Sprinkler Irrigation & Soil Moisture Uniformity

Michael D. Dukes, Ph.D., P.E., C.I.D.

Melissa Haley, Stephen Hanks

Nov. 6, 2006, IA Int'l Irrig. Show, San Antonio, TX

UNIVERSITY OF FLORIDA

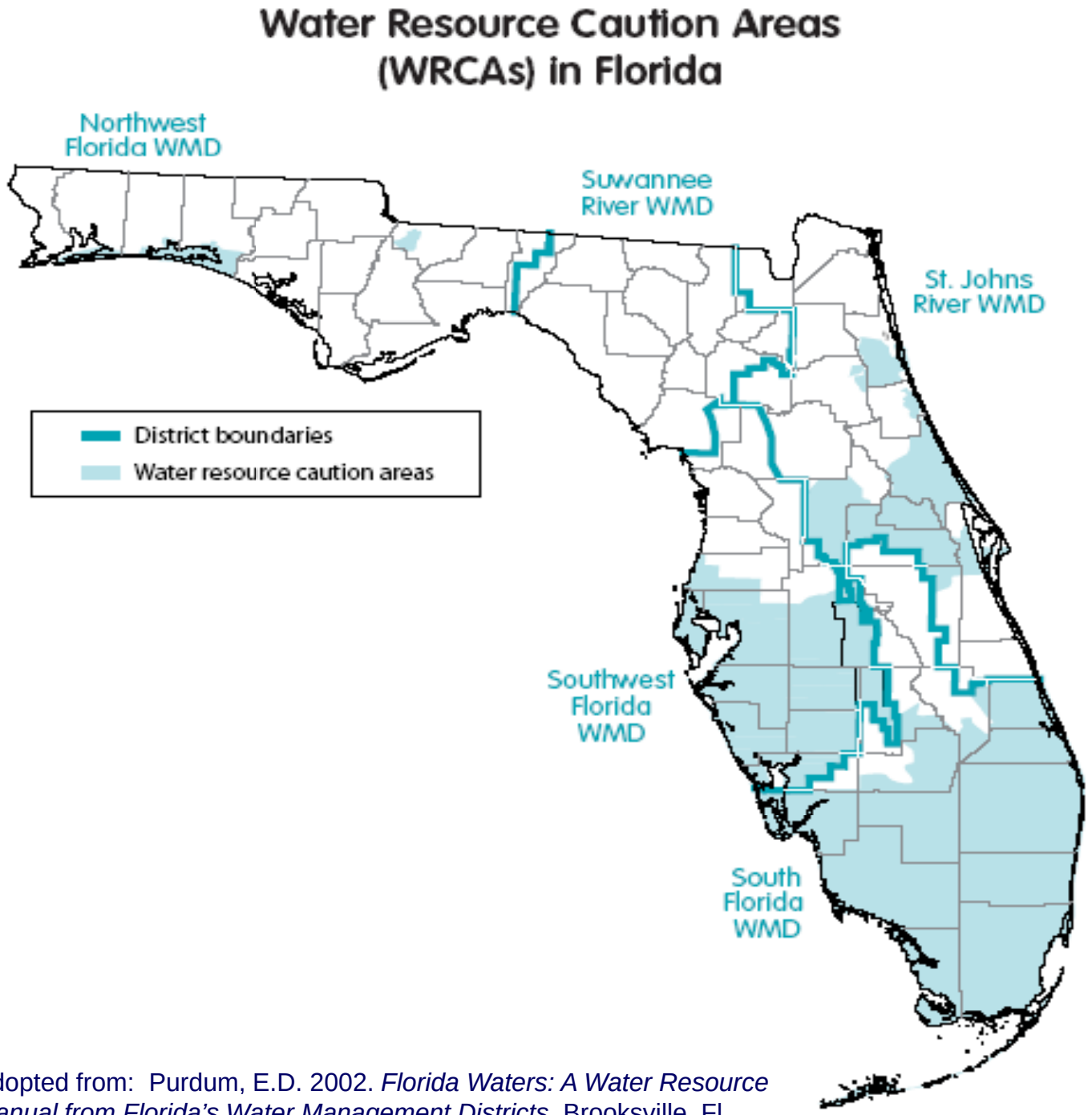
Agricultural & Biological Engineering Department

Background

- Population served by public supply
  - 5.4 million 1970
  - 17 million 2004
  - 20 million 2020
- + ~1,000 people/day
- 11% U.S. new home construction in FL
- 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

Florida's Water Crisis

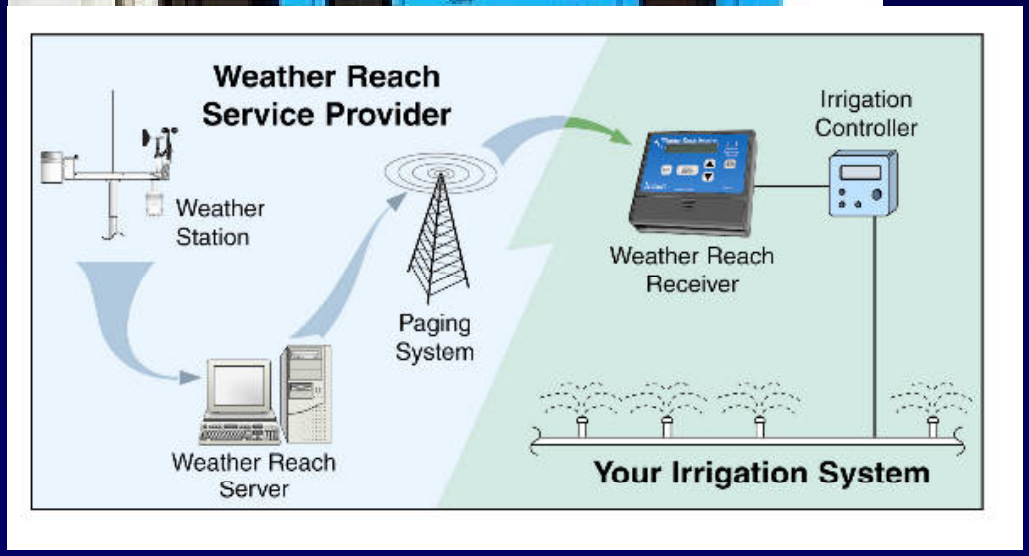
<u>Water Resource Caution Areas</u>: places where water is either scarce or contaminated as defined by Florida's Water Management Districts



