Control Technologies to Reduce Residential Irrigation Water Application

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GreenTrends 2006, Gainesville, FL

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Agricultural & Biological Engineering Department

Background

- Population served by public supply
  - 5.4 million 1970
  - 17 million 2004
  - 20 million 2020
- 11% U.S. new home construction in FL
- + ~1,000 people/day
- FL uses the most groundwater in the U.S.
- Most new homes in FL include irrigation
- ~60% household water use for irrigation
- High quality landscapes and low water holding capacity

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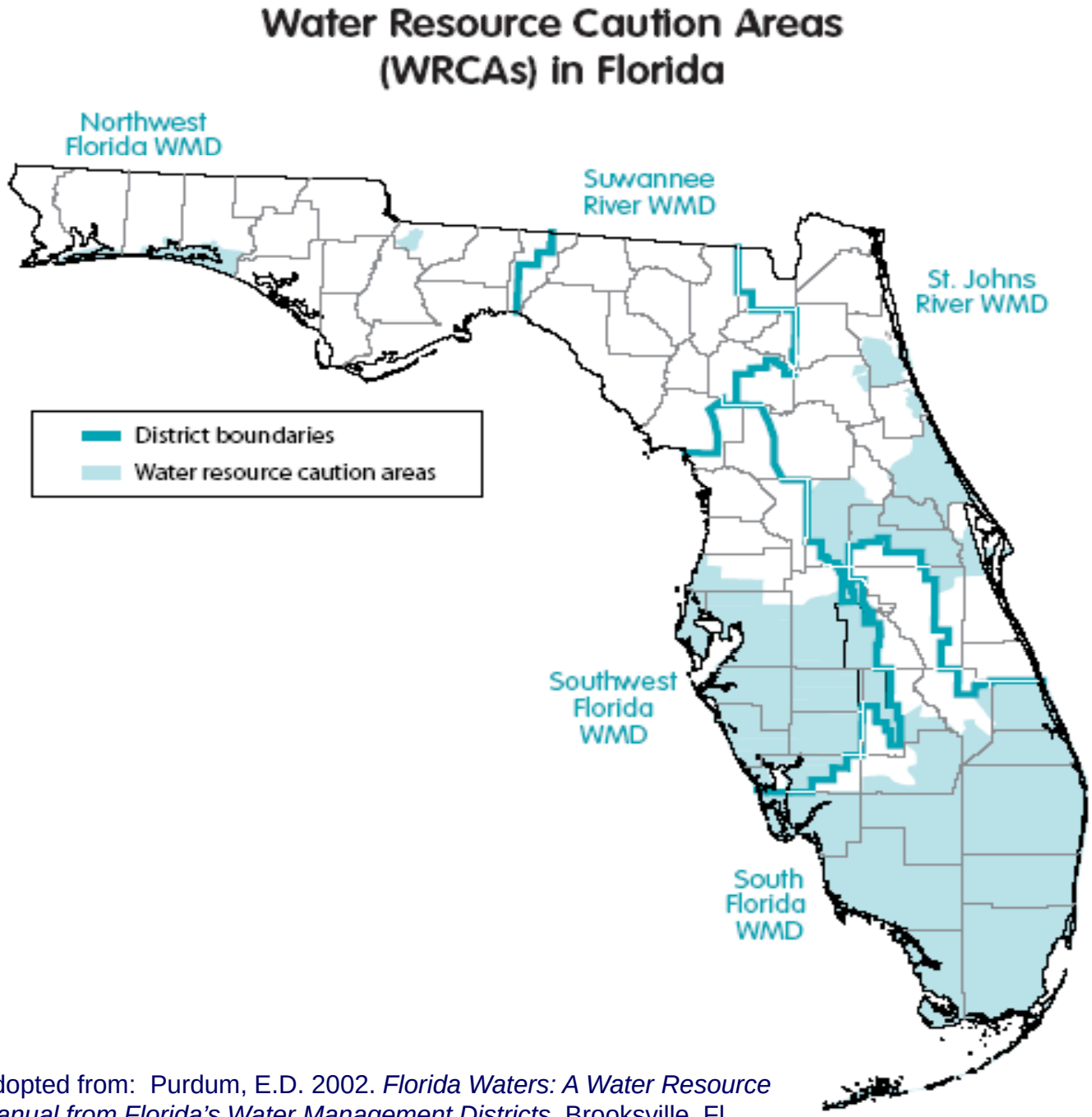
Florida's Water Crisis

