Smartphone Irrigation app based young tree irrigation scheduling

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Water application

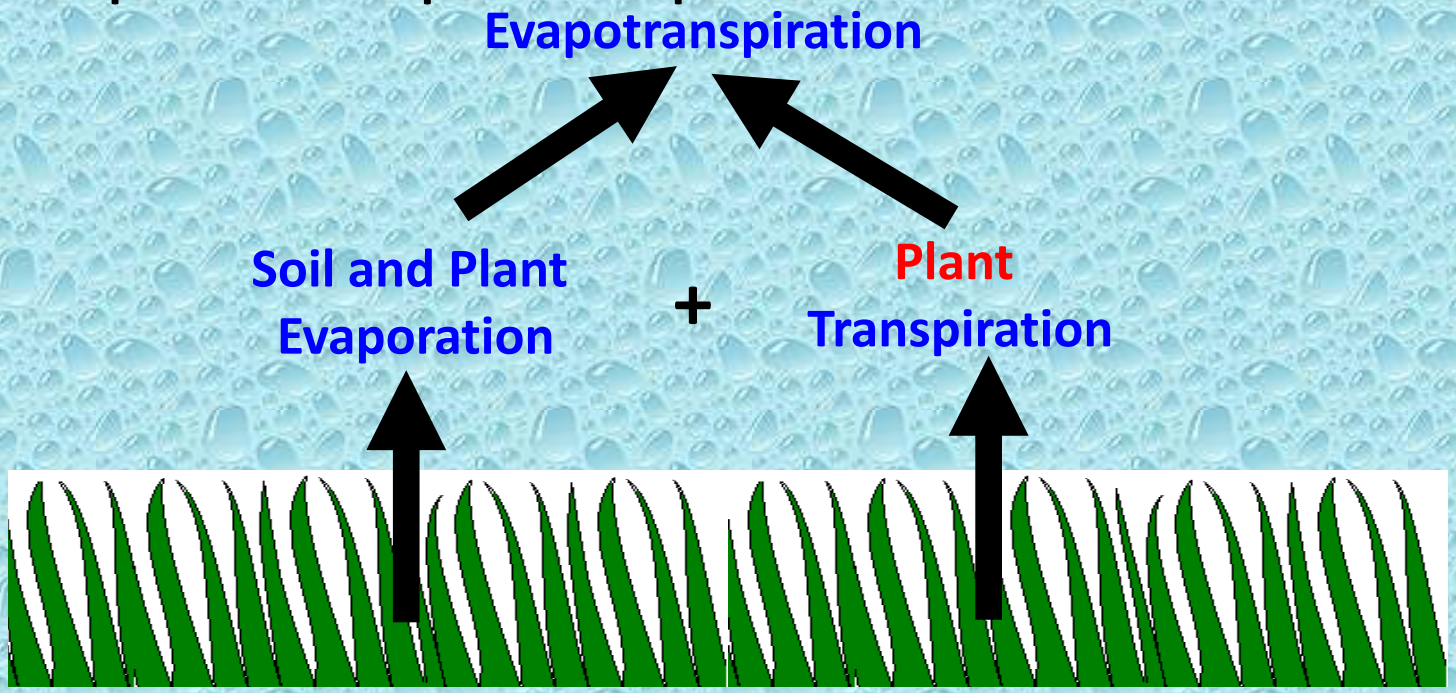
- Reduced water amounts can result in smaller trees and increased time to initial harvest.
- The lack of water in any stage of the citrus trees' growth decreases yield and fruit quality.
- Higher irrigation amounts could result in substantial loss of nutrients and herbicides from citrus root zone through deep percolation and surface run

Conclusions for Irrigation Studies on HBL Affected Trees

- Greater water use by greening infected trees from daily irrigation than healthy trees.
- Daily irrigation resulted in improved irrigation management compared with current IFAS or Intermediate irrigation schedule.
- Tree water use or Kc were evaluated to determine water amount for daily irrigation.
- Water uptake or use reduction was proportional to leaf area reduction for HLB affected trees.

Evapotranspiration (ET)

Definition: The loss of water from a vegetated surface through the combined processes of soil and plant evaporation and plant transpiration



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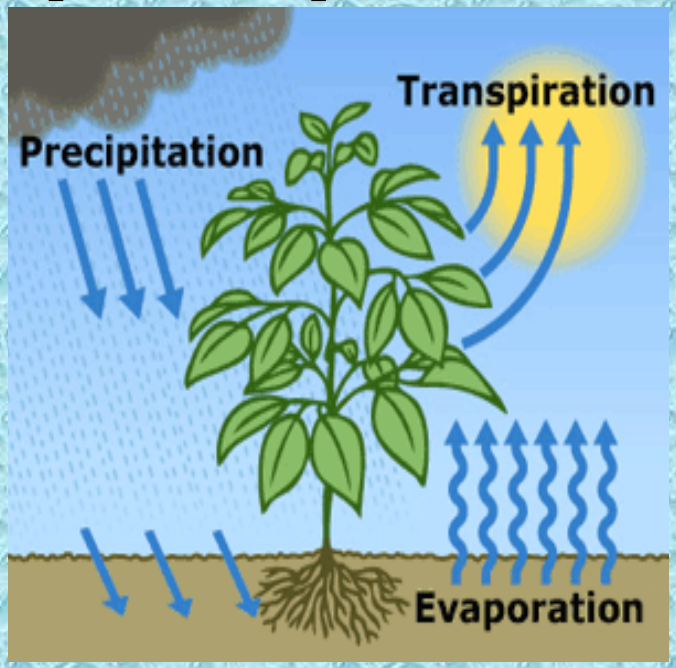

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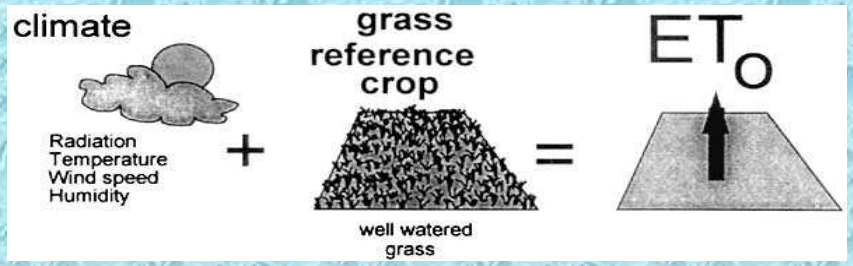
ET_o Calculation Methods

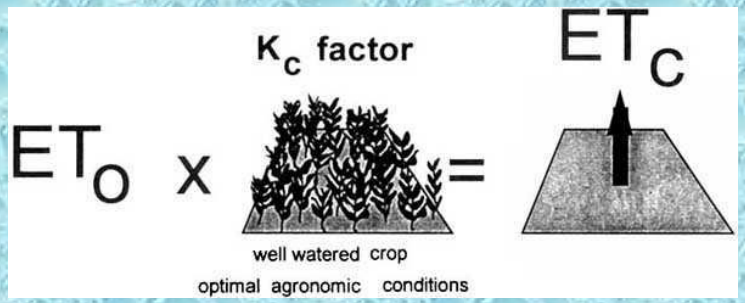
- Combination: Penman, Penman-Monteith
- Radiation: Jensen-Haise, Priestley-Taylor
- Temperature: FAO-Blaney-Criddle, Hargreaves
- Evaporation pan: FAO-Pan

Reference ET vs. Crop ET

Reference ET (ETo): The evapotranspiration from a hypothetical grass reference crop.



Actual ET (ETc): The crop evapotranspiration under standard conditions



Adopted from: Allen, R.G., L.S. Pereira, D. Raes, and M. Smith. 1998. *Crop Evapotranspiration. Guidelines for Computing Crop Water Requirements*. FAO Irrig. and Drain. Paper No. 56, Rome, Italy.