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

Sensor Based Irrigation

Soil moisture sensors (SMS)



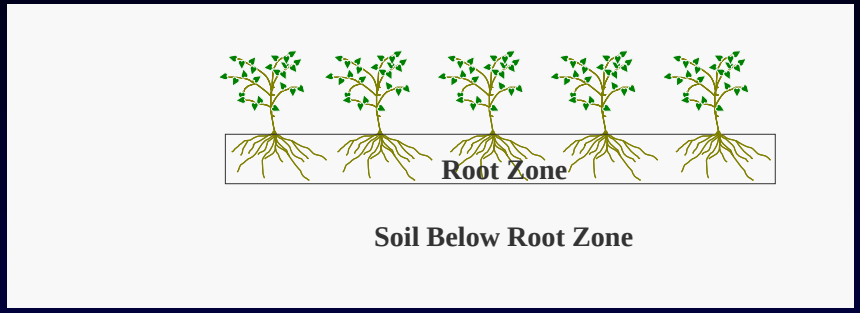
Evapotranspiration (ET) based controllers

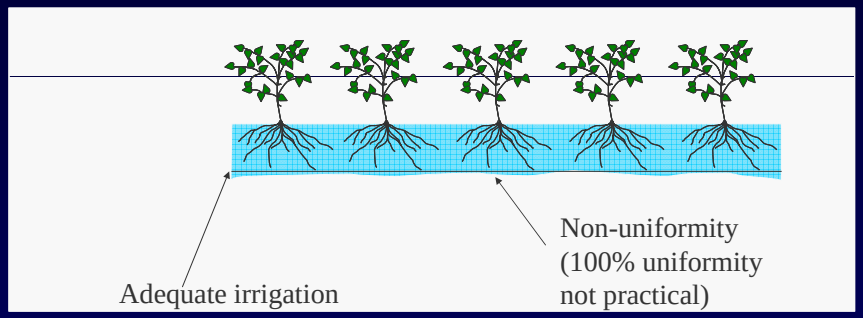
UF UNIVERSITY of FLORIDA IFAS

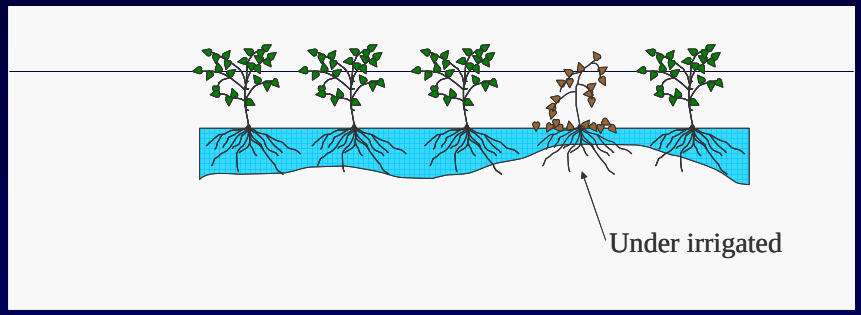
Current Turf/Landscape Irrigation Research

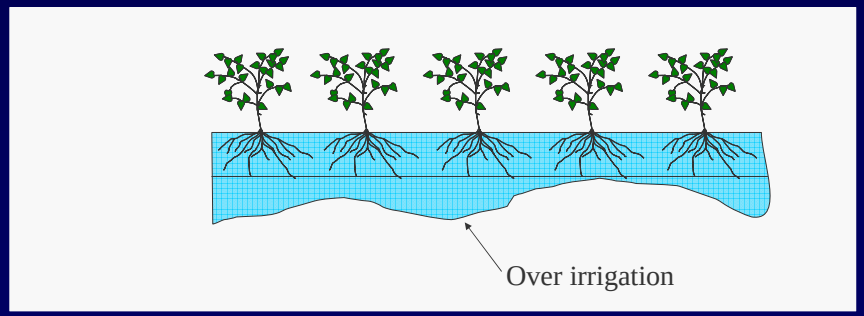
1. SMS plots, Gainesville
2. Rain Sensor evaluation, Gainesville
3. SMS plots & ET controllers, Citra (Turfgrass Research Unit)
4. SMS on cooperating homes, Pinellas Co.
5. SMS development scale, Lake Jovita, Pasco Co.
6. ET controller plots, GCREC Hillsborough Co.

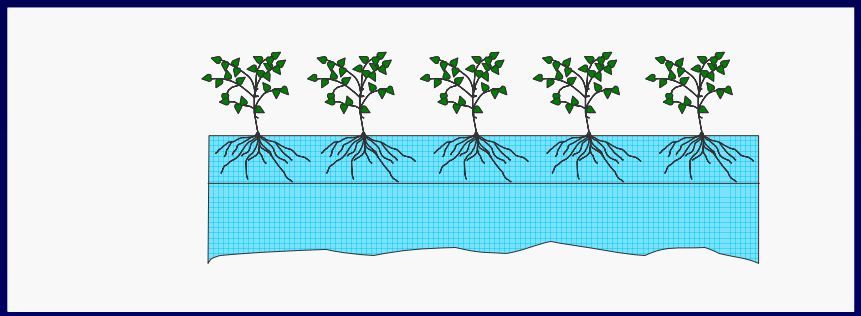
Potential Uniformity Impact











Improper Coverage

UF UNIVERSITY of FLORIDA IFAS

Narrow Areas

Catch Can Testing

Literature Review

- Analytical yield & uniformity relationship
- Yield reduction due to non-uniformity not well documented in the field
- Redistribution of irrigation water within canopy (ag. crops)
- Minimal information on turf quality & uniformity