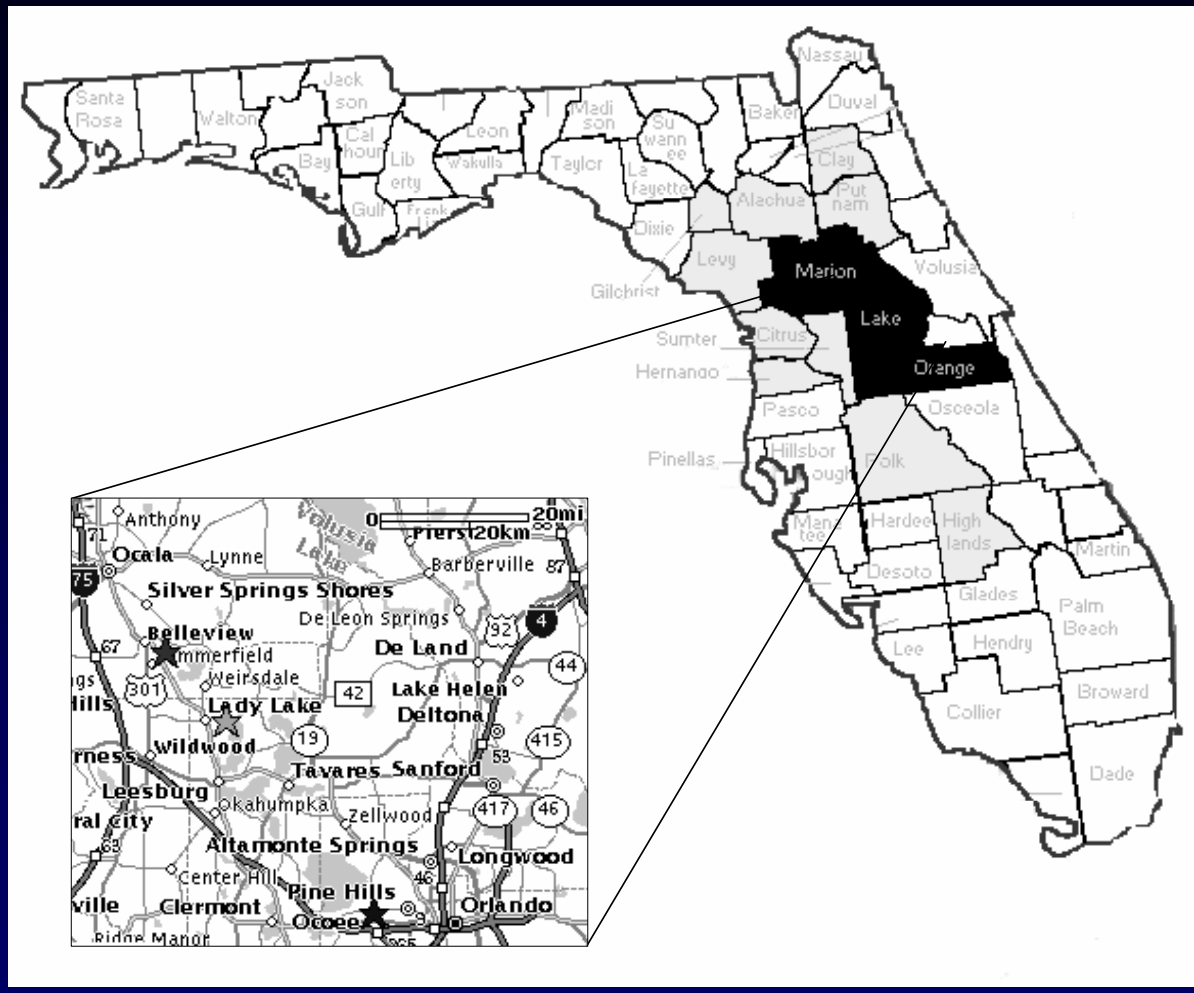
<u>Water Resource Caution Areas</u>: places where water is either scarce or contaminated as defined by Florida's Water Management Districts



Adopted from: Purdum, E.D. 2002. *Florida Waters: A Water Resource Manual from Florida's Water Management Districts*. Brooksville, Fl.

SJRWMD Residential Irrigation Study

- Homeowners asked to volunteer at a series of workshops
- Nine cooperators recruited in each of three counties in Central Florida
- Nine homes randomly divided into three groups with three replications



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T1

T1 = Existing landscape and irrigation, only monitored

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T2

T2 = T1 landscape, reduced irrigation schedule

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T3

T3 = T2 irrigation schedule + 65% microirrigated ornamentals

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Data Collection & Monitoring

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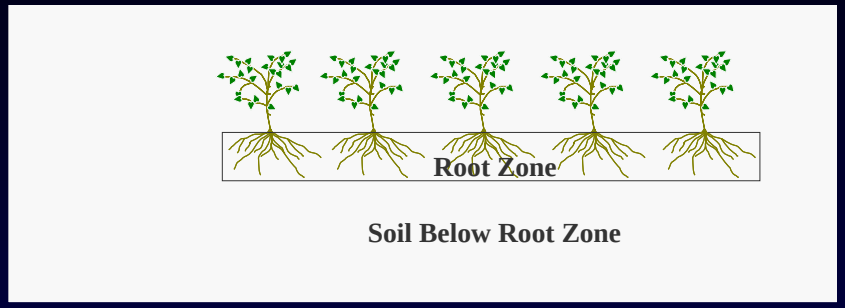
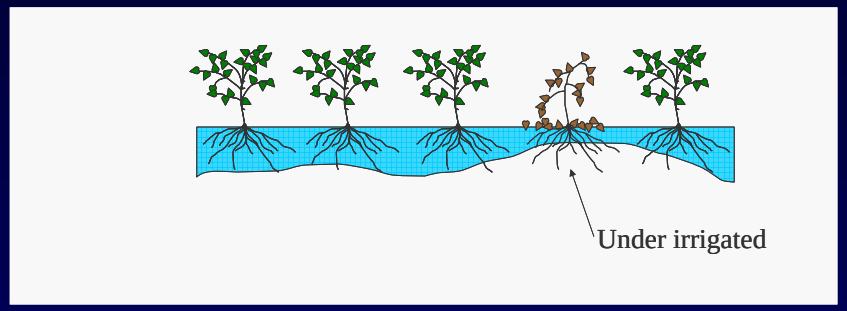
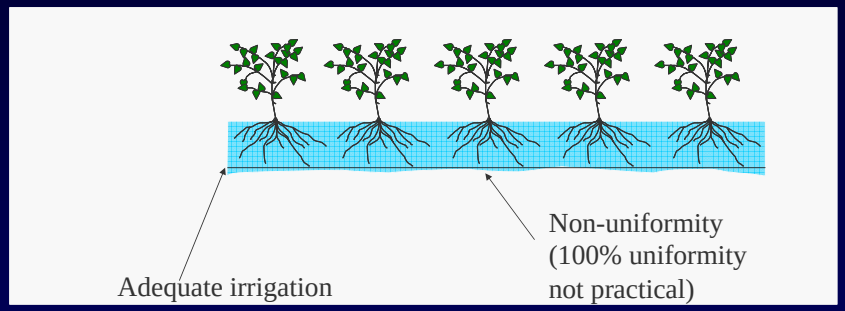
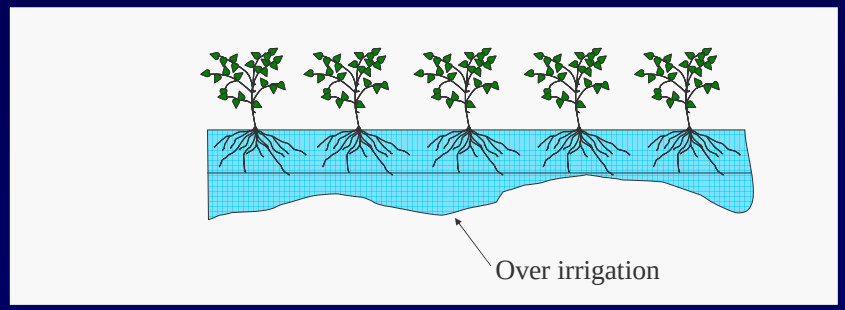
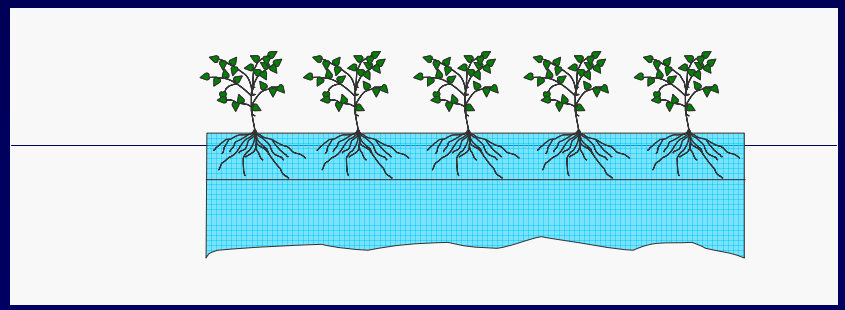
Potential Uniformity Impact











