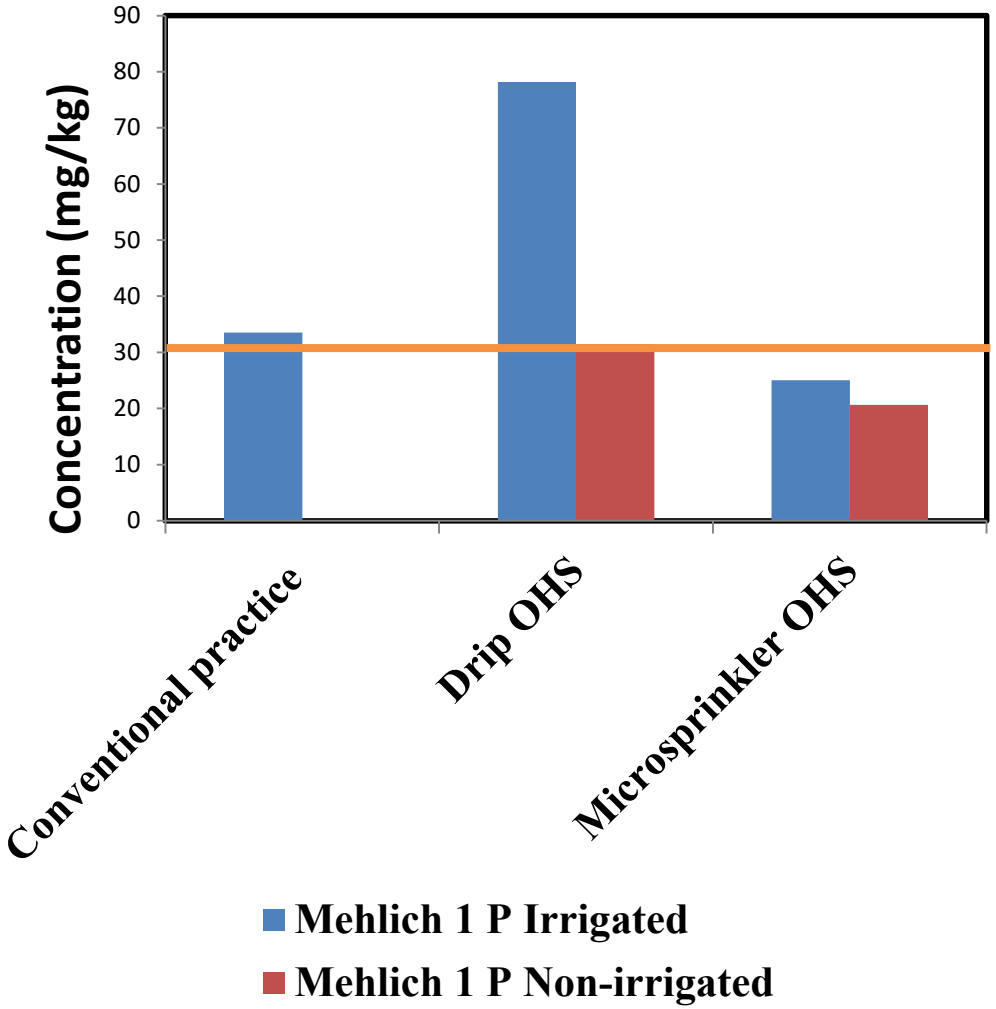
ACPS Nutrition Studies (4)



Ammonium and nitrate distribution in the irrigated and non-irrigated zone

- Greater inorganic N in irrigated than non-irrigated zones
- Better N contents in irrigated zones of ACPS than Conventional.