Turf Quality & Non-uniformity

Methodology

- **Plots**
  - **4.6 m X 4.6 m (15 ft X 15 ft)**
  - **15Q Spray heads**
  - **25 catch cans**
- **Tests at 3 pressures**
  - **414 kPa (60 psi)**
  - **138 kPa (20 psi)**
  - **69 kPa (10 psi)**

Experimental Site

UF UNIVERSITY of FLORIDA IFAS

Methodology

- **Arredondo FS**
  - **Field capacity 7-10% (no runoff)**
  - **Permanent wilting point 2-3%**
  - **Infiltration rate 179 mm/hr (7 in/hr)**

$$DU_{lq} = \frac{V_{low25\%}}{V_{avg}}$$

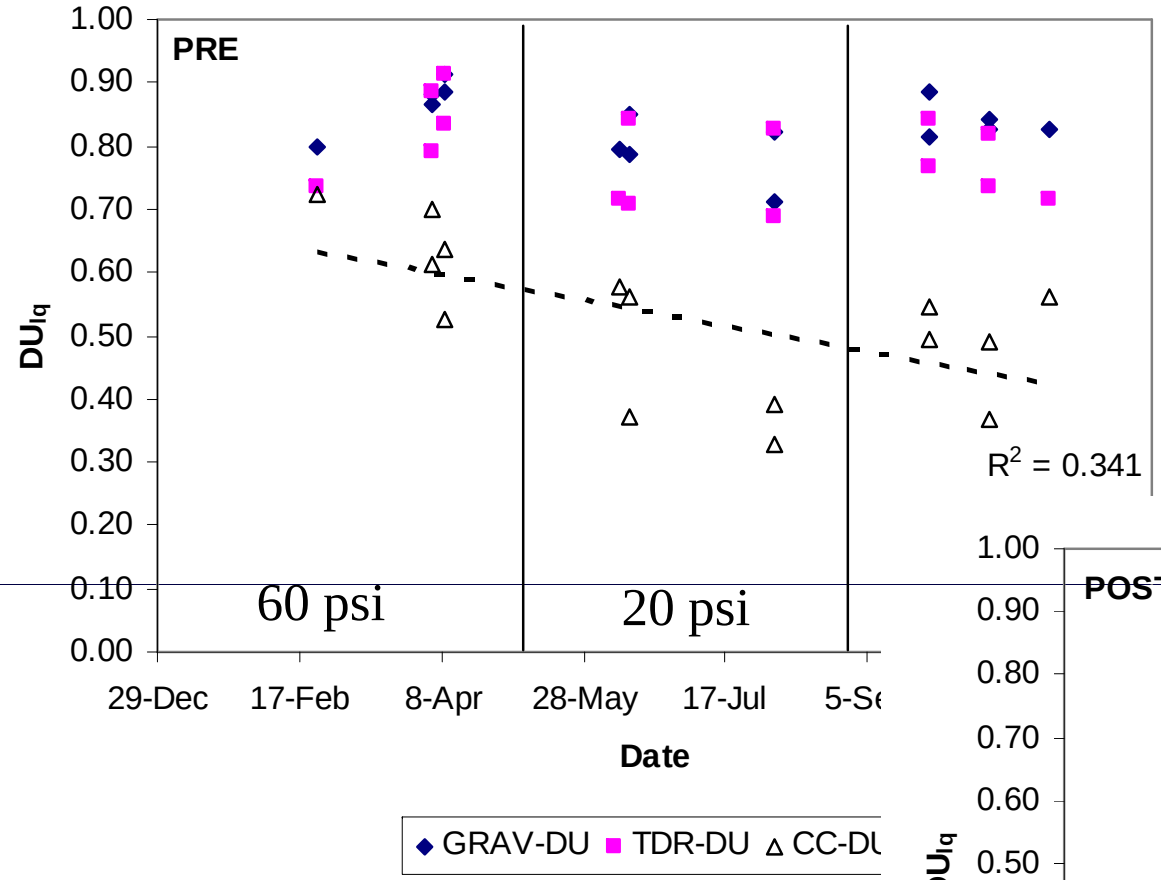
Testing Conditions

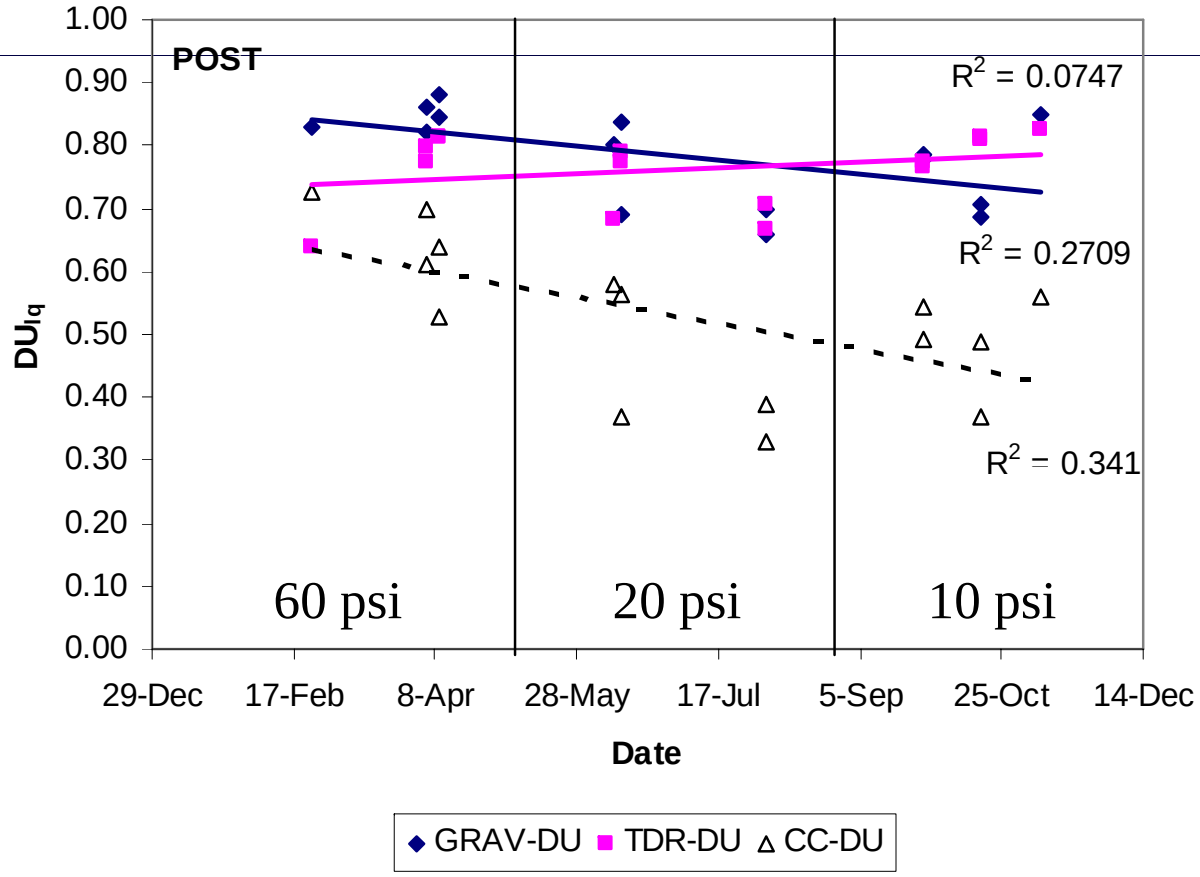
- **Soil moisture content**
  - **Gravimetric 10 cm (4 in) long X 5.7 cm (2.2 in) dia.**
  - **TDR 20 cm (8 in) long rods**