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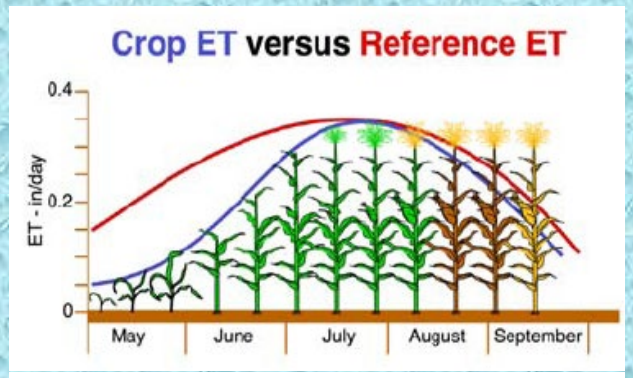
Crop Evapotranspiration (ET_c)

- $ET_c = ET_o * K_c * K_s$

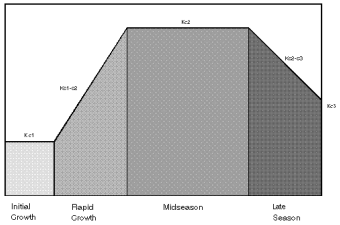
- Where,
- ET_o = Reference ET.
- K_c = Crop Coefficient,
- K_s = Soil water extraction factor.

Crop Evapotranspiration

- ET provides reference measure of water use based on plant water demand
- Scalable for specific crop, growth stage, climate, and season of year
- $ET_c = ET_o * K_c$



Generalized Crop Coeffecients and Crop Growth Stages



K_c Values	Growth Stage	Description
K_{c1}	Initial	The average K_c value from planting to about 10% ground cover.
K_{c1}-K_{c2}	Rapid Growth	From 10% ground cover to 75% cover or to peak water use, which ever comes first.
K_{c2}	Midseason	The average value from the end of the rapid growth stage until water use begins to decline due to crop aging.
K_{c2}-K_{c3}	Lateseason	From when K_c begins to decline until harvest or when water use ceases or becomes minimal.

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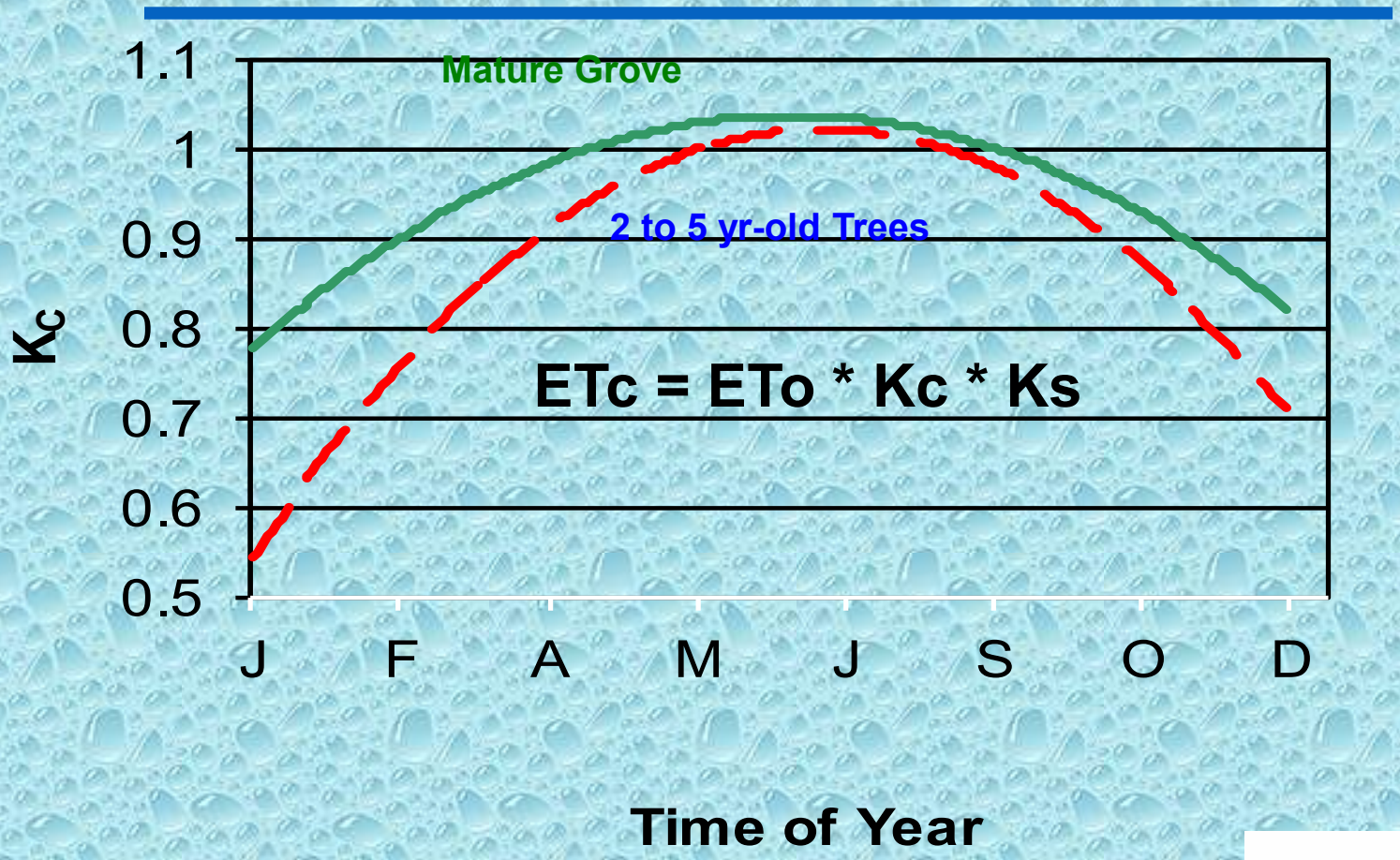
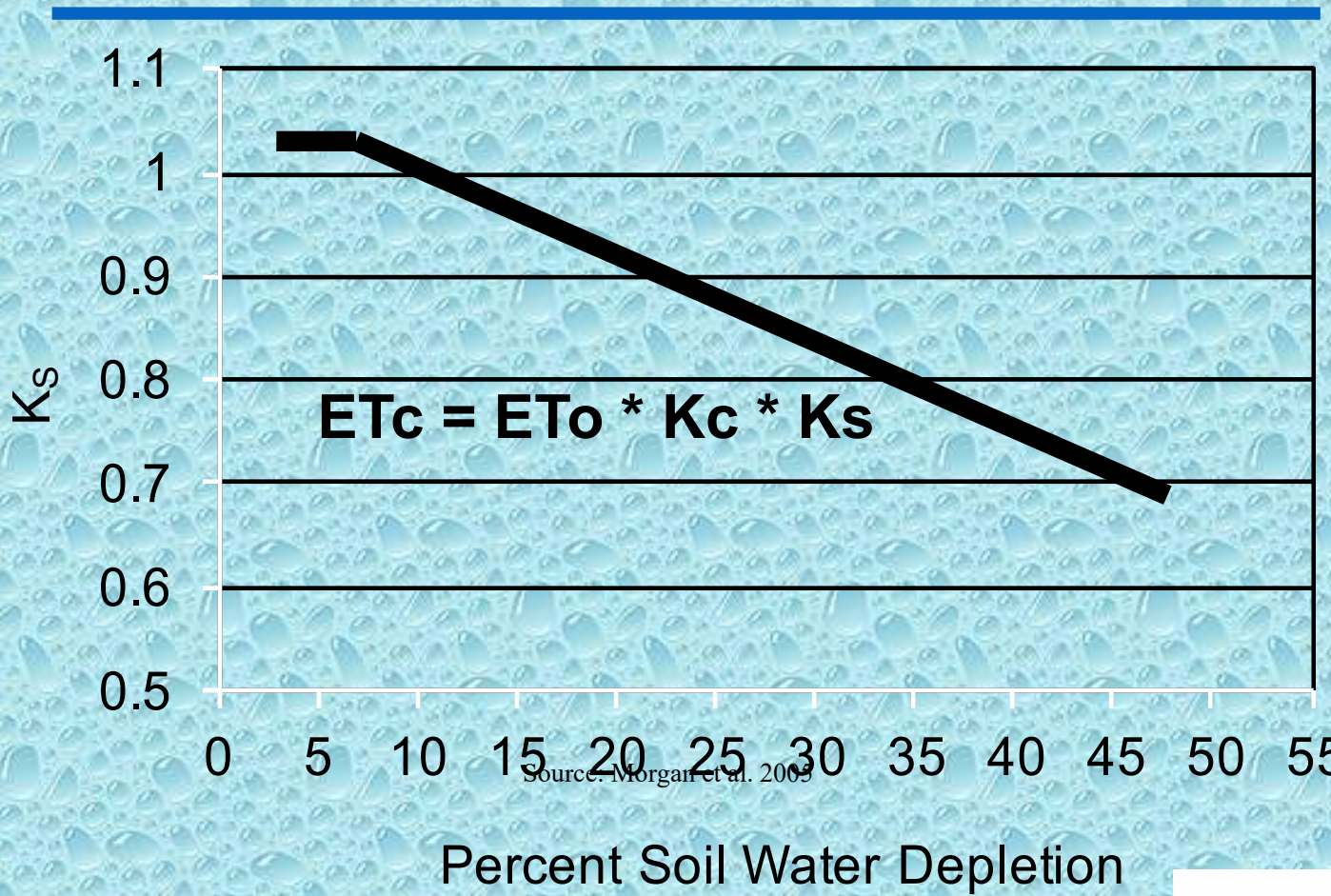
Effect of Time of Year