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Narrow Areas

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Microirrigation in Narrow Areas

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Improper Coverage

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Irrigation Water Use - Conclusions

- Despite “low uniformity”, turf quality similar across homes in most seasons
- Significant reductions in water use (20% and 40%) can be achieved by irrigation scheduling (T2) and scheduling + landscape changes (T3)

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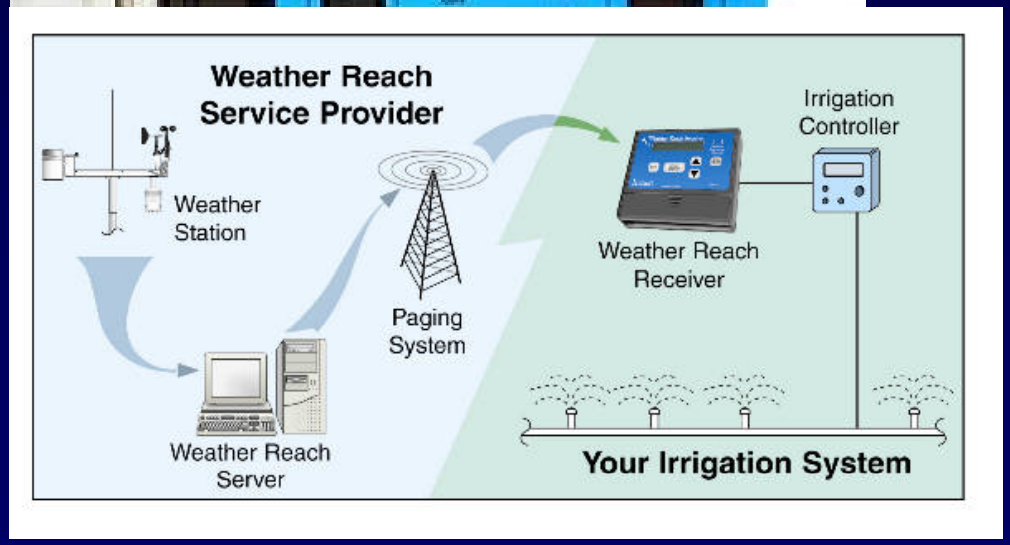
Sensor Based Irrigation



Soil moisture sensors (SMS)

Evapotranspiration (ET) based controllers

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SMS Experimental Design

- 1 d/wk four brands SMS
- 2 d/wk four brands SMS
- 7 d/wk four brands SMS

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- 1 d/wk four brands SMS
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- **Time 2 d/wk with rain sensor**

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- 7 d/wk four brands SMS
- Time 2 d/wk with rain sensor
- 60% of time 2 d/wk with rain sensor
- Time 2 d/wk without rain sensor
- **Non-irrigated**

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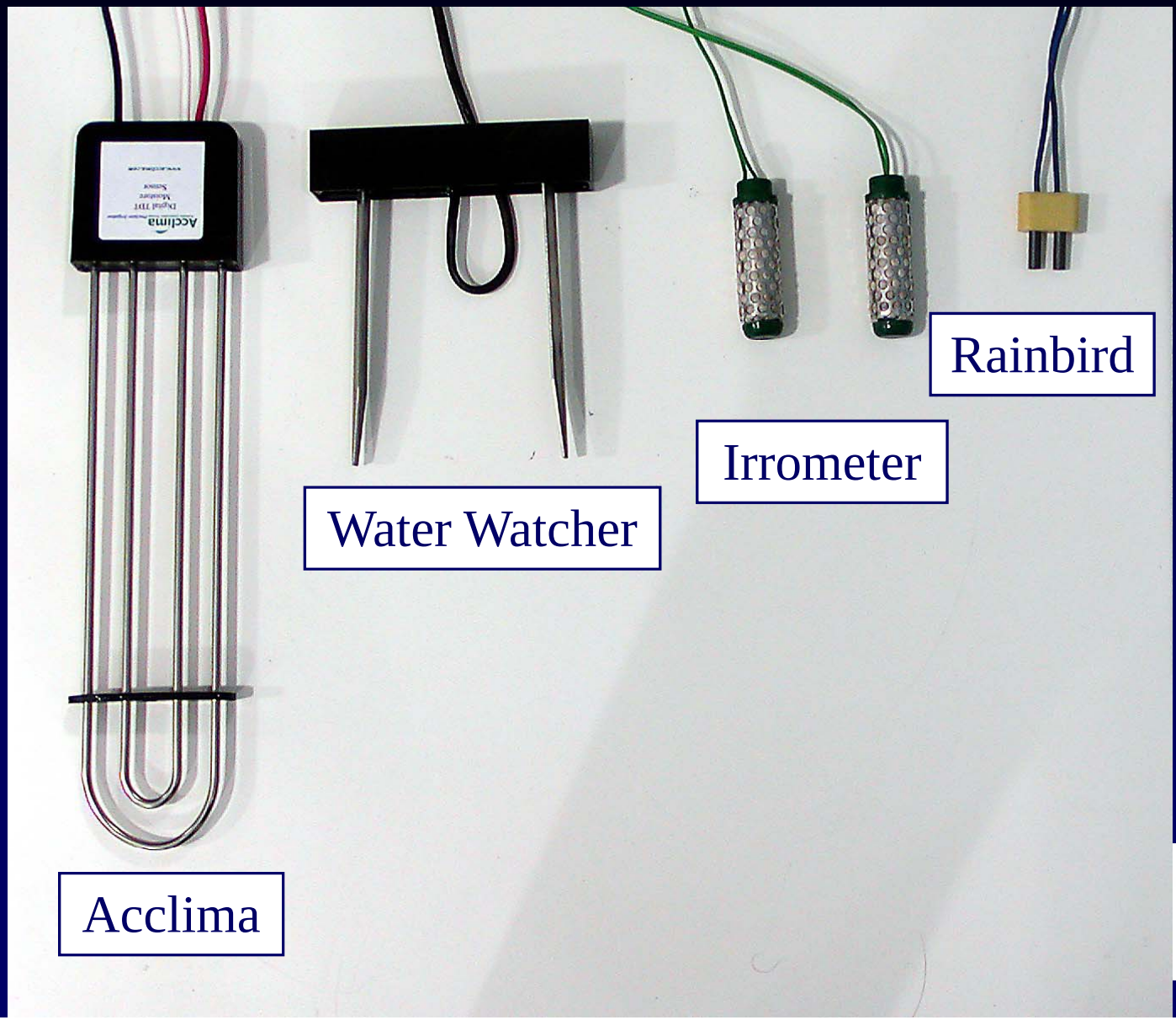
Soil Moisture Control Sensors