- **Soil sample & TDR collection rotated 90 deg.**
- **Soil sample locations repacked**
- **Low wind (< 2.5 m/s; 5 mph)**

Uniformity Data Collection

UF UNIVERSITY of FLORIDA IFAS

Irrigation Effect on DU_{lq}





Statistical Results

- **Interaction between measurement type & pressure level on DU_{lq}**
  - **Gravimetric**
  - **TDR**
  - **Catch Can**

Pressure Effect on Distribution Uniformity

Pres.	TDR Pre-Irr.	Grav. Pre-Irr.	TDR Post-Irr.	Grav. Post-Irr.	Catch Can
(psi)	----------DU_{lq}----------				
60	0.77 a	0.83 a	0.74 a	0.83 a	0.63 a
20	0.81 a	0.86 a	0.79 a	0.83 a	0.55 b
10	0.78 a	0.81 a	0.75 a	0.69 b	0.39 c

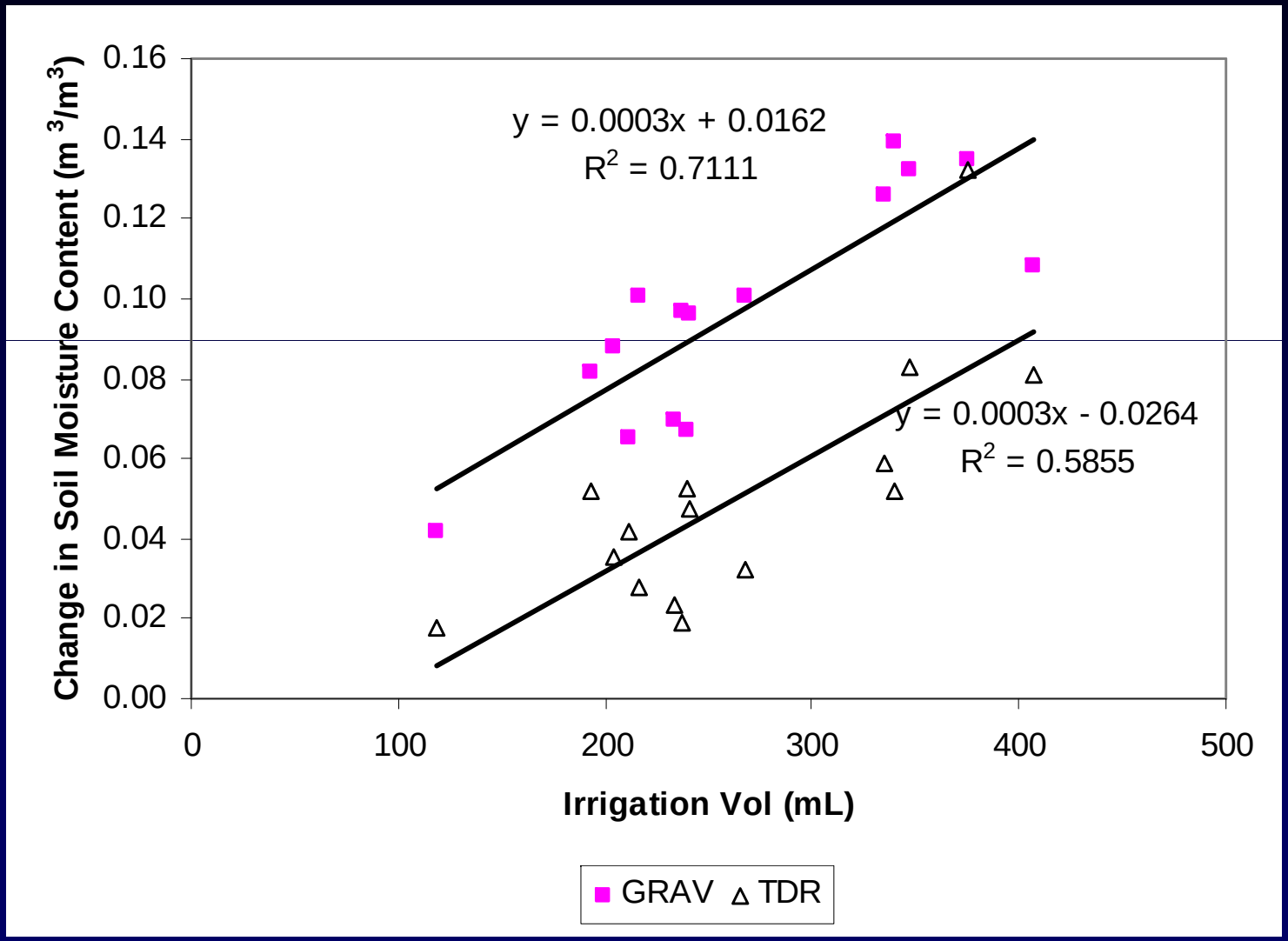
Different letters indicate a significant difference within columns

