

# This presentation premiered at WaterSmart Innovations

[watersmartinnovations.com](http://watersmartinnovations.com)



# Soil moisture sensor system (SMS) = probe + controller





# Research: SMS have saved PW

- Turfgrass plots: 44 - 72%

*(Cardenas et al., 2008; McCreedy et al., 2009; Cardenas et al., 2010  
Grabow et al., 2013)*

- Homes: 42 - 65%

*(Grabow et al., 2010; Haley and Dukes, 2011; Nautiyal et al., 2014)*

- Turf quality above minimum acceptable





- Homes connected to RW have autom. irrigation system



- RW has become a limited resource in certain municipalities in FL



# Irrigation restrictions:

- Normal weather: 3 d/wk (voluntary)



- Dry weather: 2 d/wk (“enforced”)

- Severe dry weather: delivered 2 d/wk

# RW in the US

State	Population (2006 est)	Reported Reuse <sup>1</sup> in Millions of Gallons per Day	Reuse per Capita in Gallons per Day per Person	Rank
Florida	18,019,093	663.0	36.79	1
California	36,121,296	580.0 <sup>2</sup>	16.06	2
Virginia	7,628,347	11.2	1.46	3
Texas	23,367,534	31.4	1.34	4
Arizona	6,178,251	8.2	1.33	5
Colorado	4,751,474	5.2	1.09	6
Nevada	2,484,196	2.6	1.03	7
Idaho	1,461,183	0.7	0.50	8
Washington <sup>3</sup>	6,360,529	0	0	9

# RW users in Florida (2005)

User	Quantity
Golf courses	462
Residences	201,465
Parks	572
Schools	251

Source: *FL-DEP, 2006*



# Use of SMSs under RW:

## Why is it different?

- RW may contain higher levels of salts than potable water
- Salts may affect the readings of the SMSs





# OBJECTIVES

(under PW & RW irrigation)

## Main:

- Quantify the potential irrigation water savings of 4 SMS brands

## Secondary:

- Analyze the behavior consistency of SMS replicates within a brand
- Compare the different brands against each other

# Materials and Methods



# Materials and Methods

- 60 turfgrass plots in Gainesville, FL
- Irrigated with PW in 2009 and RW in 2010 (0.75 dS/m)



# Water salinity

Type of water	ppm	dS/m
Rainfall	10	0.02
Potable water, typical city water in US	<100	<0.16
Potable water, typically restricted to	500	0.78
Colorado River water	700	1.09
Typical limit agriculture irrigation	2,000	3.13
Brackish water, mildly salty limit	5,000	7.81
Sea water (Average)	35,000	54.70

Source: [www.waterboards.ca.gov](http://www.waterboards.ca.gov)





**Acclima**



**AquaSpy**



**Baseline**



**Dynamax**

Brand	Acclima	AquaSpy	Baseline	Dynamax
Controller	SCX	AquaBlu Regulator	WaterTec S100	IL200-MC Moisture Clik
Probe	Digital TDT	AquaSpy Sensor	biSensor	SM200
Technology	TDT	FDR	TDT	ADR

# Treatments: codes & descriptions

Treatment Codes	SMS Brand or Treatment Description	Replicates codes
<b><u>Time-Based</u></b>		
WOS	Without sensor feedback	
WRS	With rain sensor (1/4" threshold)	
DWRS	Deficit with rain sensor (60% of WRS)	



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<b><u>SMS-Based</u></b>		
ACL	Acclima	1-ACL, 2-ACL, 3-ACL
AQU	AquaSpy	1-AQU, 2-AQU, 3-AQU
BAS	Baseline	1-BAS, 2-BAS, 3-BAS
DYN	Dynamax	1-DYN, 2-DYN, 3-DYN