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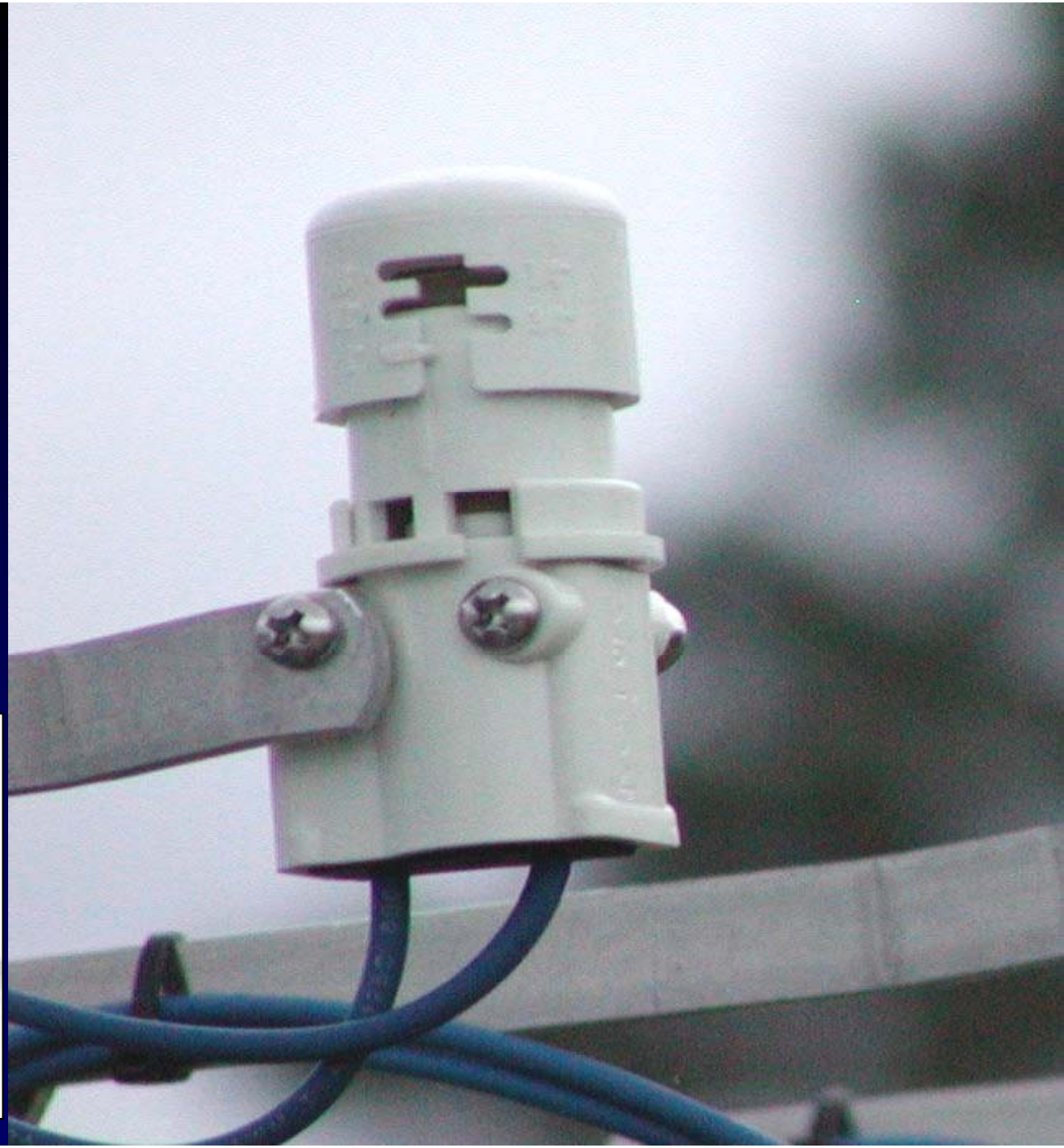