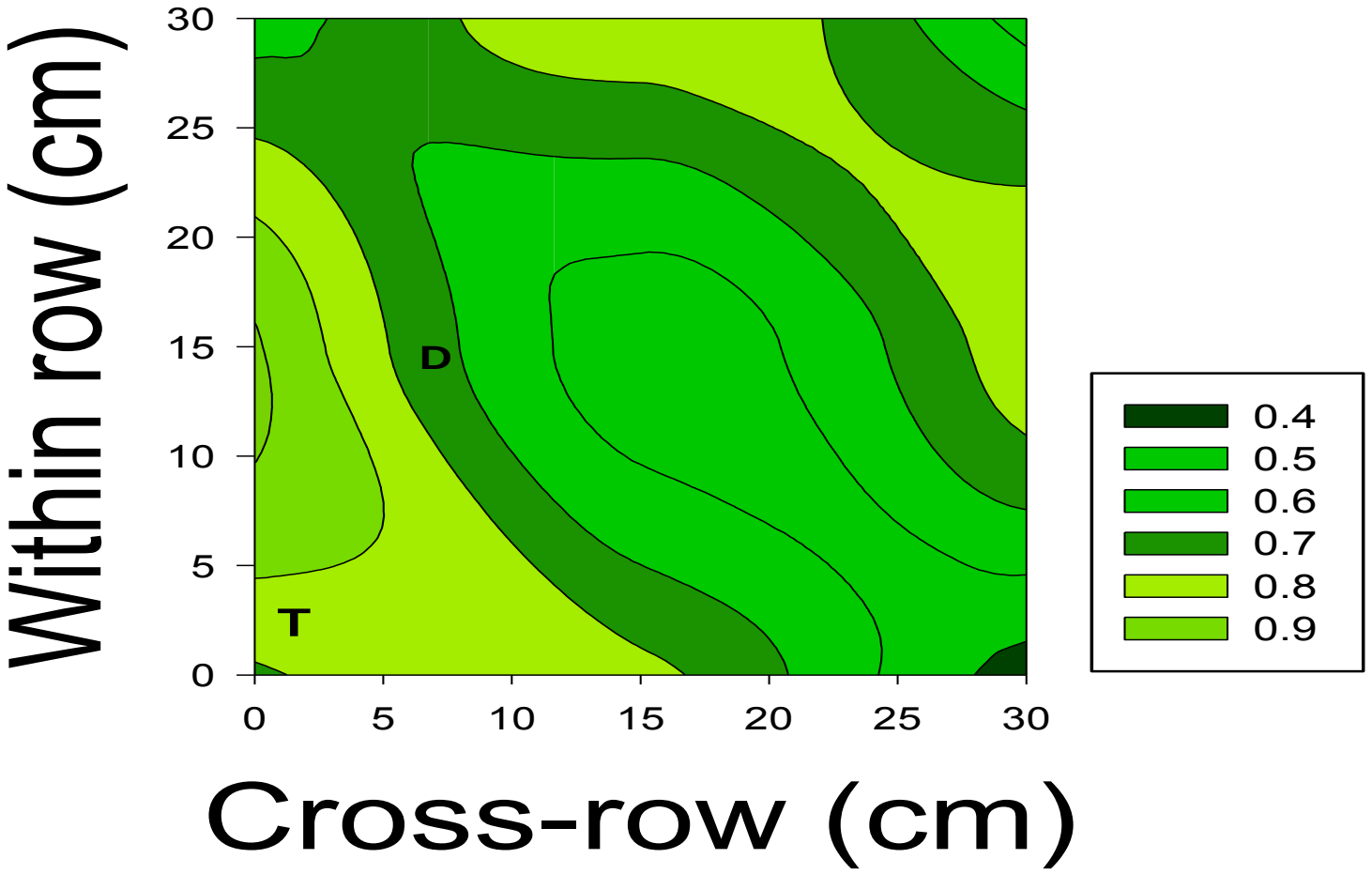
ACPS Nutrition Studies (5)



Soil P distribution in the irrigated and non-irrigated zones

- Greater P in irrigated than non-irrigated zones
- Soil P contents in irrigated zones of Drip greater than Conventional.