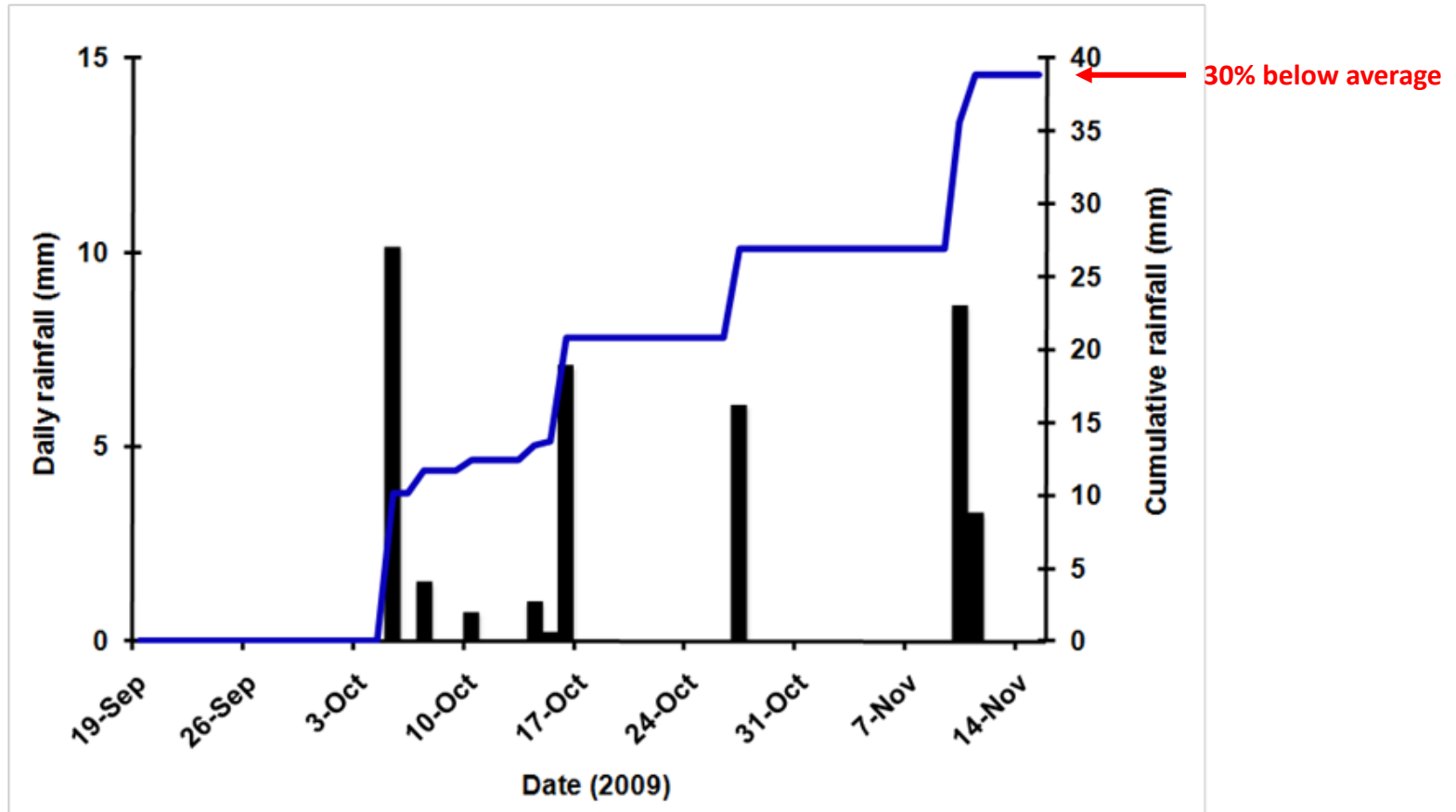
- All treatments set to run 3 d/wk (Pinellas Co.)
- All treatments set to the same run time, except for DWRS (60%)
- Run times adjusted monthly, to replace 100% of the historical ET-based irrigation schedule (*Dukes and Haman, 2002*)