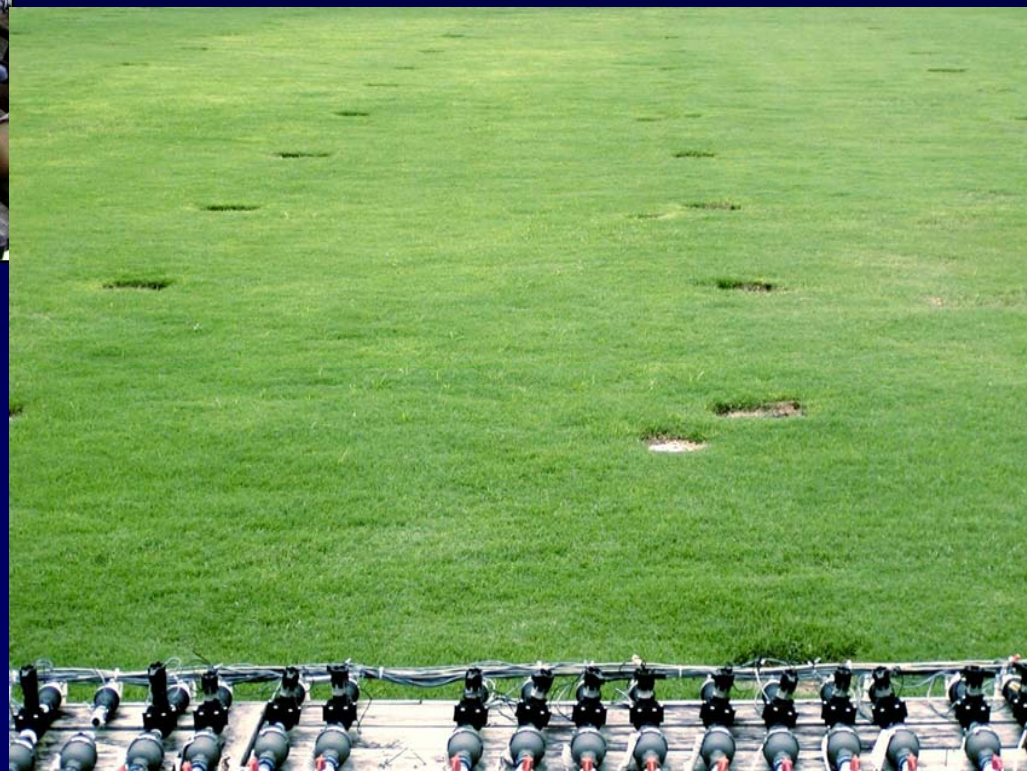
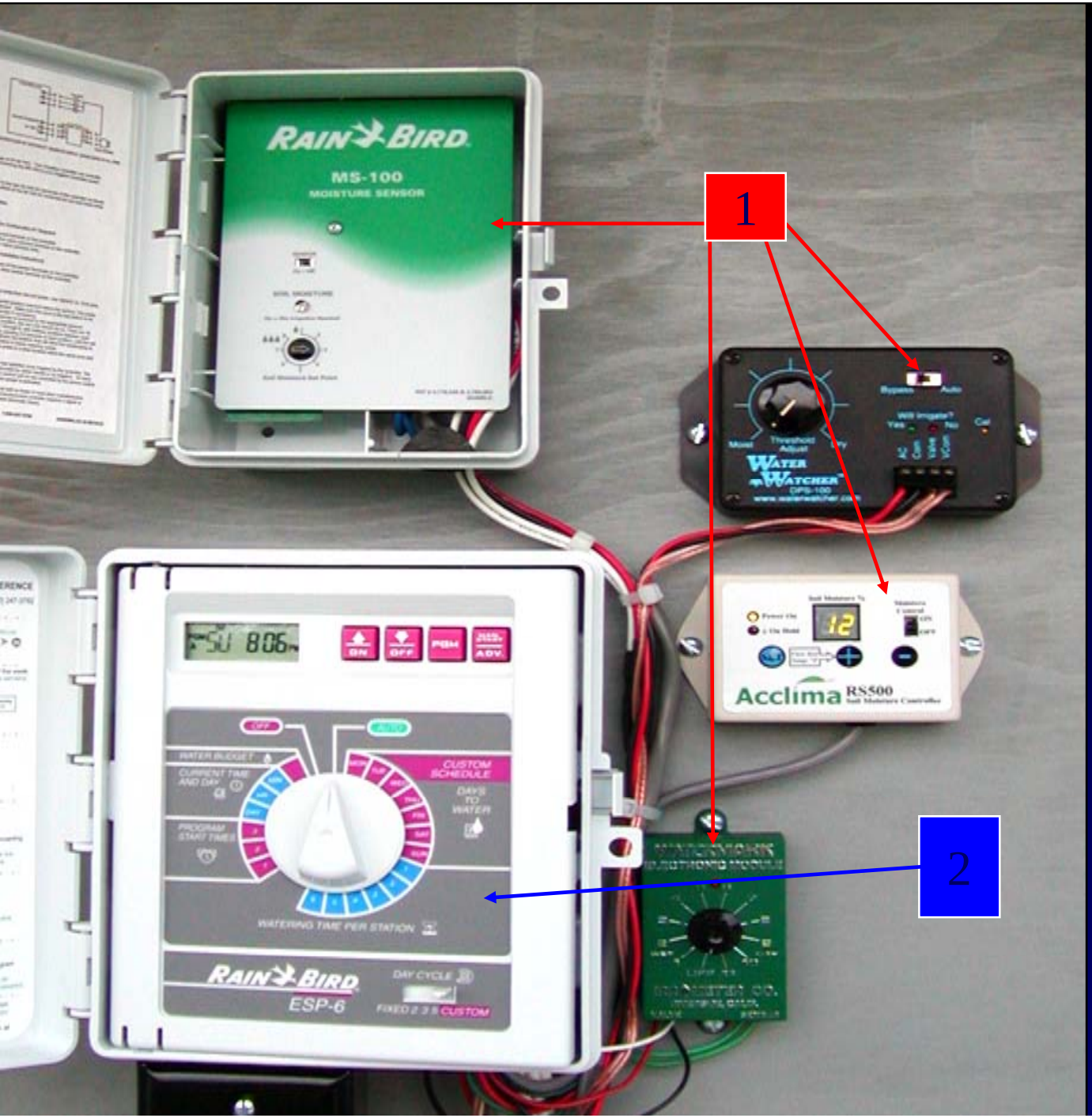
Rain sensor