Pressure Effect on Soil Moisture Content

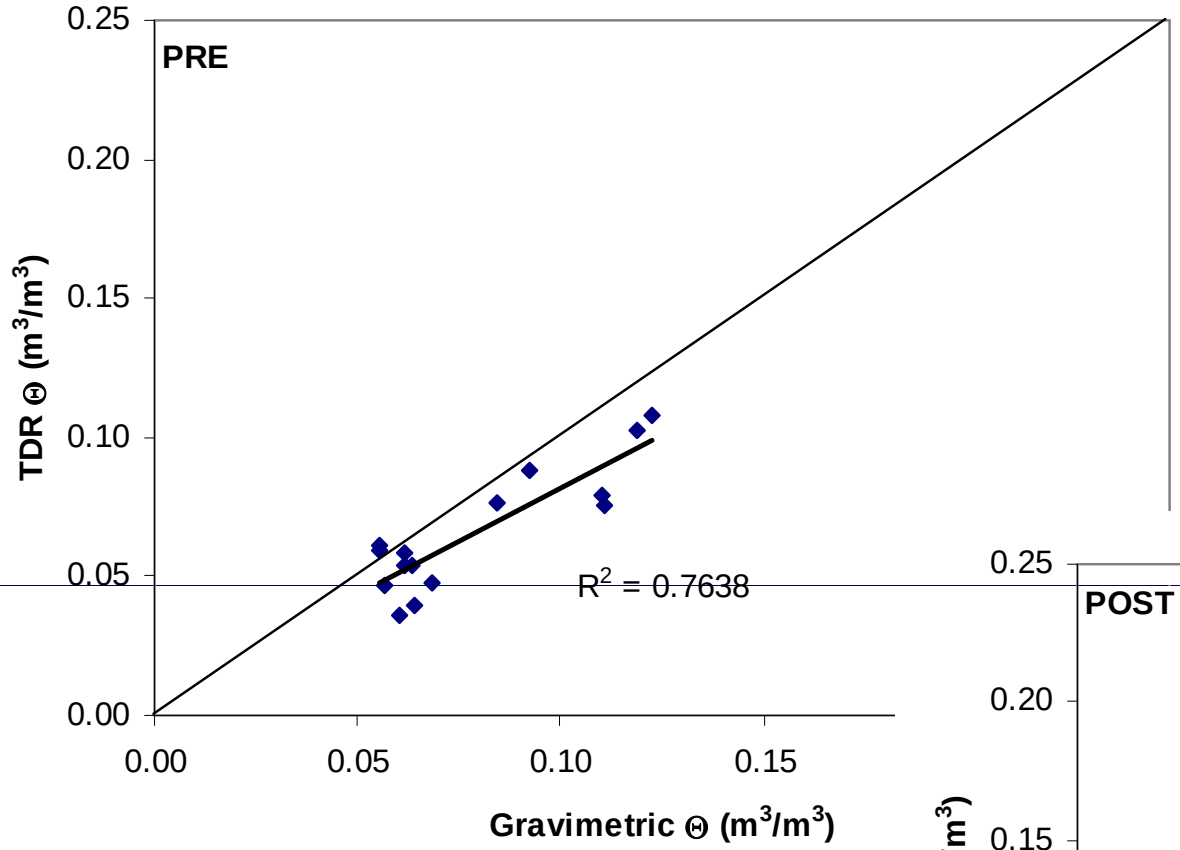
Pres.	TDR Pre-Irr.	Grav. Pre-Irr.	TDR Post-Irr.	Grav. Post-Irr.	Catch Can
(psi)	----------(m^3/m^3)----------				(in)
60	0.07 a	0.07 a	0.15 a	0.20 a	0.72 a
20	0.07 a	0.09 a	0.11 b	0.17 b	0.47 b
10	0.06 a	0.08 a	0.09 b	0.15 c	0.39 c