# Results

## 2009



# Daily and Cumulative Rainfall

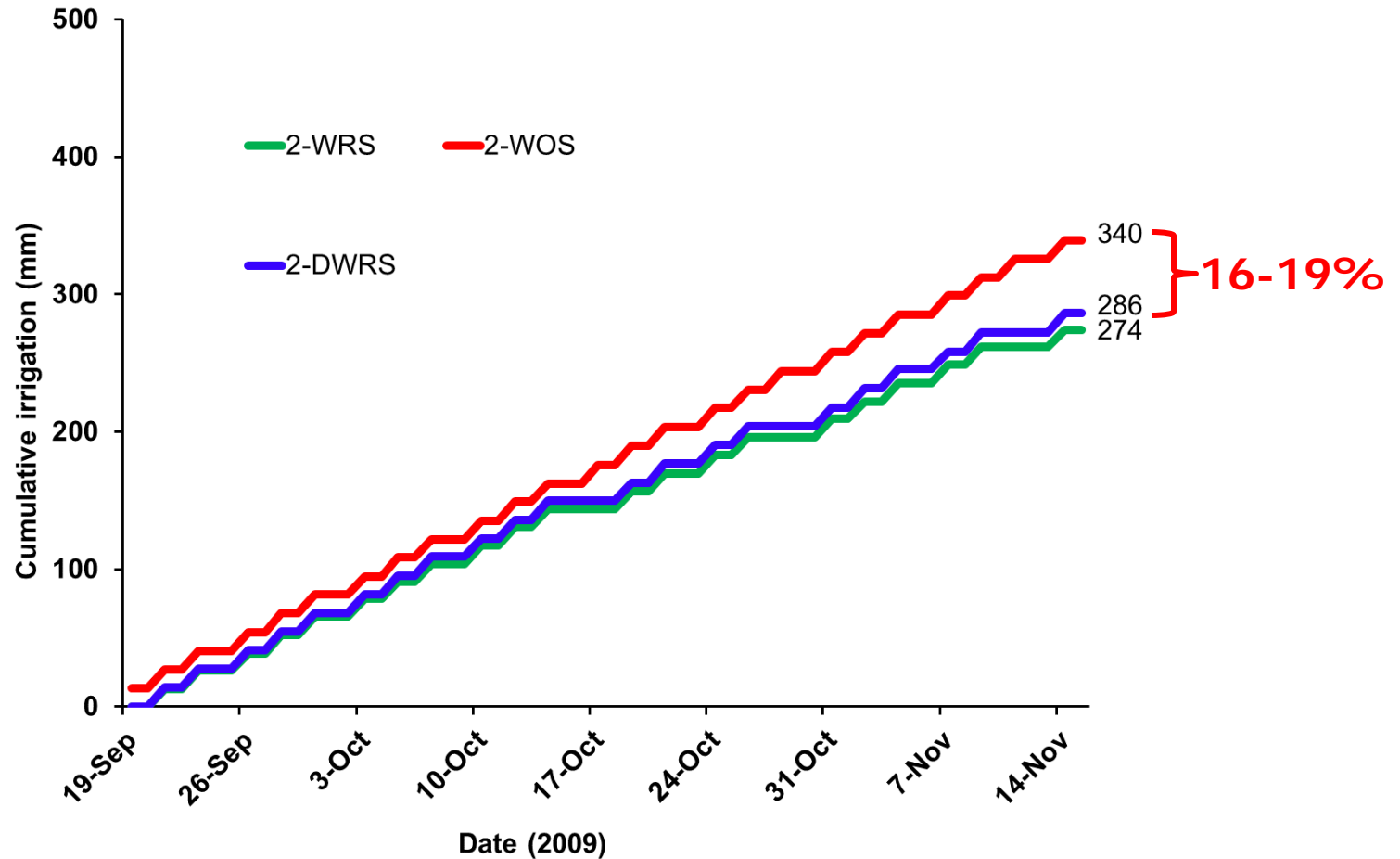