Effect of Soil Drying



Source: Morgan et al. 2009

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Computer Programs

- Web based
  - Schedule based on nearest FAWN station
  - Enter: Field capacity, spacing, irrigation specifications
- PC Irrigation program
  - Same information required
  - Stores irrigation data
  - Print reports
- Smart Phone Apps
  - Use real-time data
  - Irrigation schedule in units of time
  - Send notifications and forecasted probability of rainfall

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FAWN Florida Automated Weather Network

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Search Database

chill hours are available from our new temperature threshold tool by clicking Temperature Threshold. values in the summary reports are in error. The summary reports will be completely replaced soon.

Site: LAKE ALFRED | Type: Daily Summary | From: 04/15/2006 | To: 04/22/2006 | Search

Attention: Date/Time in this table is East Standard Time.

LAKE ALFRED Weather Daily Summary:

Date (EST)	Air Temp (°F)		Rainfall	TotalRad	ET	Hours Below Certain Temperature (hours)							
	Min	Max	(inches)	(cal/inch^2)	(inches)	40°F	45°F	50°F	55°F	60°F	65°F	70°F	75°F
Apr 15, 2006	57.5	86.9	0.00	3586.6		0.0	0.0	0.0	0.0	5.1	1.9	-7.0	-4.0
Apr 16, 2006	59.1	84.0	0.00	3514.0	0.159	0.0	0.0	0.0	0.0	0.8	10.5	-6.8	-2.8
Apr 17, 2006	65.6	86.4	0.00	3547.3	0.173	0.0	0.0	0.0	0.0	0.0	0.0	-9.6	-4.9
Apr 18, 2006	67.8	86.3	0.00	3087.9	0.159	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	-6.3
Apr 19, 2006	67.3	88.6	0.01	2972.9	0.156	0.0	0.0	0.0	0.0	0.0	0.0	9.2	-6.3
Apr 20, 2006	68.5	92.0	0.00	3282.4	0.174	0.0	0.0	0.0	0.0	0.0	0.0	6.9	-7.3
Apr 21, 2006	68.9	92.5	0.24	2640.0	0.151	0.0	0.0	0.0	0.0	0.0	0.0	3.4	-2.8
Apr 22, 2006	68.2	87.8	0.09	2469.3	0.138	0.0	0.0	0.0	0.0	0.0	0.0	7.1	-6.3

FAWN Partners...
Location Info...

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Irrigation Scheduler - Input

- Irrigation Schedulers
  - Citrus
  - Vegetable, Strawberry
  - Row crops
  - Turf grass

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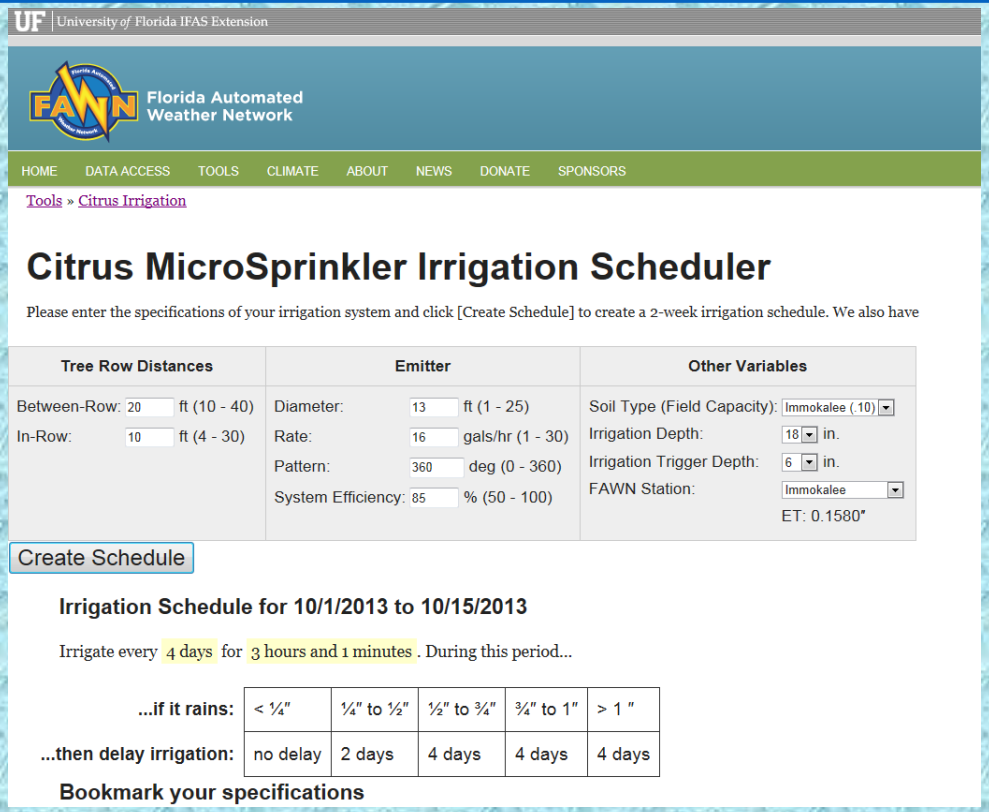
Irrigation Scheduler - Output



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Florida Automated Weather Network

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Tools » Citrus Irrigation

Citrus MicroSprinkler Irrigation Scheduler

Please enter the specifications of your irrigation system and click [Create Schedule] to create a 2-week irrigation schedule. We also have

Tree Row Distances		Emitter		Other Variables	
Between-Row: 20	ft (10 - 40)	Diameter: 13	ft (1 - 25)	Soil Type (Field Capacity):	Immokalee (.10)
In-Row: 10	ft (4 - 30)	Rate: 16	gals/hr (1 - 30)	Irrigation Depth: 18	in.
		Pattern: 360	deg (0 - 360)	Irrigation Trigger Depth: 6	in.
		System Efficiency: 85	% (50 - 100)	FAWN Station:	Immokalee
					ET: 0.1580"

Create Schedule

Irrigation Schedule for 10/1/2013 to 10/15/2013

Irrigate every 4 days for 3 hours and 1 minutes. During this period...