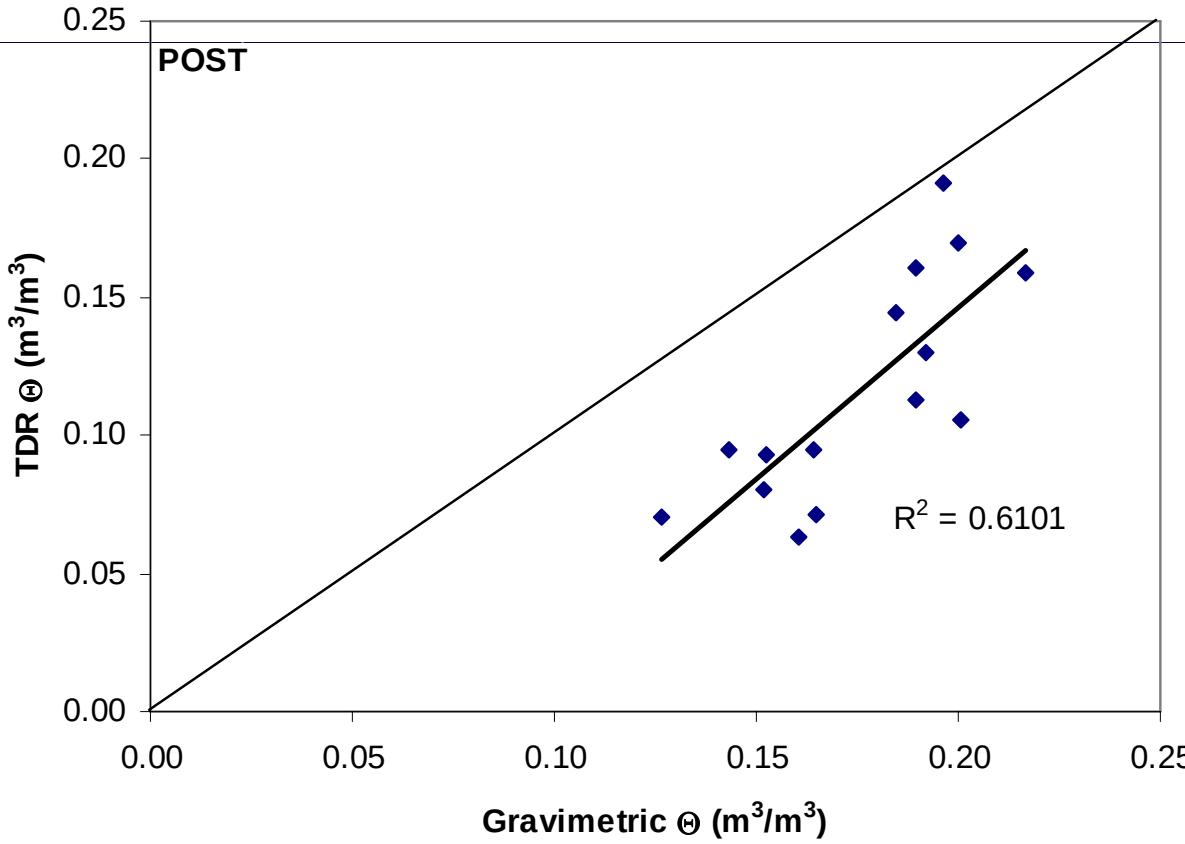
Different letters indicate a significant difference within columns