Relatively dry

# Cumulative irrigation in 2009

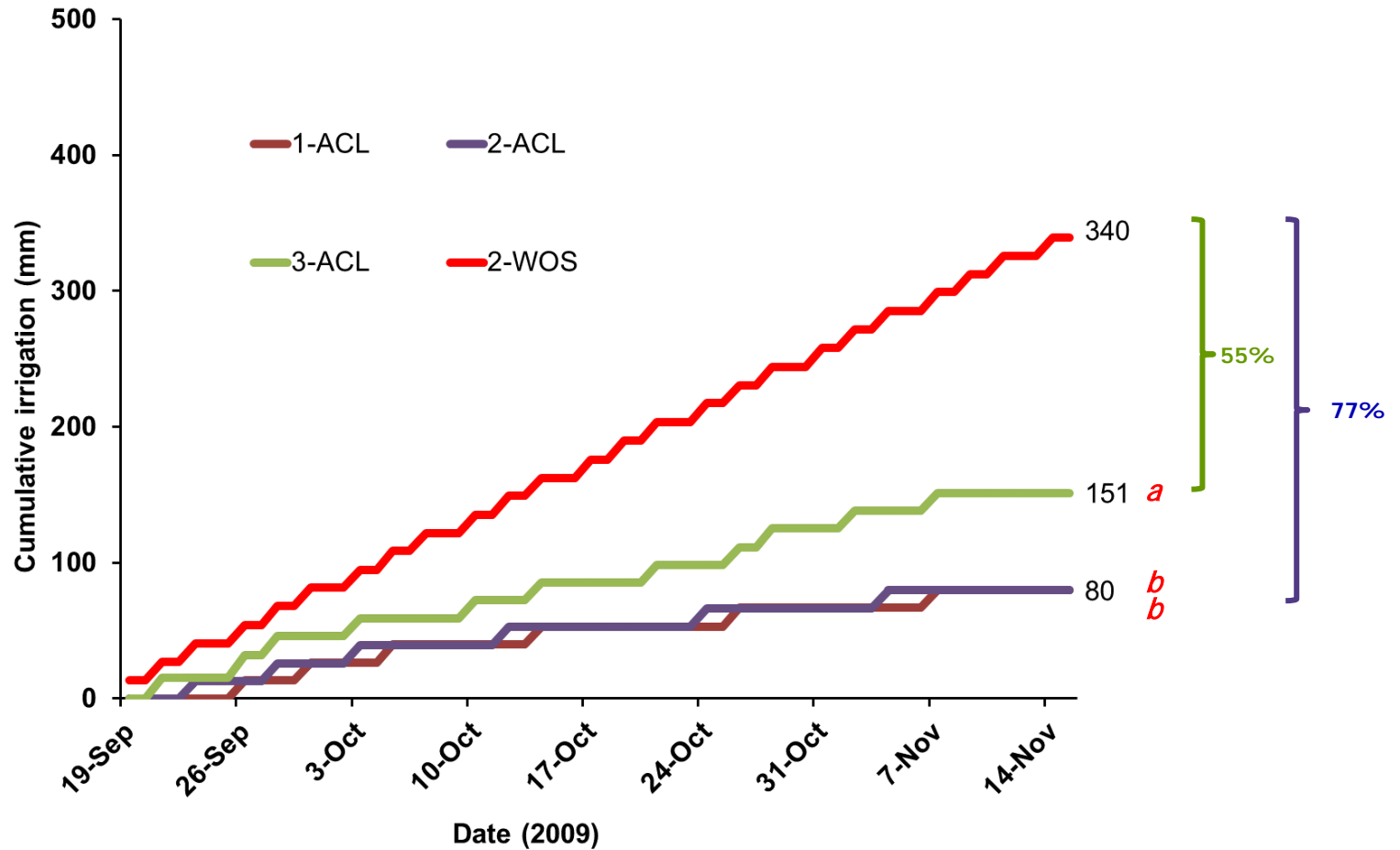