...if it rains:	< ¼"	¼" to ½"	½" to ¾"	¾" to 1"	> 1 "
...then delay irrigation:	no delay	2 days	4 days	4 days	4 days

Bookmark your specifications

- Provides record of inputs
- Two week schedule based on ET
- Delay for rainfall

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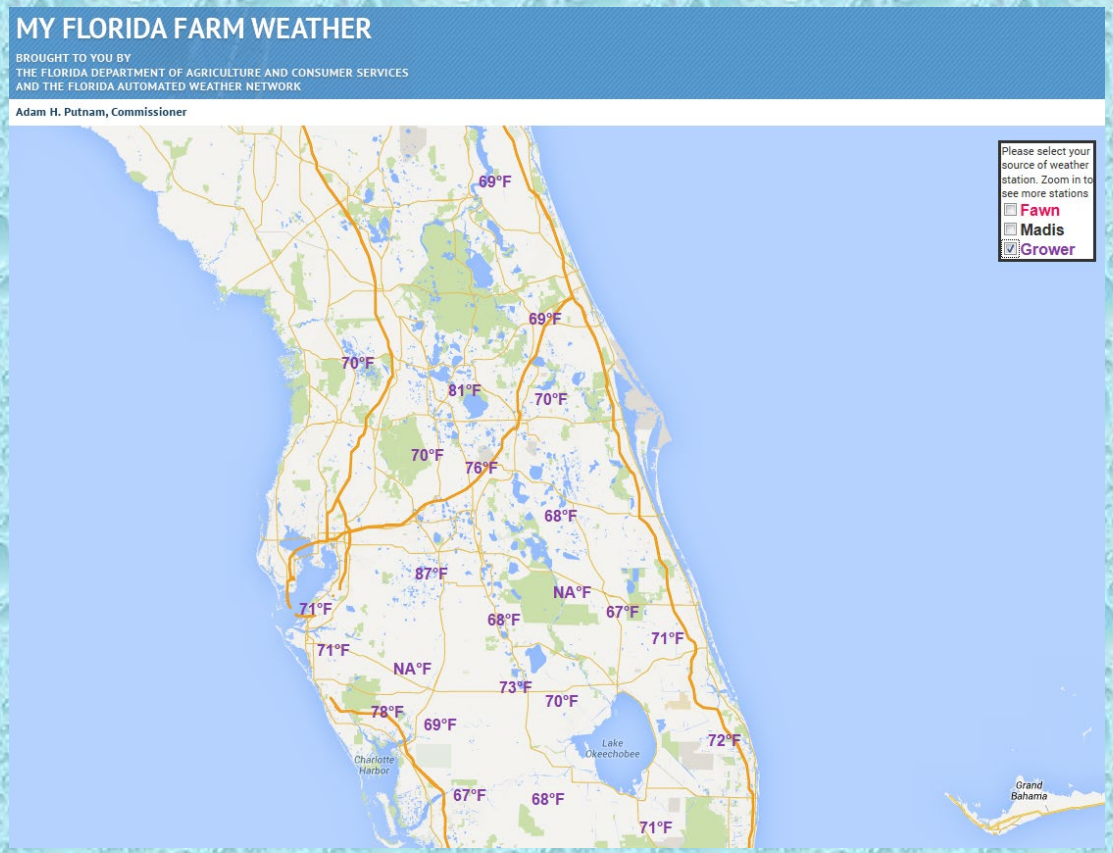
FDACS/IFAS – My Florida Farm Weather Program



- Cost share for weather stations
- Real-time data
- Frost protection and irrigation scheduling

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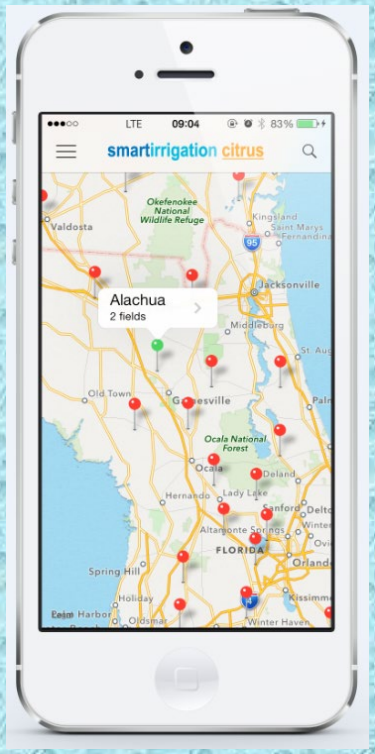
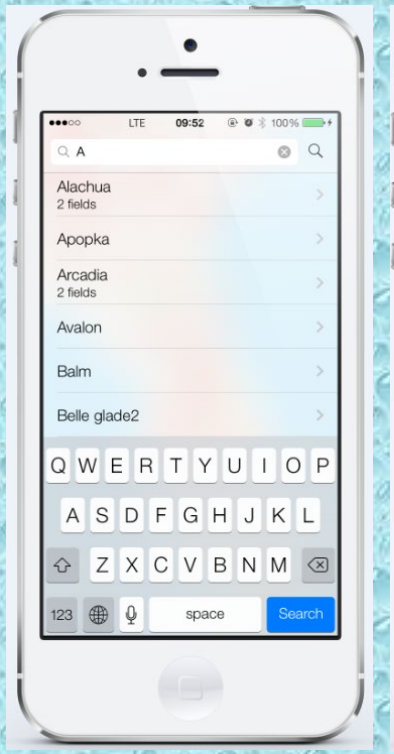
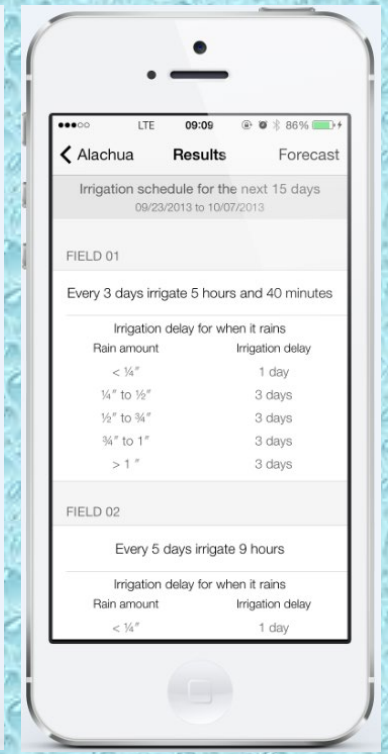
Smartphone Apps







- I phone or Android
- FAWN ET, expand to grower weather stations
- Real-time data
- Citrus, Strawberry, Turf, expand to row crops, vegetable

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Site description and treatment

- Initiated in November 2017 with eight-month-old sweet orange ‘Valencia’ (Citrus sinensis) trees grafted on the ‘US-897’

- Two and three rows of five-540-foot-long beds with drainage swales on each side.

- Two irrigation treatments (62% and 100%) of daily crop evapotranspiration (ETc) were adjusted during 2019 to (81%, 53%, 40.5%, and 26.5% of ETc).

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Objective

The aim of the study was to determine the amount of water required to grow young trees at higher tree densities.

Lower irrigation rate (62% ETo)

Higher irrigation rate (100% ETo)

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Citrus planting densities

The grove comprised 60 sub-plots divided into six trees densities as following:

1) 181 trees per acre (10 feet * 24 feet),
2) 207 trees per acre (14 feet * 15 feet),
3) 242 trees per acre (7.5 feet * 24 feet),
4) 290 trees per acre (10 feet * 15 feet),
5) 303 trees per acre (6 feet * 24 feet), and
6) 363 trees per acre (8 feet *15 feet).