Effect of Irrigation on Soil Moisture

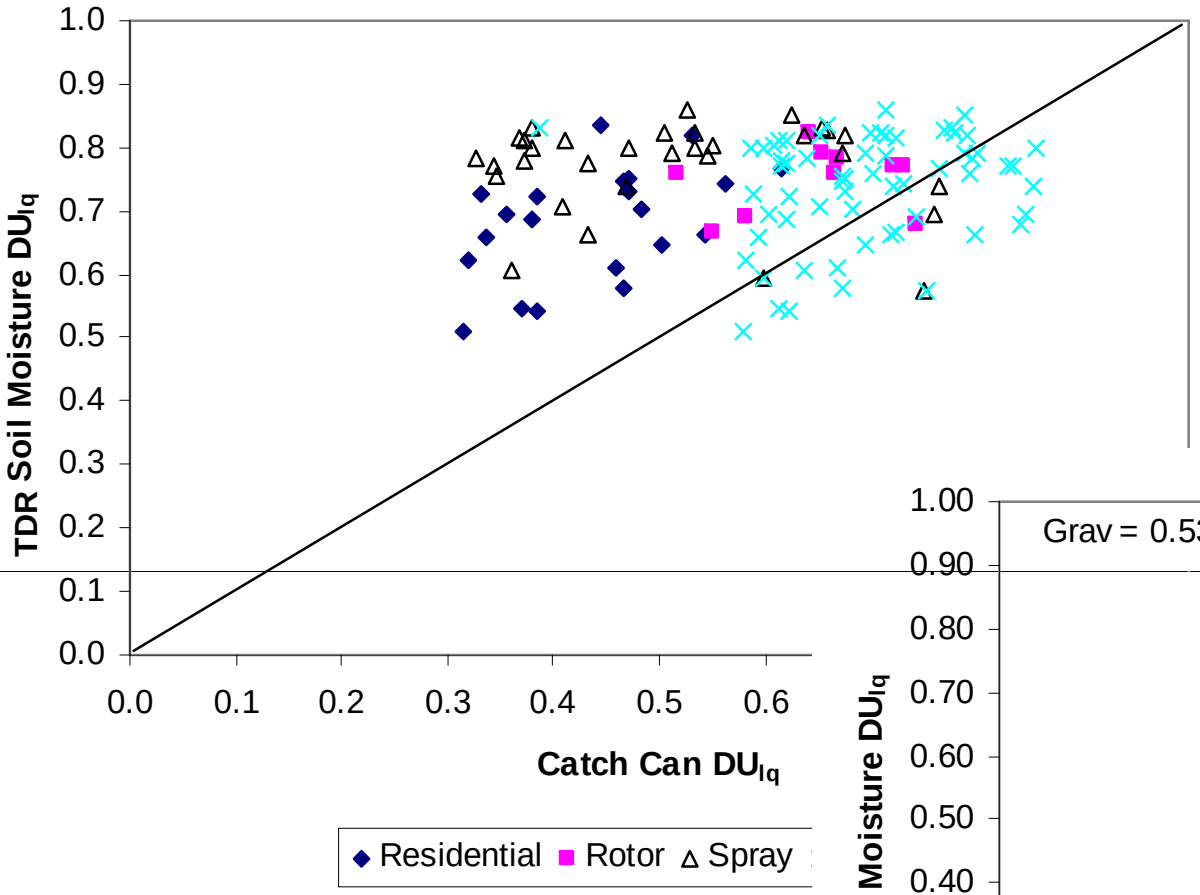


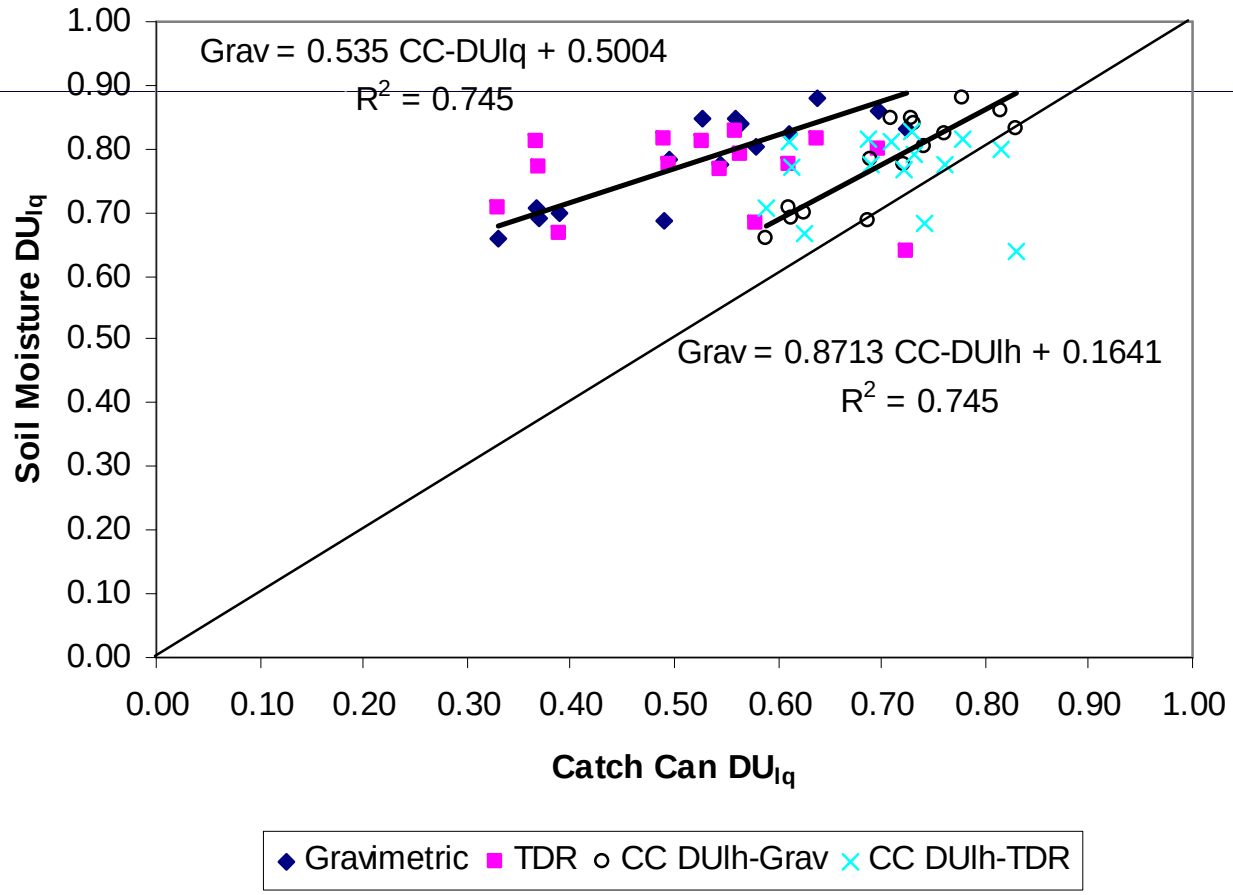
TDR SMC vs. Gravimetric SMC





Residential Testing





$$DU_{lh} = 0.386 + (0.614 * DU_{lq})$$

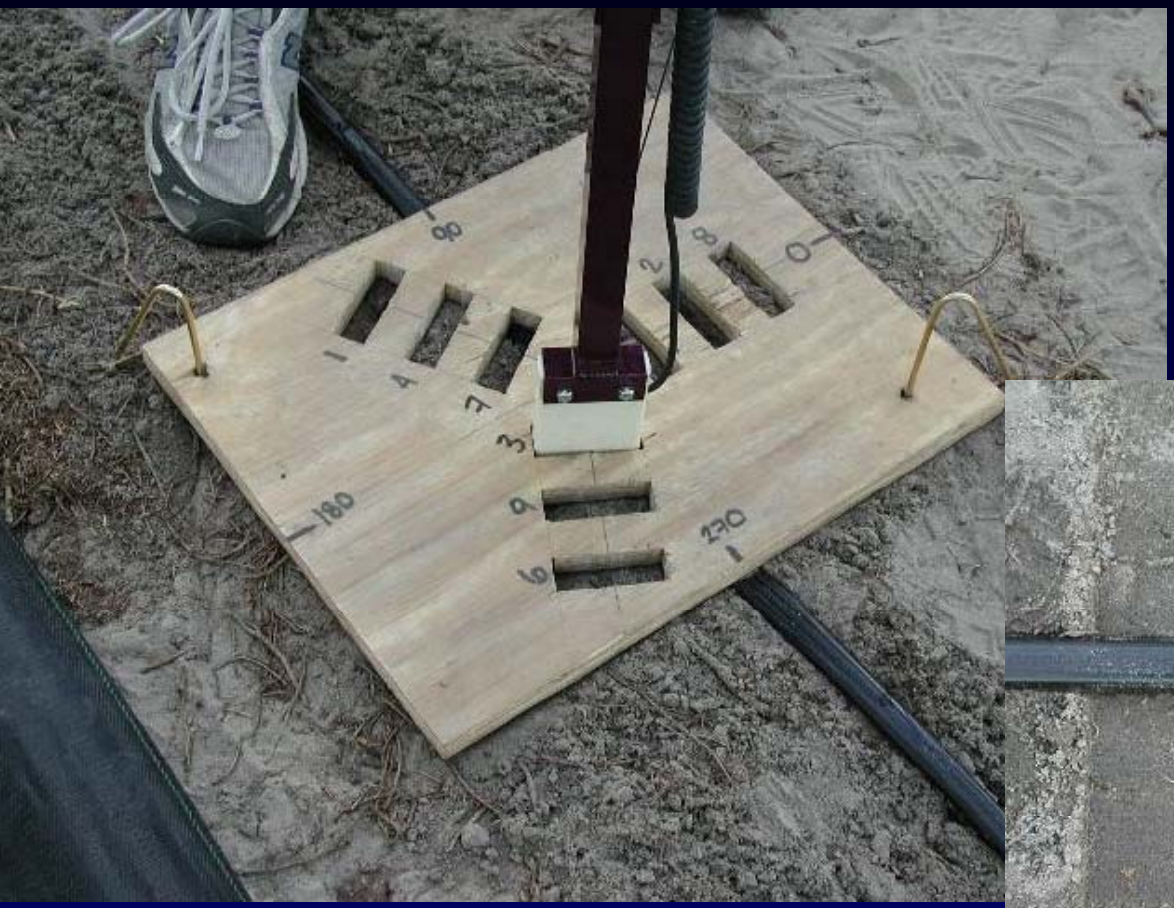
Plot Testing

Conclusions

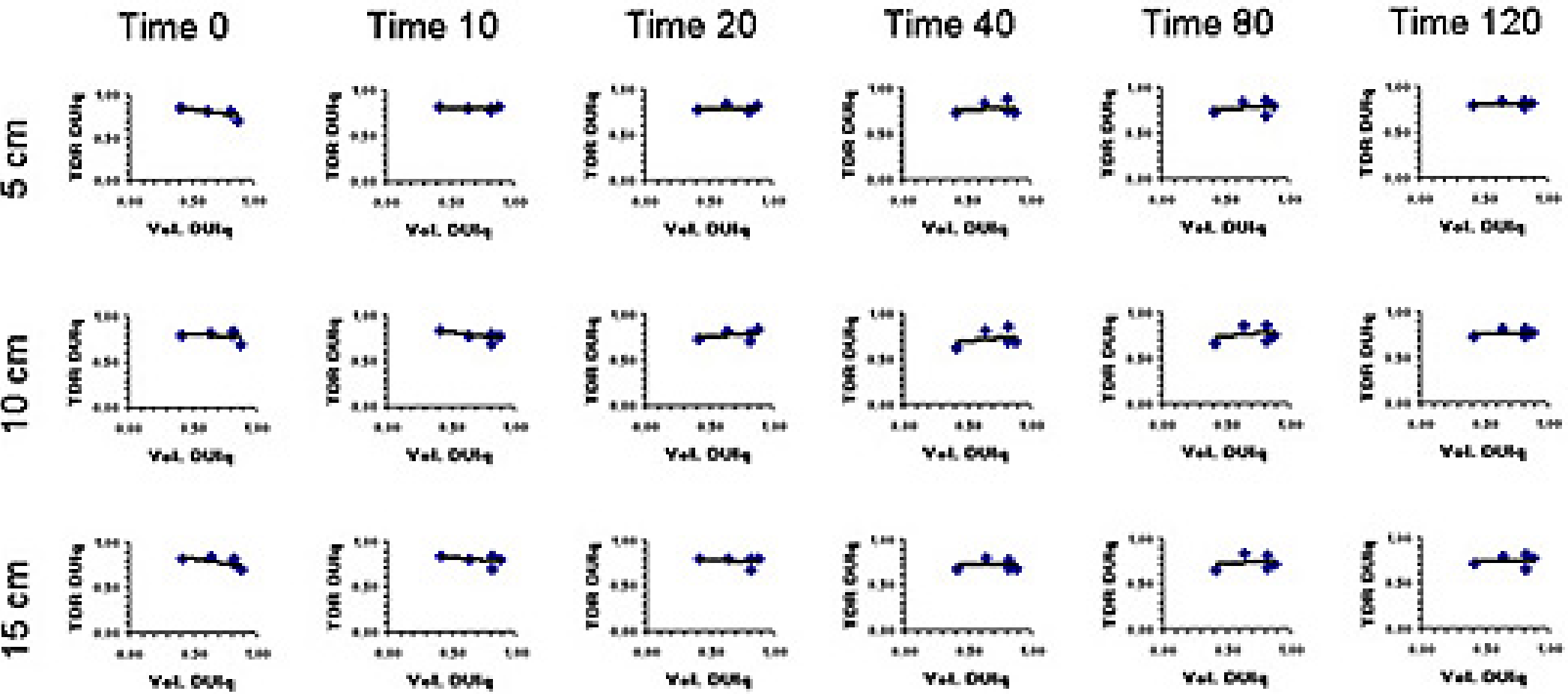
- SMC uniformity relatively insensitive to irrigation uniformity levels tested here (CC DU_{lq} 0.39-0.63)
- CC DU_{lh} approximates SMC DU_{lq}
- CC DU_{lh} may be a reasonable indicator of irrigation system performance

Microirrigation Uniformity Testing

Microirrigation Uniformity Testing cont'd



Microirrigation TDR DU_{lq} vs CC DU_{lq}



Questions?

Thank you!

Acclima, Inc., Lawn Logic, Rain Bird, Toro, Hydropoint, ETWater, Weathermatic

SWFWMD, Hillsborough Co. Water Dept., Pinellas Co. Utilities

Danny Burch, Numerous undergrad and graduate students

www.ifas.ufl.edu
irrigation.ifas.ufl.edu