# Time-based

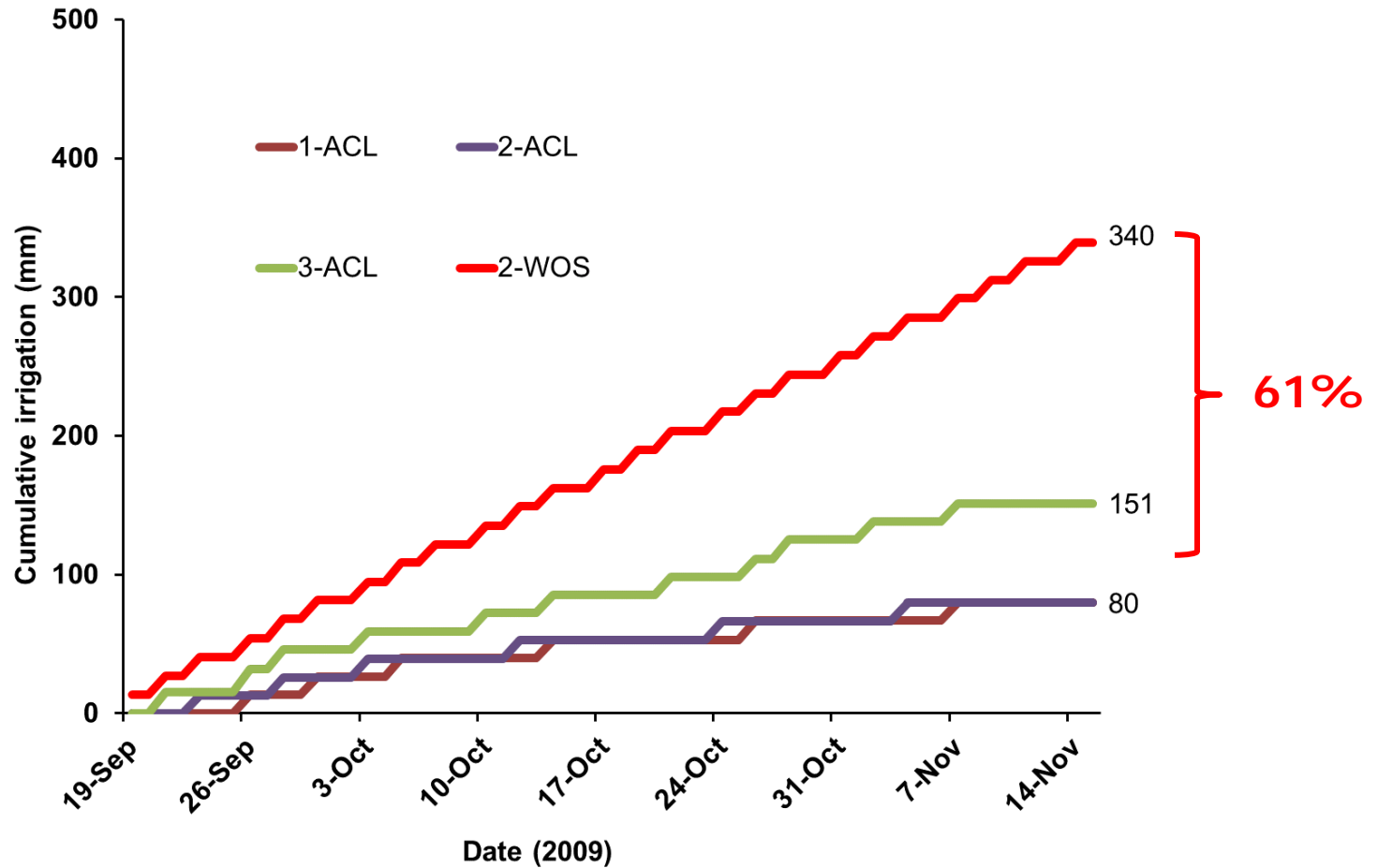