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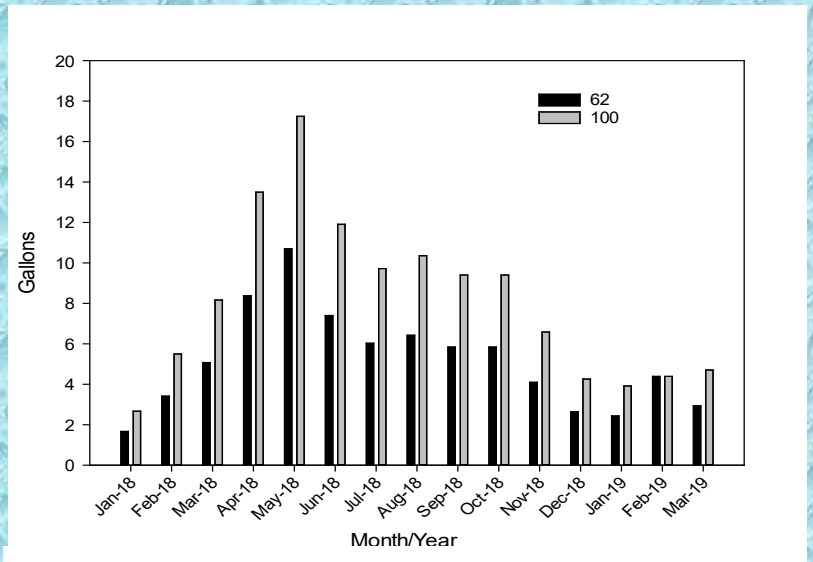
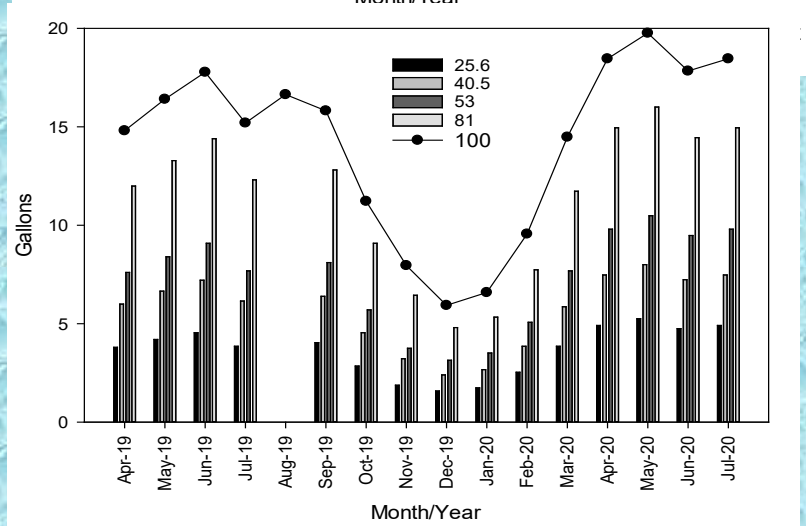
Water applied per tree





The volume of water applied per young citrus trees under different irrigation rates on daily bases

- Water applications were proportional to percentage ETo during the experiment at both two rates and four rates
- 100% line is the amount of water that would have been applied if ETo was applied each day

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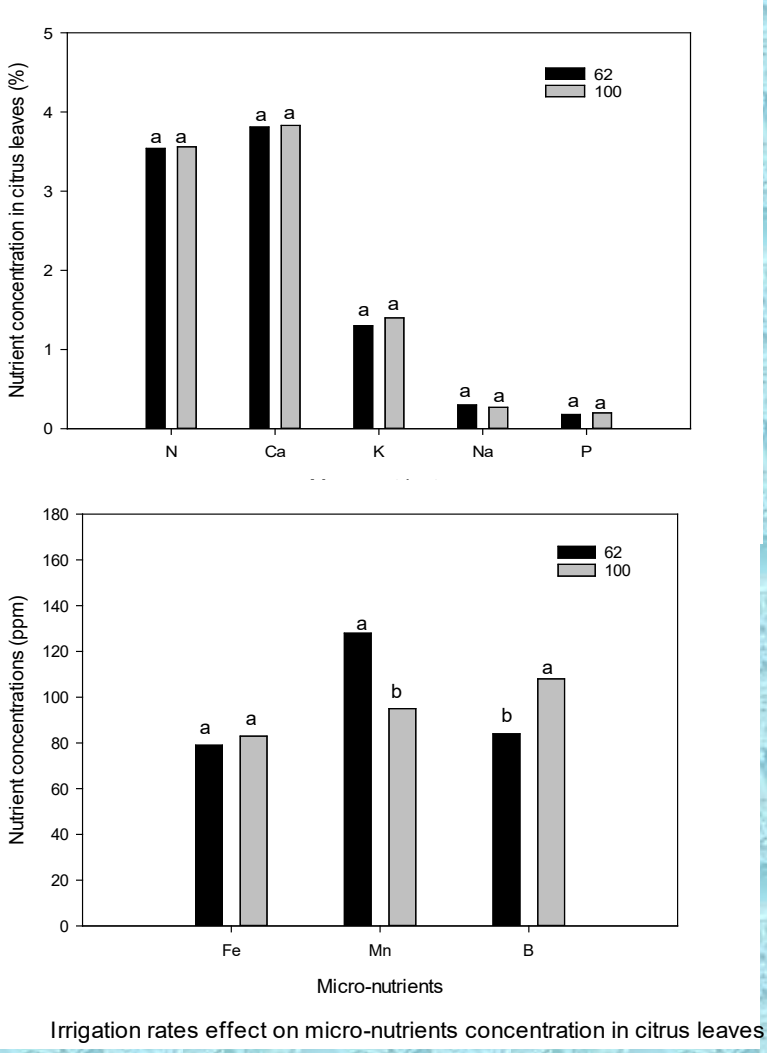
Crop coefficient (Kc) - 81% ETc

Month	ETo - Blaney-Criddle (in)	181 trees per acre	207 trees per acre	242 trees per acre	290 trees per acre	303 trees per acre	363 trees per acre
2019							
Apr	0.21	0.37	0.43	0.50	0.60	0.62	0.75
May	0.24	0.38	0.43	0.51	0.61	0.63	0.76
June	0.25	0.38	0.44	0.51	0.61	0.64	0.77
July	0.25	0.33	0.38	0.44	0.53	0.55	0.66
Aug	0.23	No irrigation					
Sep	0.23	0.38	0.43	0.51	0.61	0.63	0.76
Oct	0.21	0.29	0.34	0.39	0.47	0.49	0.59
Nov	0.17	0.25	0.28	0.33	0.40	0.41	0.50
Dec	0.16	0.20	0.23	0.27	0.33	0.34	0.41
2020							
Jan	0.15	0.25	0.28	0.33	0.40	0.41	0.50
Feb	0.17	0.30	0.34	0.40	0.48	0.50	0.60
Mar	0.16	0.50	0.58	0.67	0.81	0.84	1.01
Apr	0.25	0.40	0.46	0.54	0.65	0.67	0.81
May	0.25	0.43	0.49	0.58	0.69	0.72	0.87
June	0.25	0.39	0.44	0.52	0.62	0.64	0.77
July	0.25	0.40	0.46	0.53	0.64	0.66	0.80
Aug	0.25	0.37	0.42	0.49	0.59	0.62	0.74
Avg	0.22	0.35	0.40	0.47	0.56	0.58	0.70

Citrus tree leaves nutrition - 2018



Irrigation rates effect on micro-nutrients concentration in citrus leaves

Both Maco- and Micronutrients were equal the during the first year of the experiment indicating a consistent nutrient starting point.