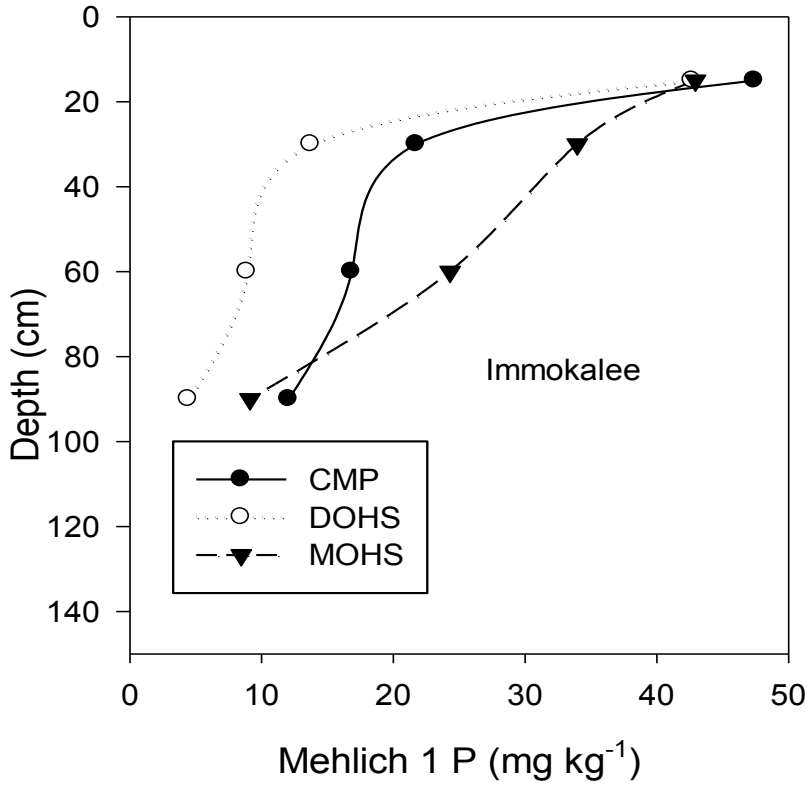
ACPS Nutrition Studies (6)

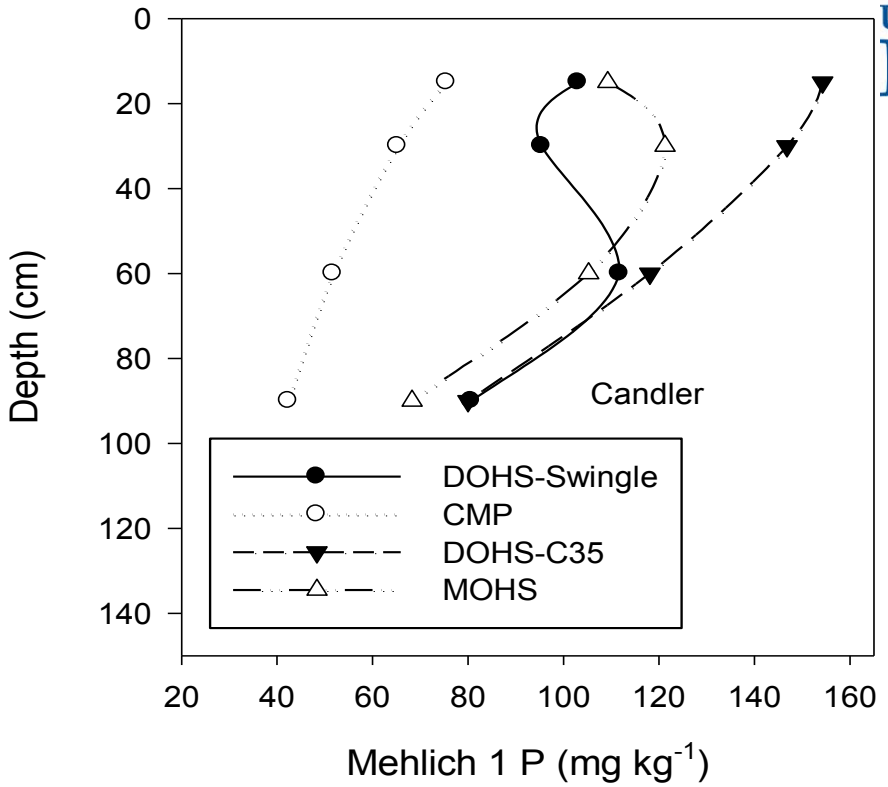


Higher NPK conc. in irrigated vs. non-irrigated zones of drip fertigation. D=area below dripper, T=tree

Lateral ammonium-N (mg/kg) distribution in July 2010 at the Lake Alfred site using drip fertigation.