WOS = without sensor  
WRS = with rain sensor  
DWRS = deficit, with rain sensor

# Acclima

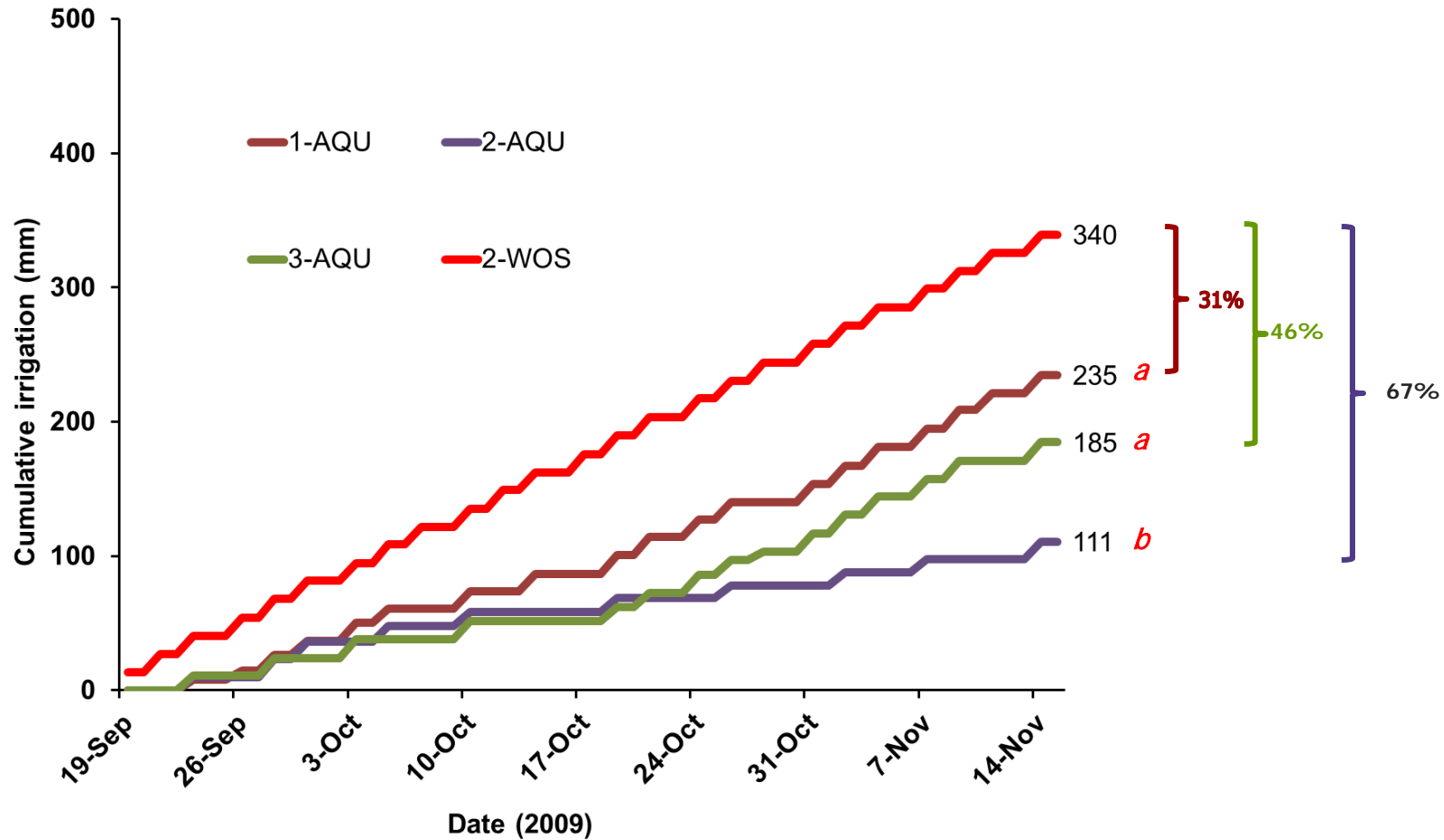


# Acclima

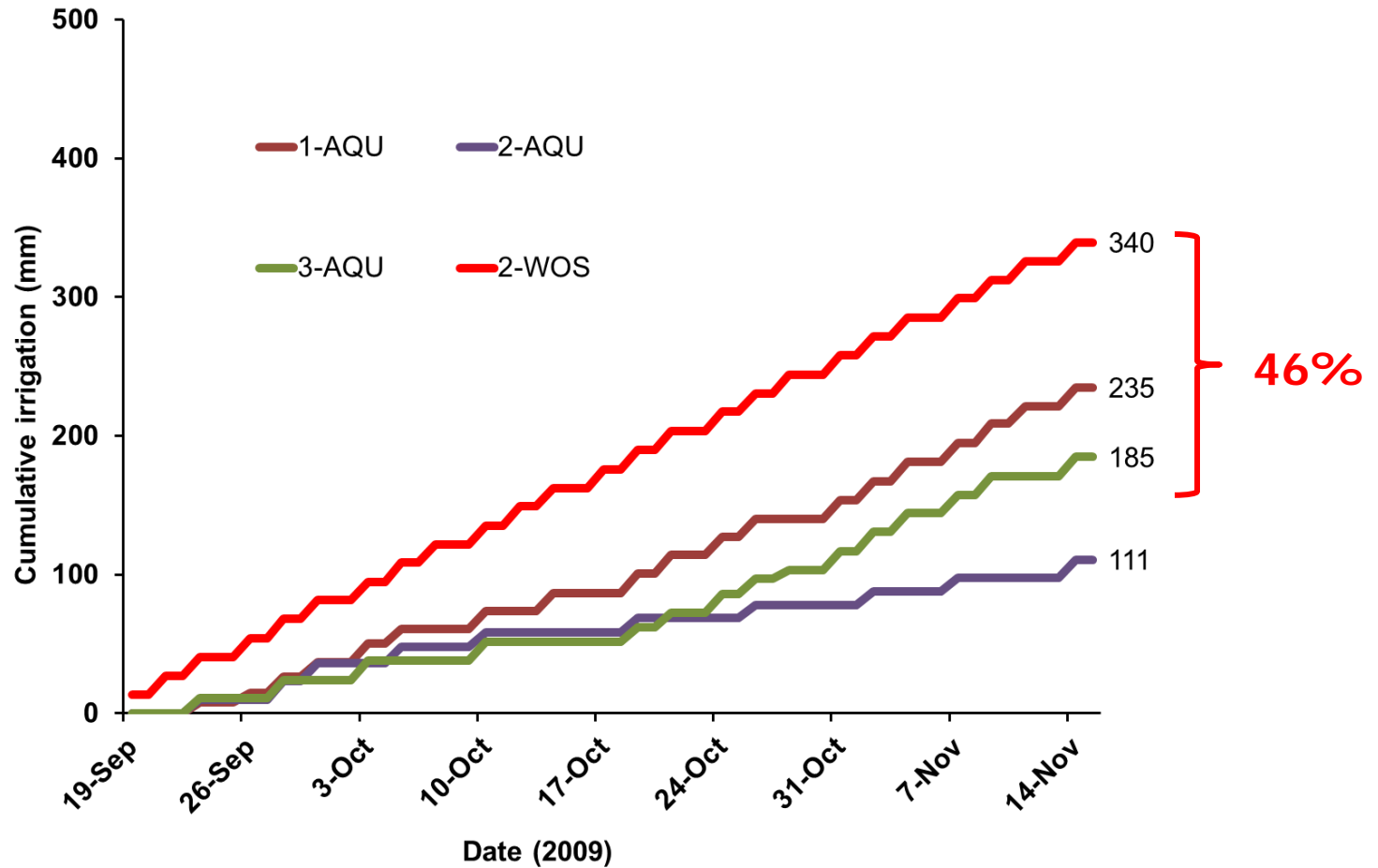