Individual Plot Control



Control Panel



1: Sensor Controllers

2:Timer

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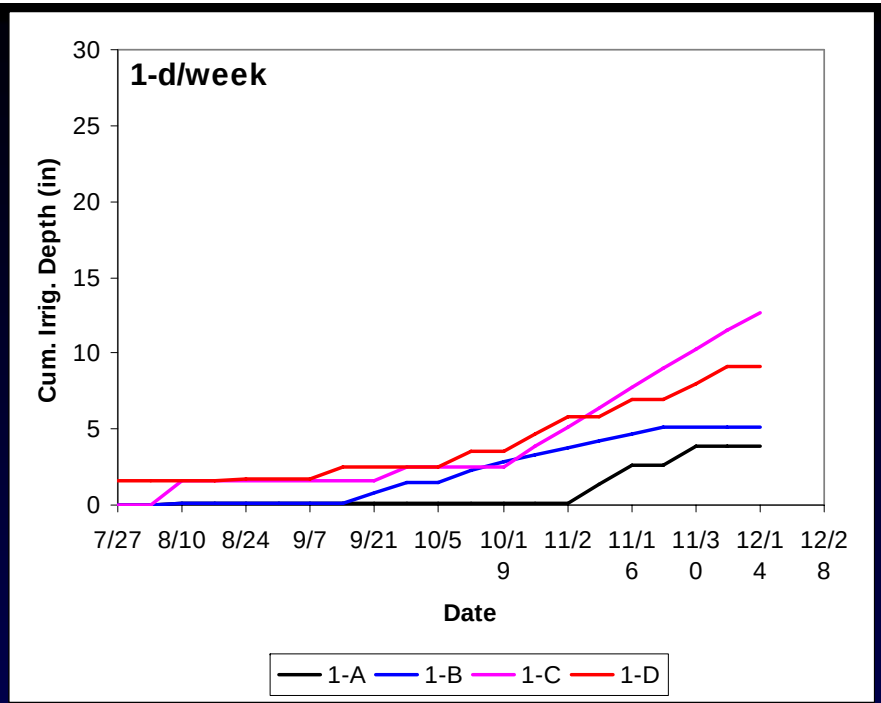
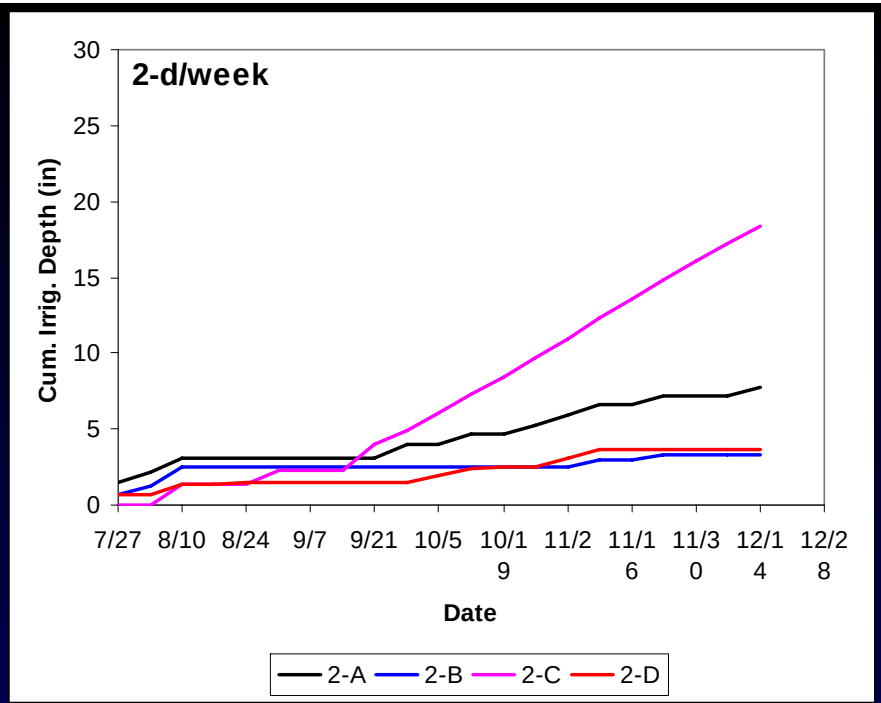
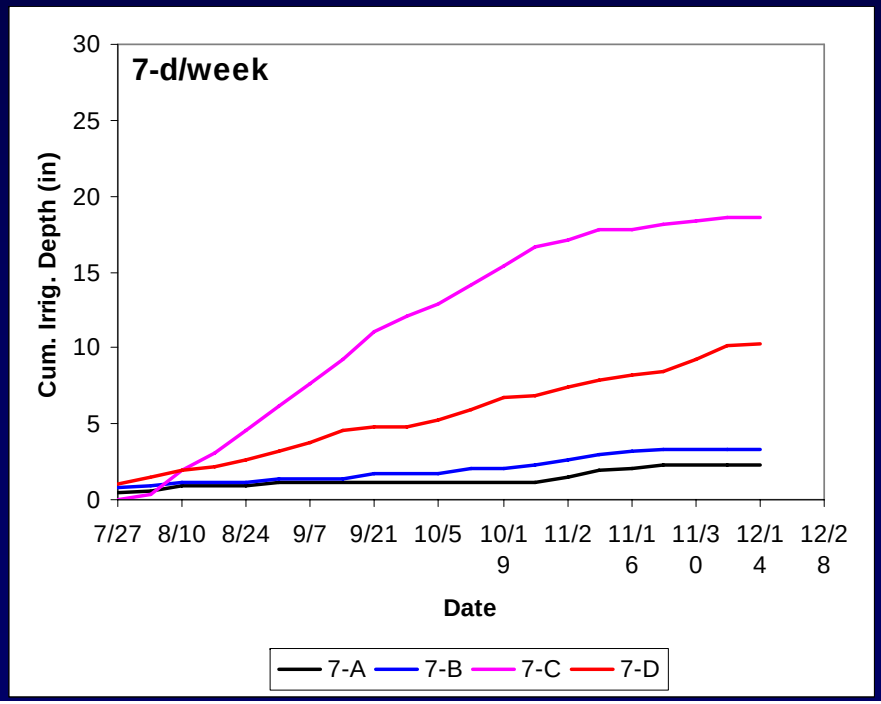

1-d/week
Cum. Irrig. Depth (in)
30
25
20
15
10
5
0
7/27 8/10 8/24 9/7 9/21 10/5 10/19 11/2 11/16 11/30 12/14 12/28
Date
1-A 1-B 1-C 1-D


2-d/week
Cum. Irrig. Depth (in)
30
25
20
15
10
5
0
7/27 8/10 8/24 9/7 9/21 10/5 10/19 11/2 11/16 11/30 12/14 12/28
Date
2-A 2-B 2-C 2-D