ACPS Nutrition Studies (7)



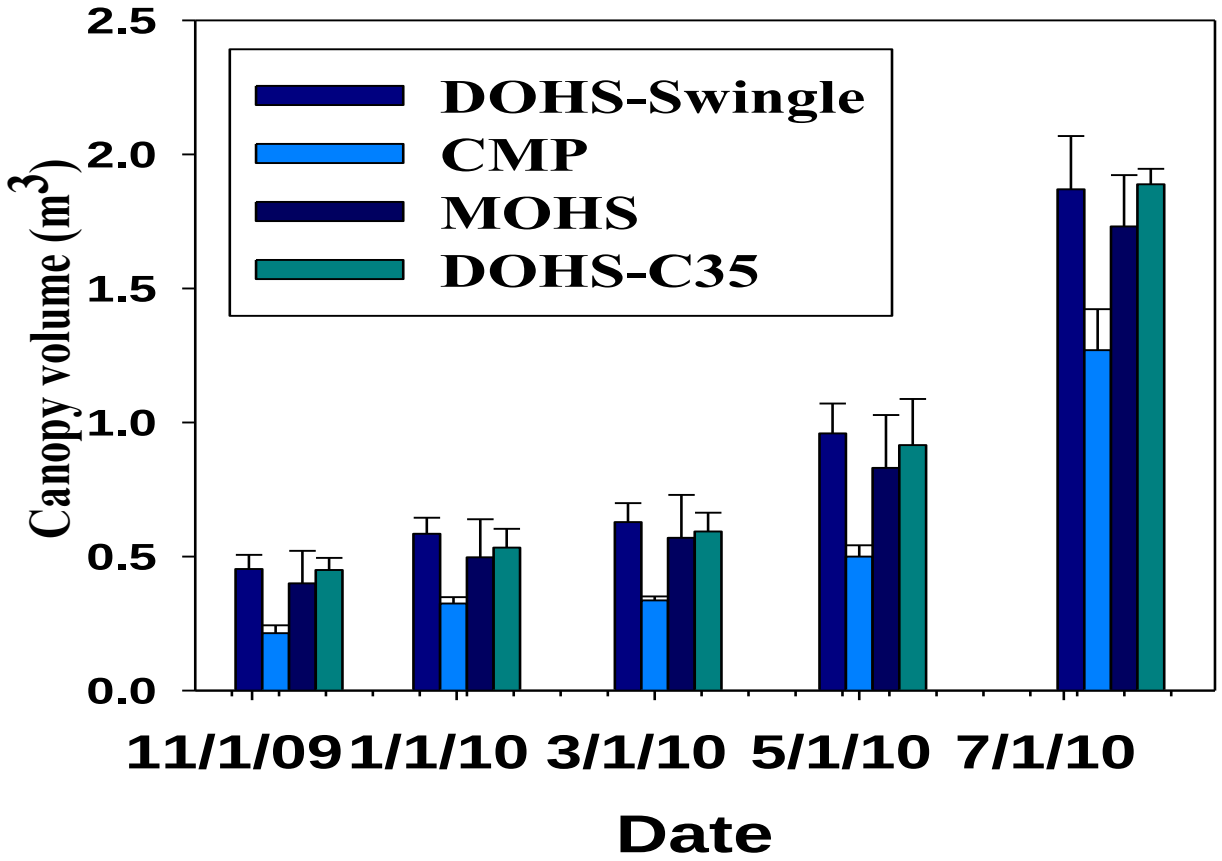


Vertical P distribution at Immokalee and Lake Alfred sites in 2010

Less P leaching with OHS than CMP in 2010.