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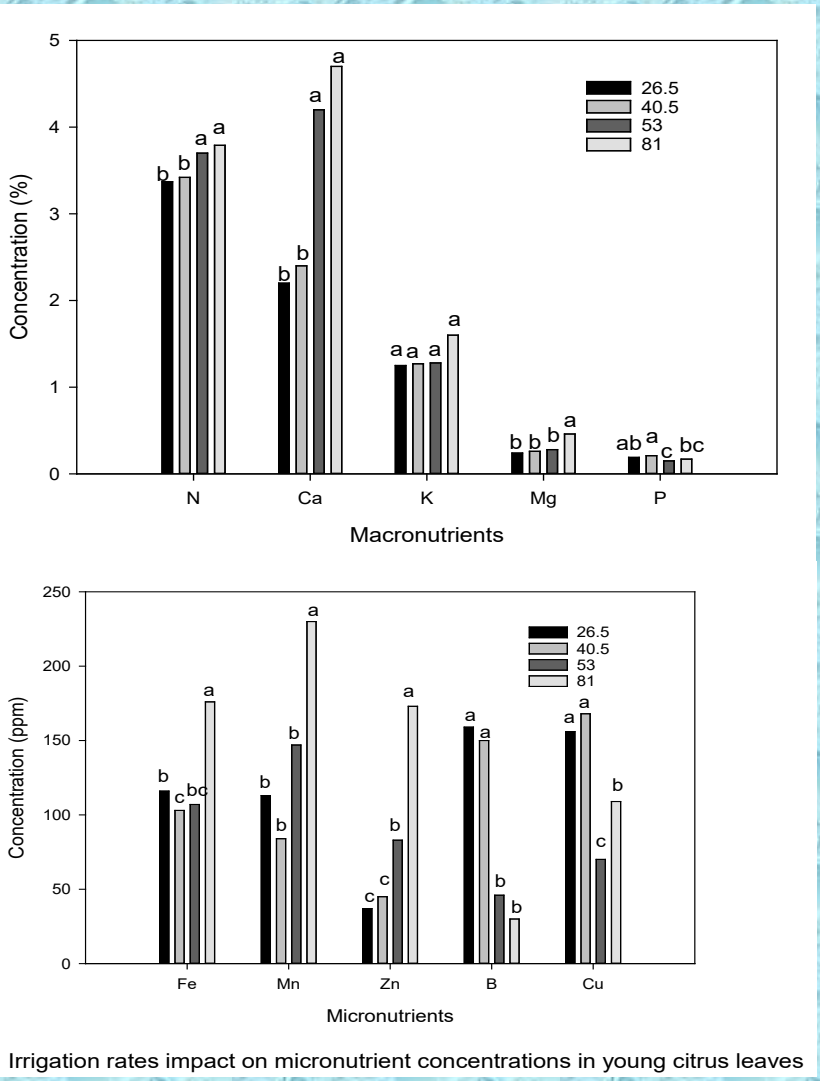
Citrus tree leaves nutrition - 2019



Irrigation rates impact on micronutrient concentrations in young citrus leaves

- **Macronutrients increased with irrigation rate the second year and third.**
- **Highest irrigation resulted in greater macronutrient uptake.**
- **Only the highest irrigation rate resulted in higher micronutrient uptake.**

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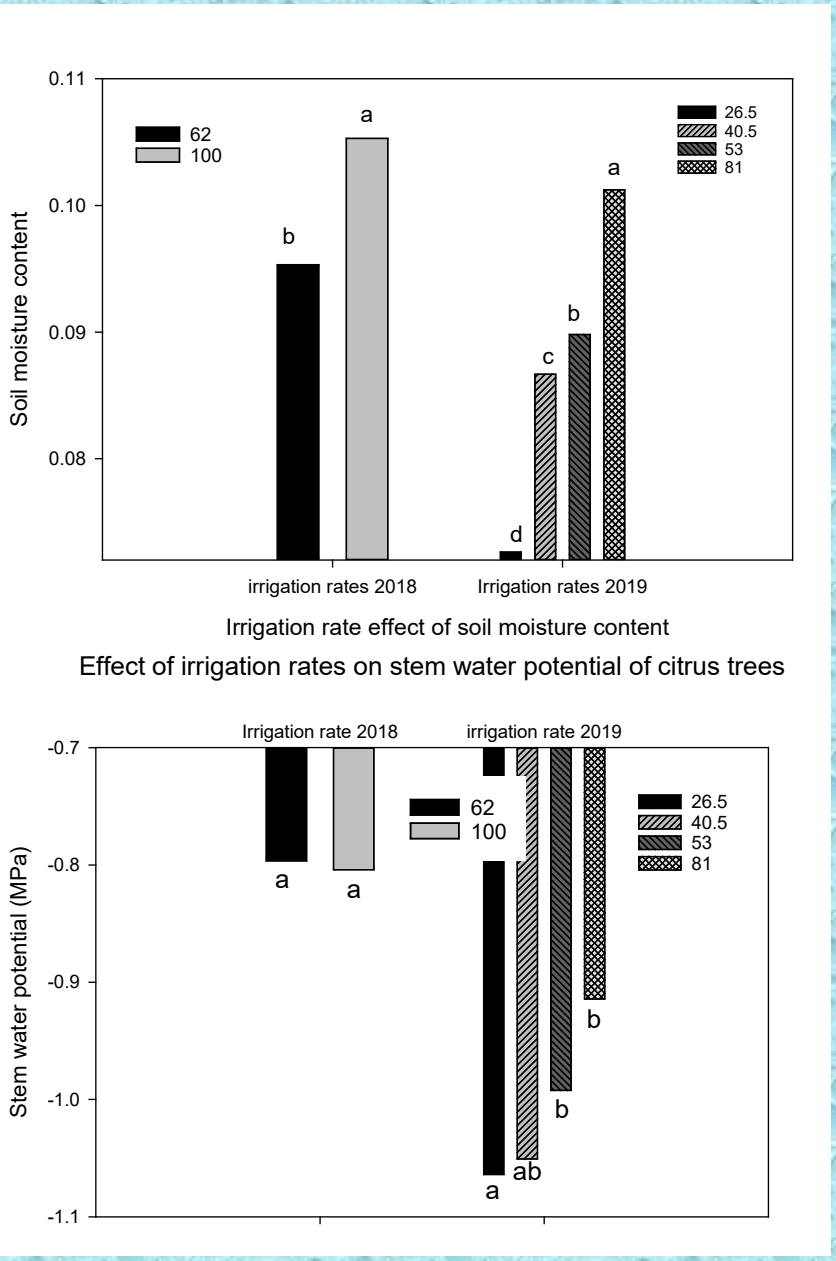
Soil moisture contents and stem water potential



- As expected, soil at higher irrigation rate resulted in soil moisture at or above field capacity (0.10).
- Stem water potential is used as an indication of stress with lower (more negative) values.
- Less stress was indicated at higher irrigation rates.

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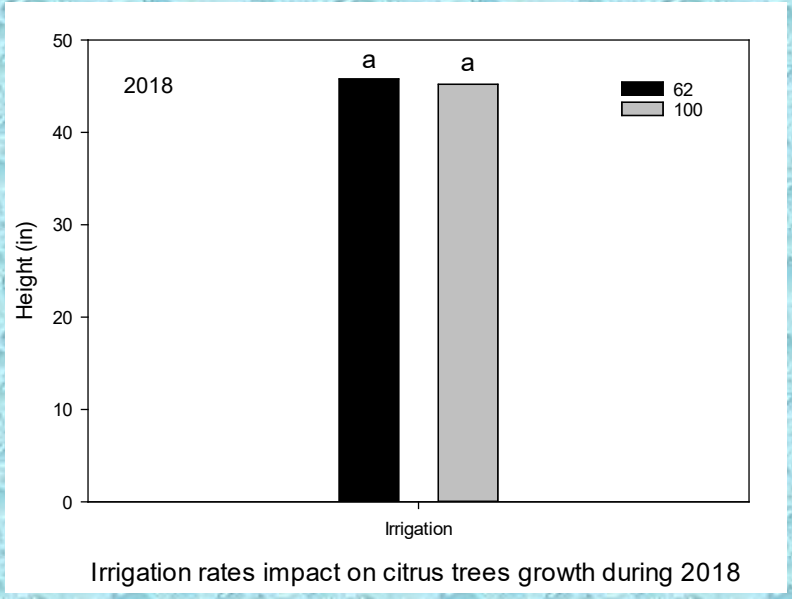
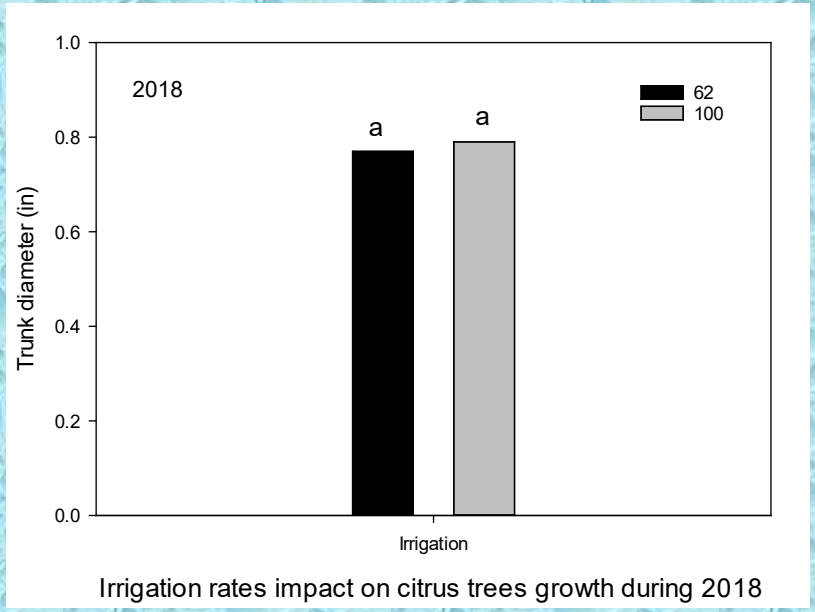
Citrus tree growth (2018)