7-d/week
Cum. Irrig. Depth (in)
30
25
20
15
10
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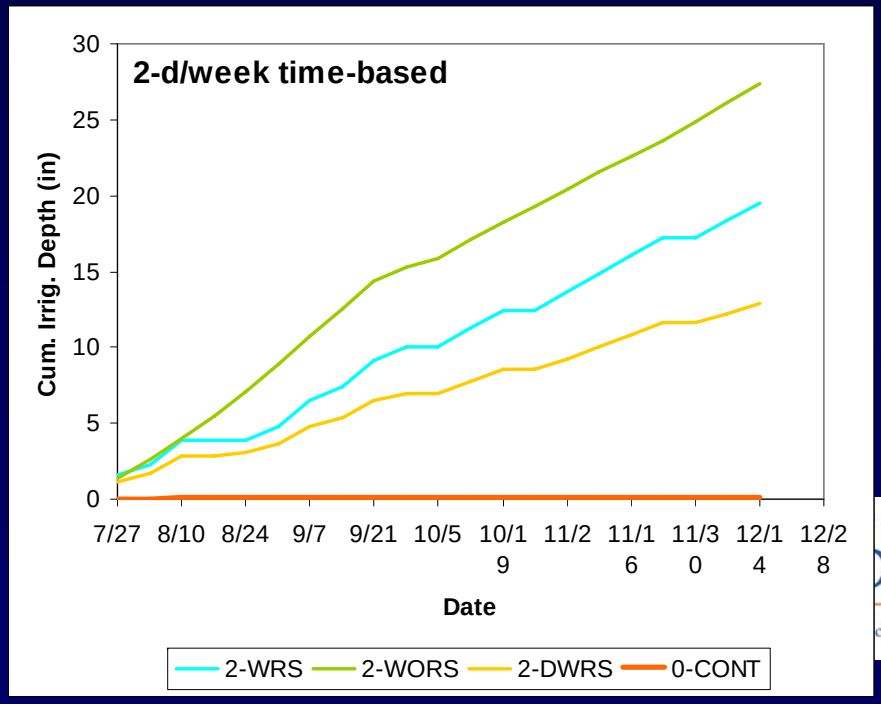
0
7/27 8/10 8/24 9/7 9/21 10/5 10/19 11/2 11/16 11/30 12/14 12/28
Date
7-A 7-B 7-C 7-D


2-d/week time-based
Cum. Irrig. Depth (in)
30
25
20
15
10
5
0
7/27 8/10 8/24 9/7 9/21 10/5 10/19 11/2 11/16 11/30 12/14 12/28
Date
2-WRS 2-WORS 2-DWRS 0-CONT

TIME vs. SMS Control

Treatment	TOTAL (in)*	Savings compared to 2-WRS (%)
2-WRS	18.9 *b*	0
2-WORS	27.4 *a*	- 45
2-DWRS	12.2 *c*	36
Sms Avg	8.1 *c*	57

* P<0.05

WRS = With Rain Sensor

WORS = Without Rain Sensor

DWRS = 60% Deficit With Rain Sensor

Sms = Soil Moisture Sensors

Avg = Average

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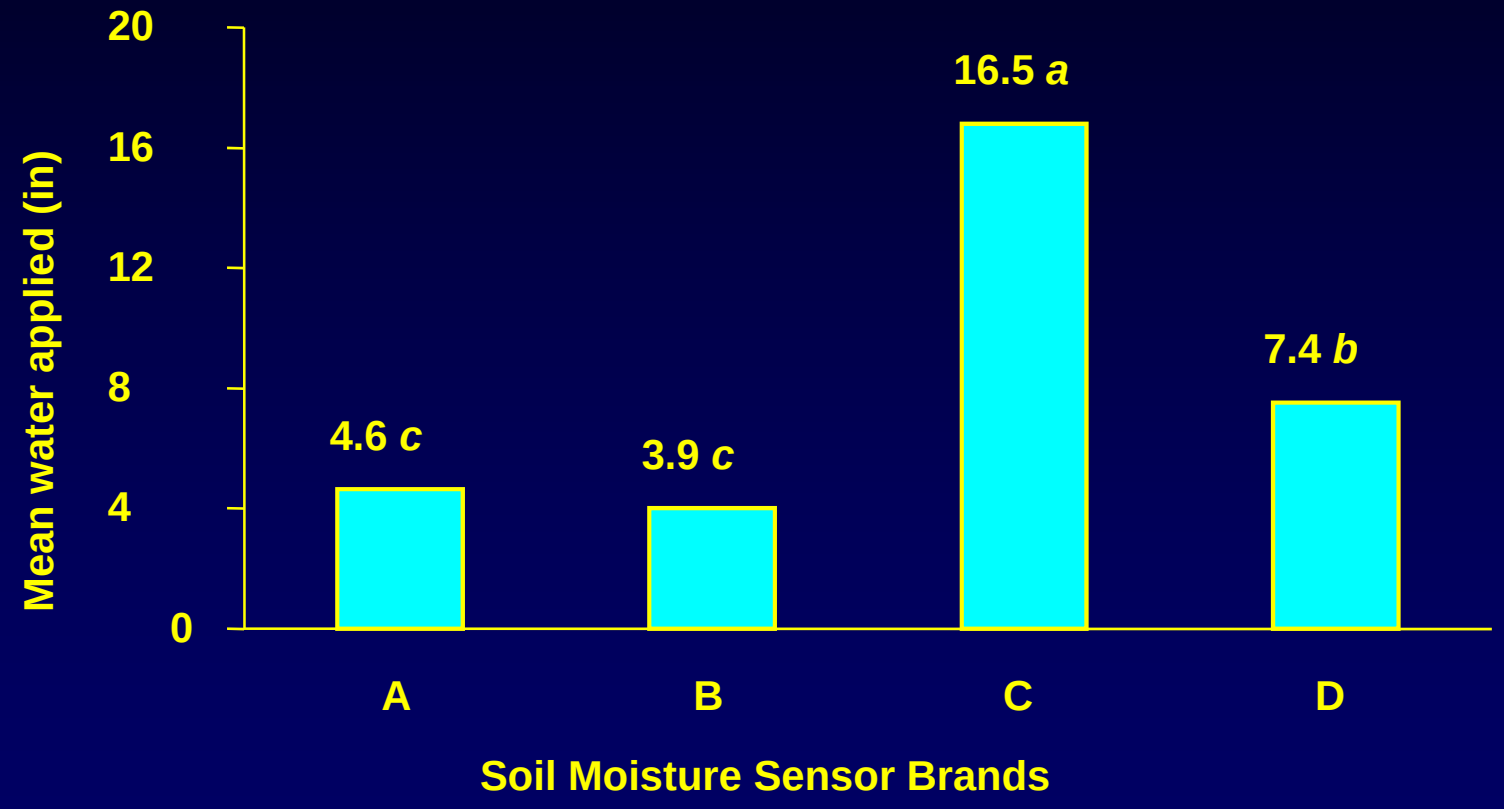
SMS Brand Comparison