High P at Lake Alfred than Immokalee

ACPS Nutrition Studies (8)

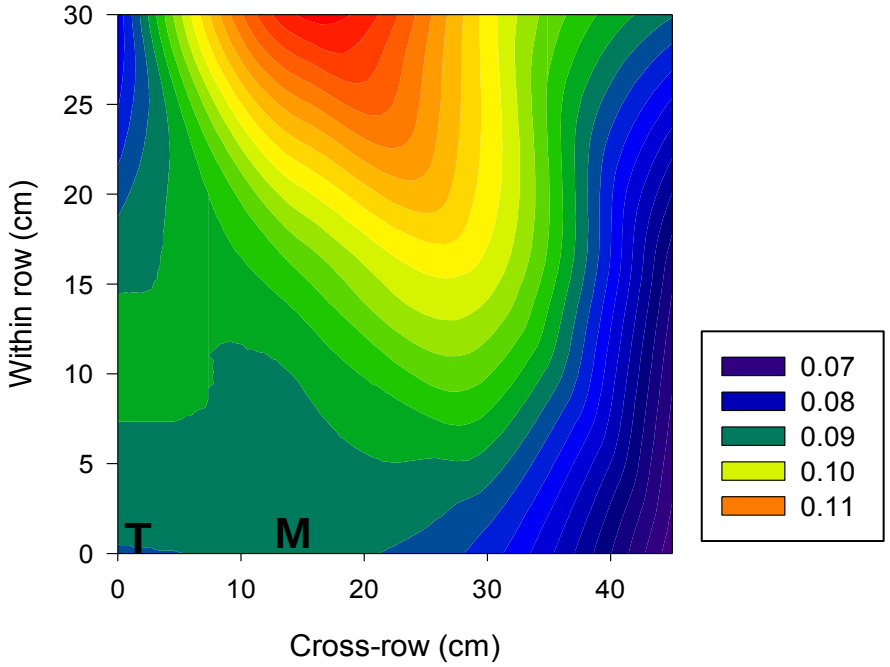


Canopy volume as a function of fertilization practice at the Lake Alfred site

ACPS fertigation had greater tree size than conventional practice

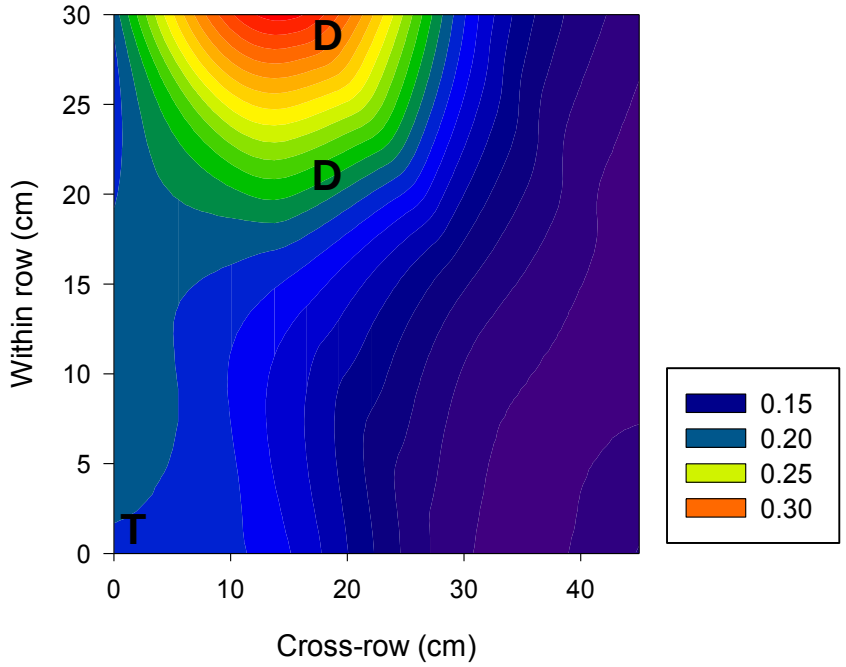
ACPS Nutrition Studies (9)