Irrigation rates impact on citrus trees growth during 2018



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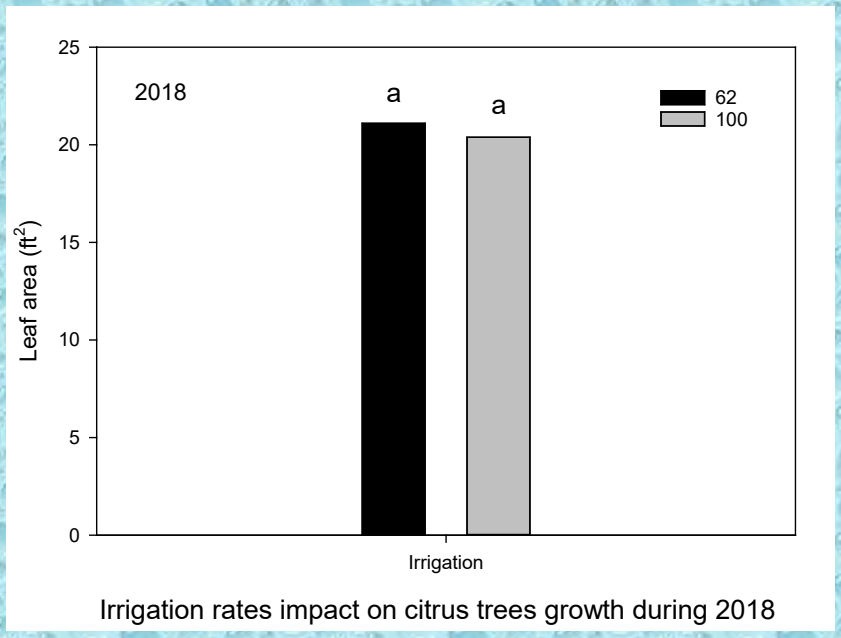

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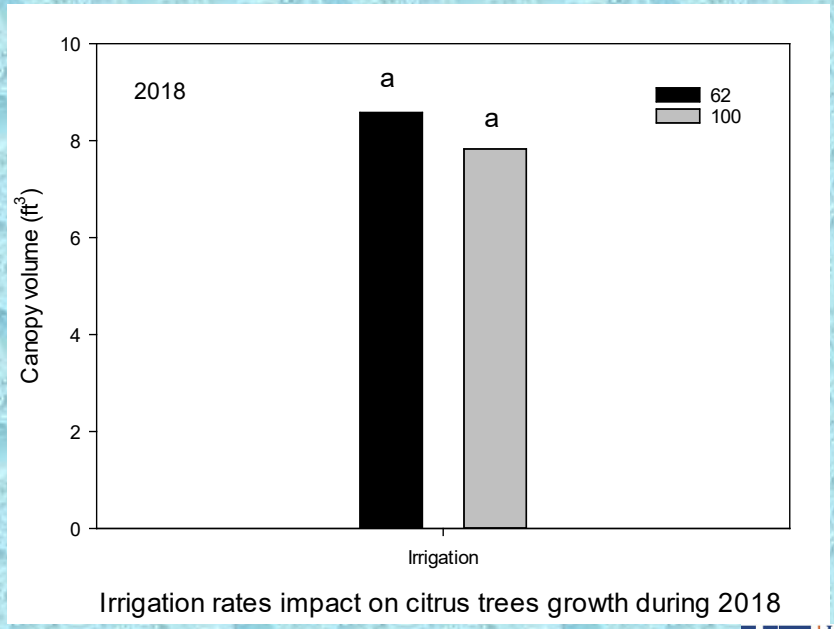

Irrigation rates impact on citrus trees growth during 2018

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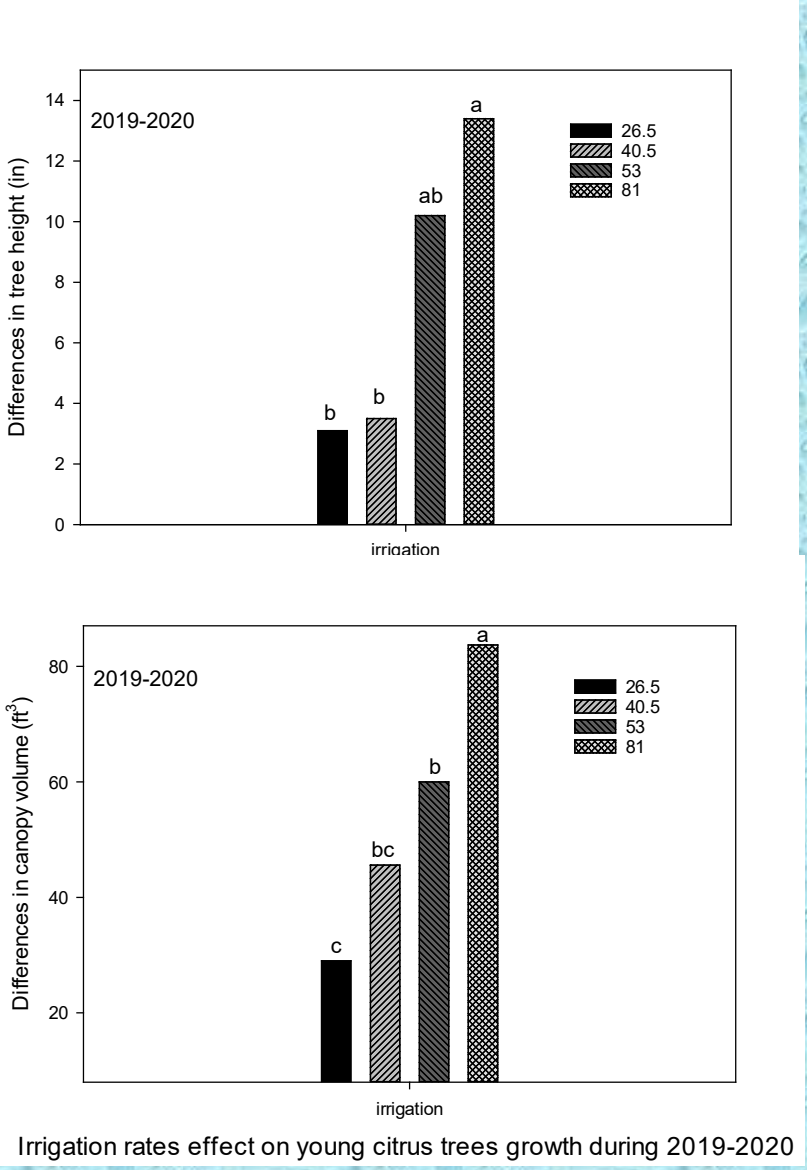
Citrus tree growth (2019-2020)