Reduction compared to 2WRS

59-88% 73-82% 34% 1-d/wk 46-81%



P<0.05

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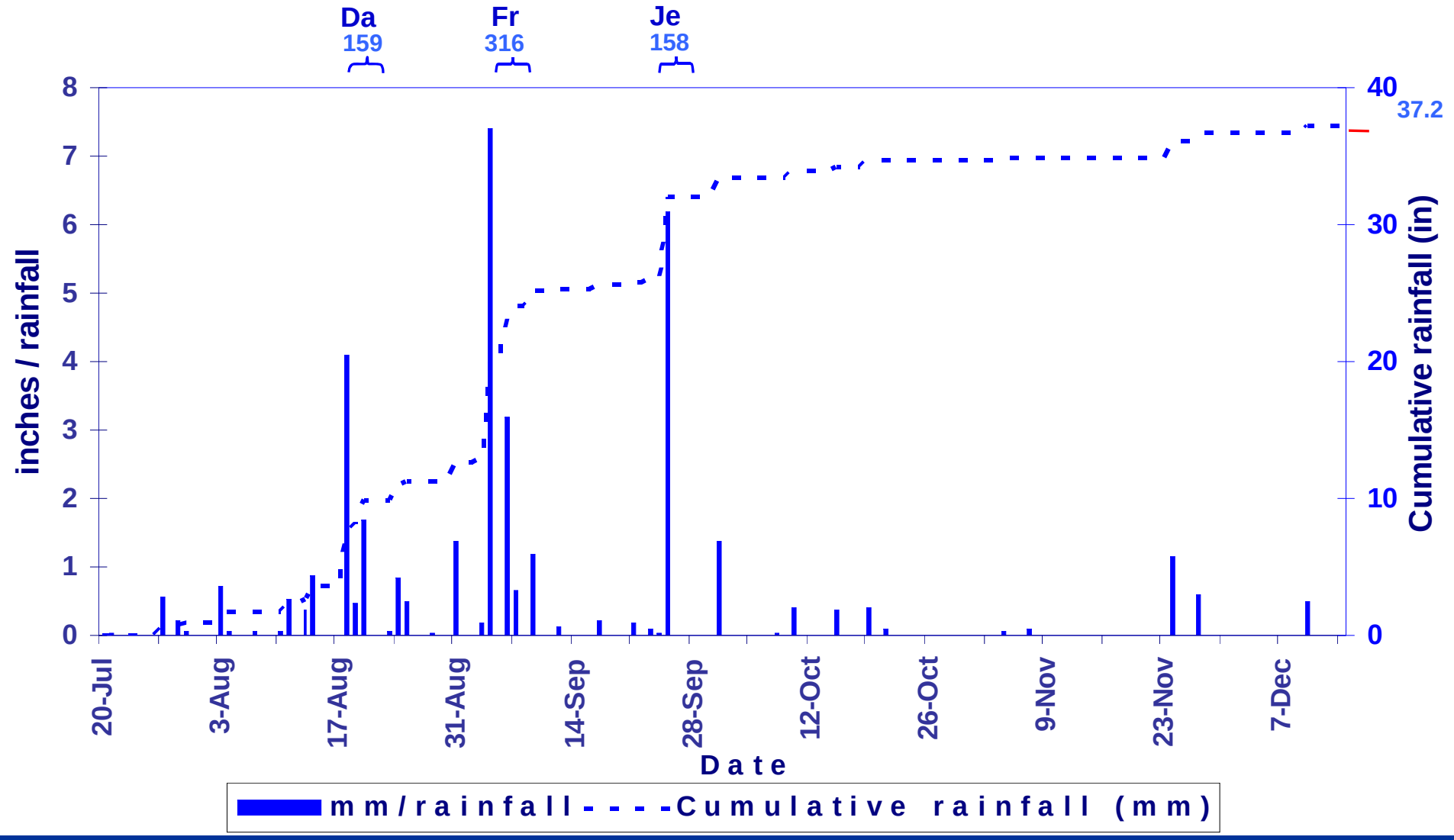
Rainfall per Event and Cumulative Rainfall



Total 37.2 in T.S. Danielle 6.2 in H. Frances 12.4 in

H. Jeanne 6.2 in 67% of total

SMS Irrigation - Conclusions

- No significant differences in turfgrass quality among treatments detected.
- WORS 45% > WRS → importance of rain sensor
- SMS savings 59-88% (excluding brand C)

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Further Research

- **SMS on homes**
  - **64 homes Pinellas Co.**
    - **16 SMS**
    - **16 control**
    - **16 rain sensors**
    - **16 educational materials**
- **ET controllers**
- **Phase I, “Landscape” plots**
- **Gulf Coast REC, Hillsborough Co.**
- **Phase II, 40-50 homes Hillsborough Co.**

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Real World Application

- Majority of new homes have automatic irrigation
- SW FL landscape ordinance
  - Pasco Co.: 50% of green space can be sprinkler irrigated
  - "…compliance with the ordinances was found to be minimal…"
  - 69% green space irrigated with sprinkler

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Lake Jovita

- Pasco Co. ordinance variance
- Full landscape irrigation if controlled with SMS
- ~400 homes in Lake Jovita currently
- 5 homes/month completed
- Historical water use since May 2001
- New homes since early 2006 will have SMS control

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Source	Irrig. Applied (mm/month)	Irrig. Applied (in/month)	Compared to Theoretical
AWWA	**77**	**3.0**	**+60%**
SJRWMD	**Dukes, Miller, Haley, 2005**		
T1	**141**	**5.6**	**+194%**
T2	**93**	**3.7**	**+94%**
T3	**80**	**3.1**	**+67%**
SWFWMD-SMS	**Dukes, Miller Cardenas, 2005**		
2-WORS	**155**	**6.1**	**+223%**
2-WRS	**107**	**4.2**	**+123%**
2-DWRS	**69**	**2.7**	**+44%**
$SMS_{avg\ (2004\text{-}05)}$	**46**	**1.8**	**0%**
Theoretical	**48**	**1.9**	**0%**

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Questions?

Thank you!
SJRWMD, SWFWMD, FDACS, Hillsborough Co. Water Dept., FTGA, FNGLA

Melissa Haley, Berndardo Cardenas, Larry Miller, Danny Burch, Numerous undergrad and graduate students

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