Lateral RLD (cm cm^{-3}) distribution using CMP



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

Lateral RLD (cm cm^{-3}) distribution using DOHS



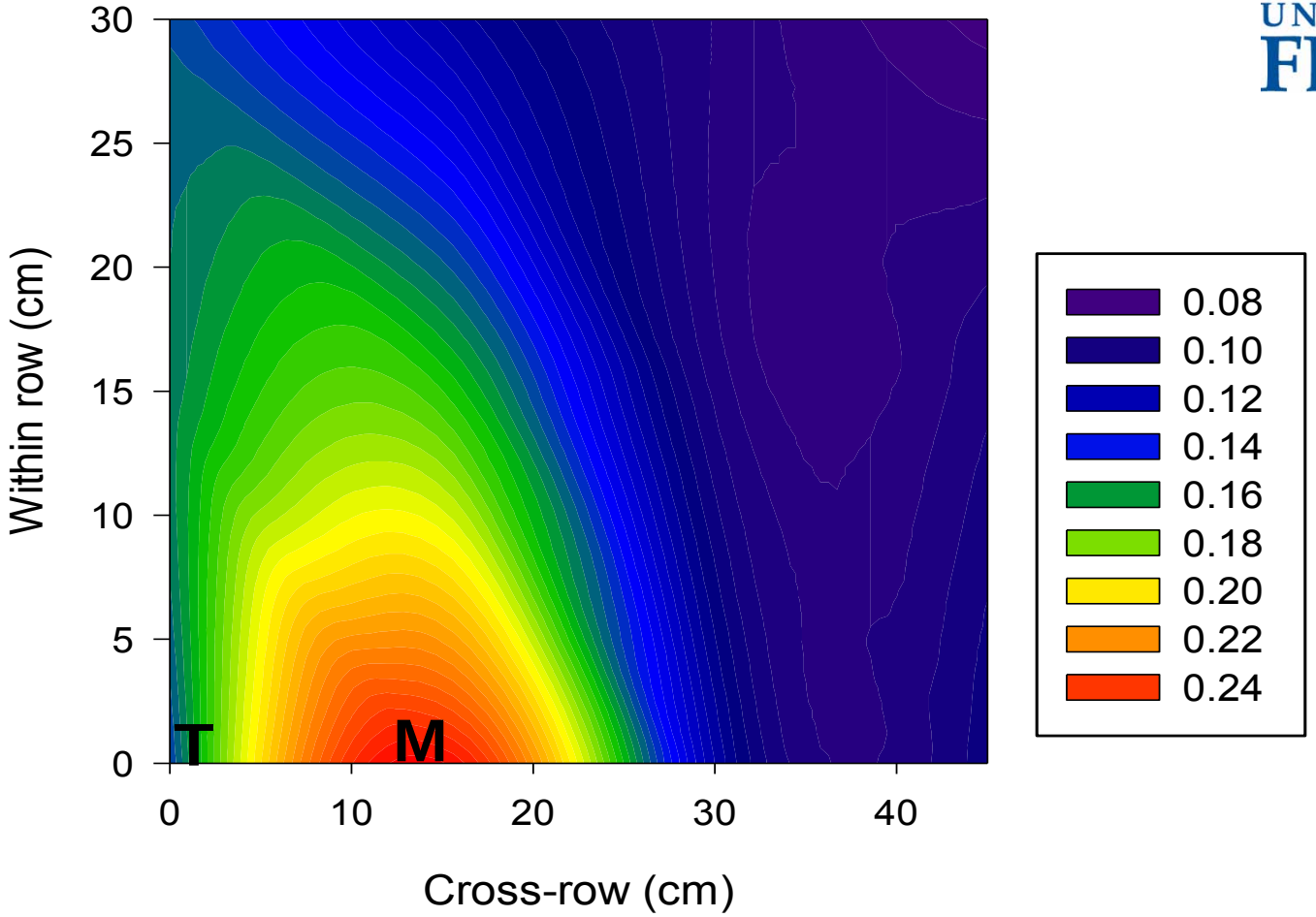
T=tree, D=dripper, Roots concentrated below the drippers

ACPS Nutrition Studies (7)

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

M=microsprinkler

T=tree



Lateral root density (cm cm^{-3}) distribution using ACPS microsprinkler

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.
- ACPS practices could be adapted to grower practices for vigorous tree growth, water use, greater root density and nutrient accumulation.

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