Irrigation rates effect on young citrus trees growth during 2019-2020

- **Tree height and canopy volume increased with irrigation rate.**

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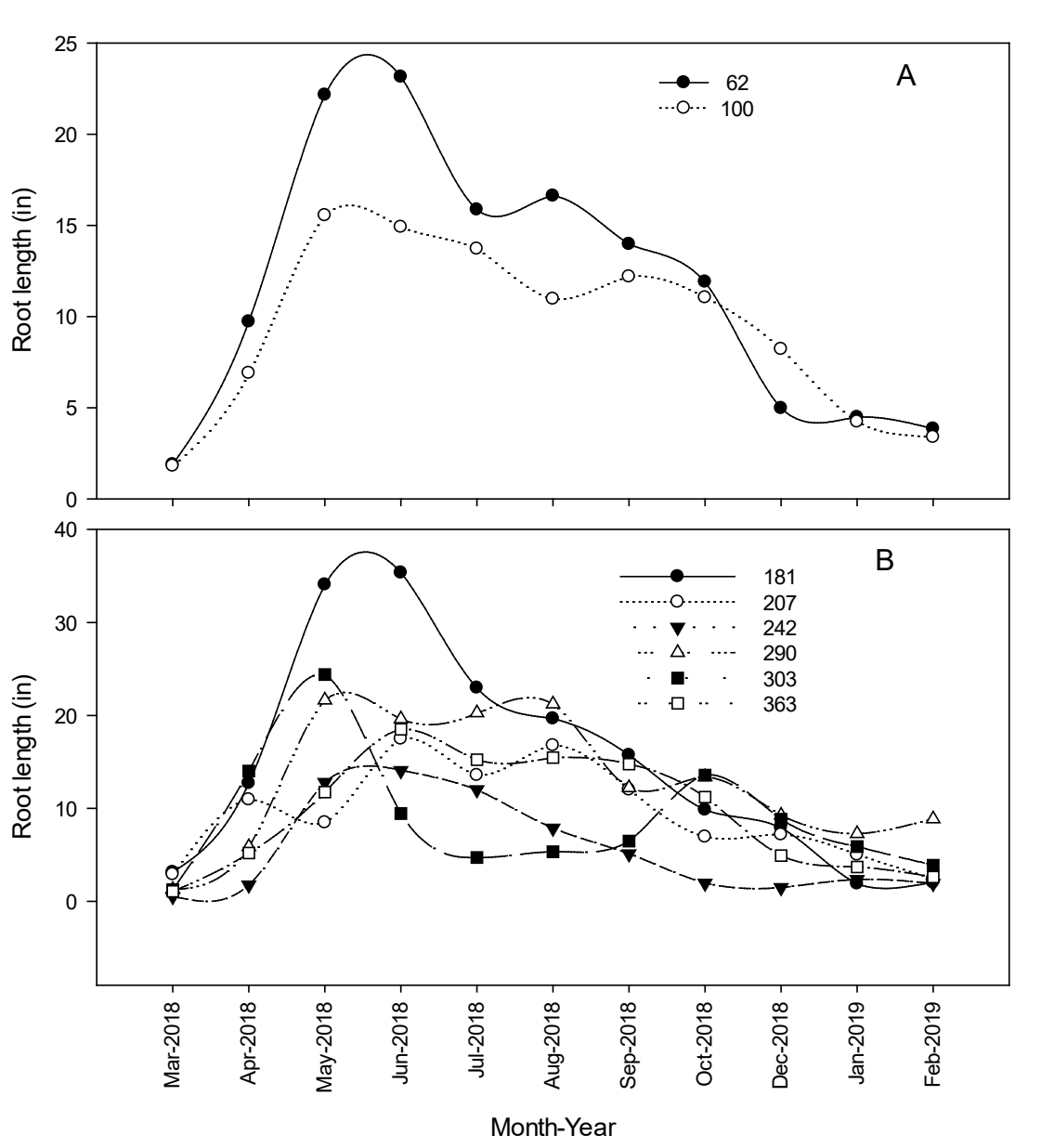
Citrus tree root growth (2018)



Impact of irrigation rate (A) and planting densities (B) of young citrus trees on root length growth (in) during 2018-2019 at the southwest Florida research and education center demonstration grove.

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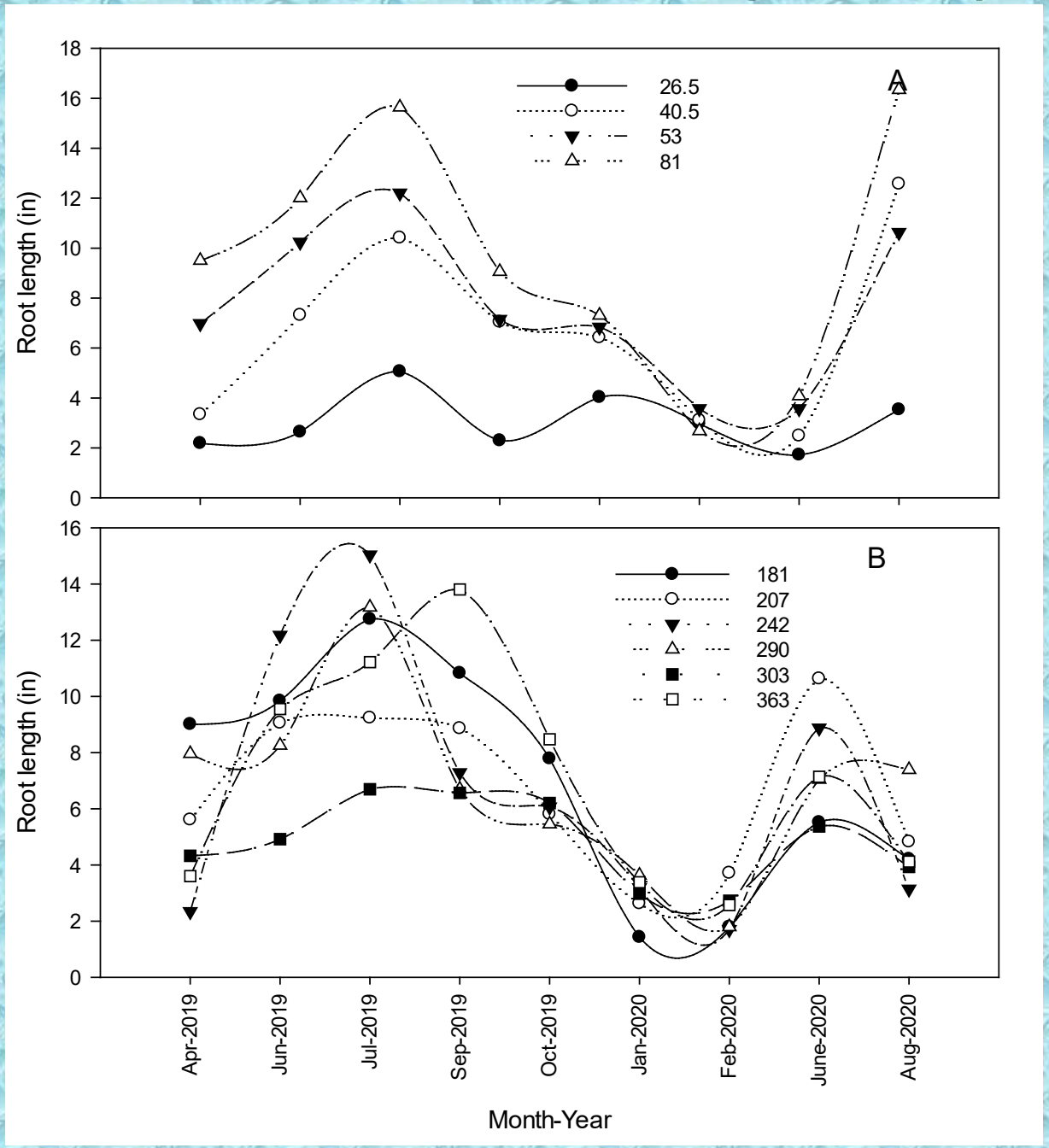
Citrus tree root growth (2019-2020)



Impact of irrigation rate (A) and planting densities (B) of young citrus trees on root length growth (in) during 2018-2019 at the southwest Florida research and education center demonstration grove.

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Conclusions

- 81% ETc maintained adequate soil moisture contents and resulted in better soil temperature, stem water potential, and lower salinity.
- 81% ETc enhanced the tree growth, including height, trunk diameter, and canopy volume.
- 81% ETc promoted citrus trees root development and minimized nutrient losses.

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Thank you