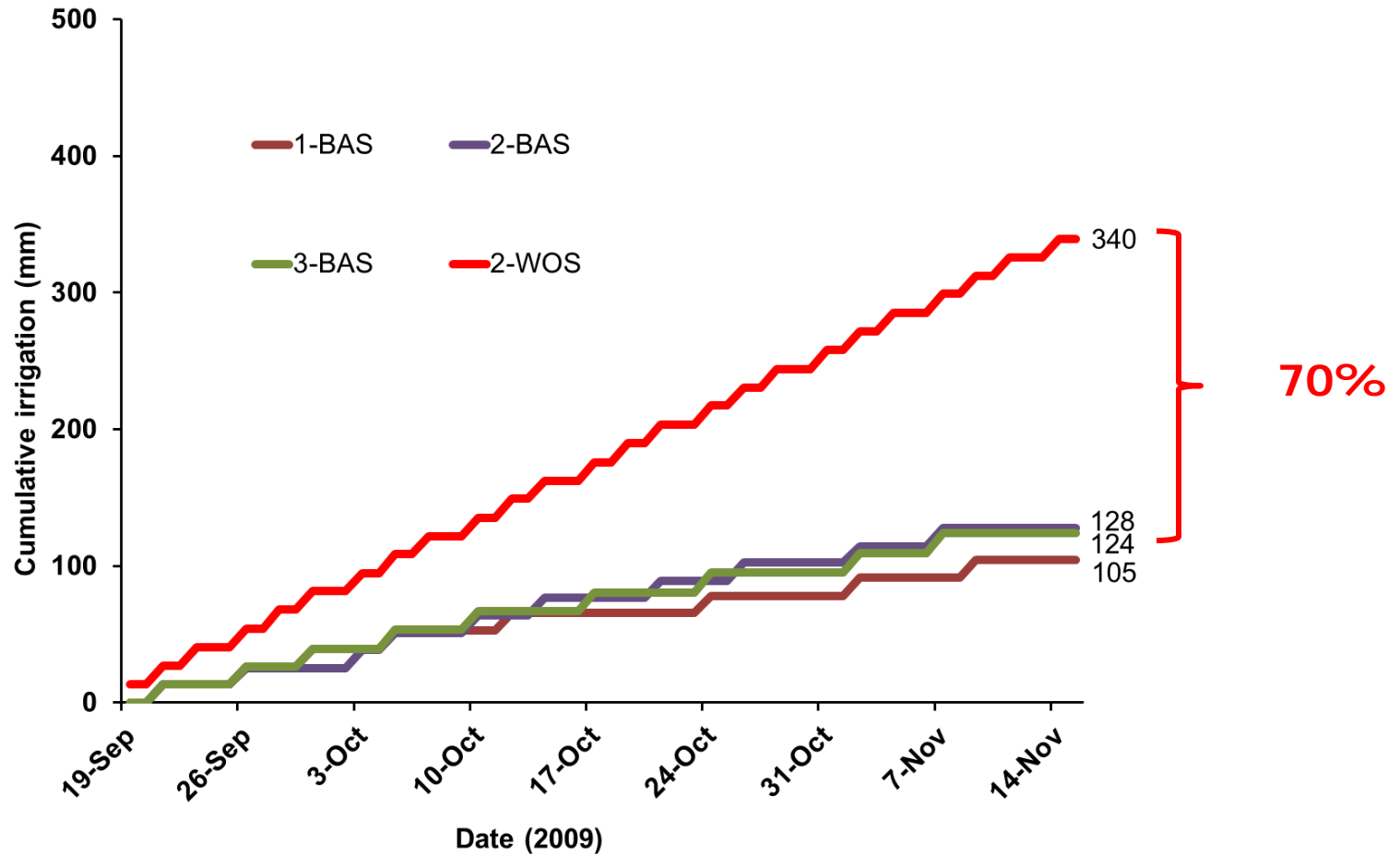
# AquaSpy



# AquaSpy

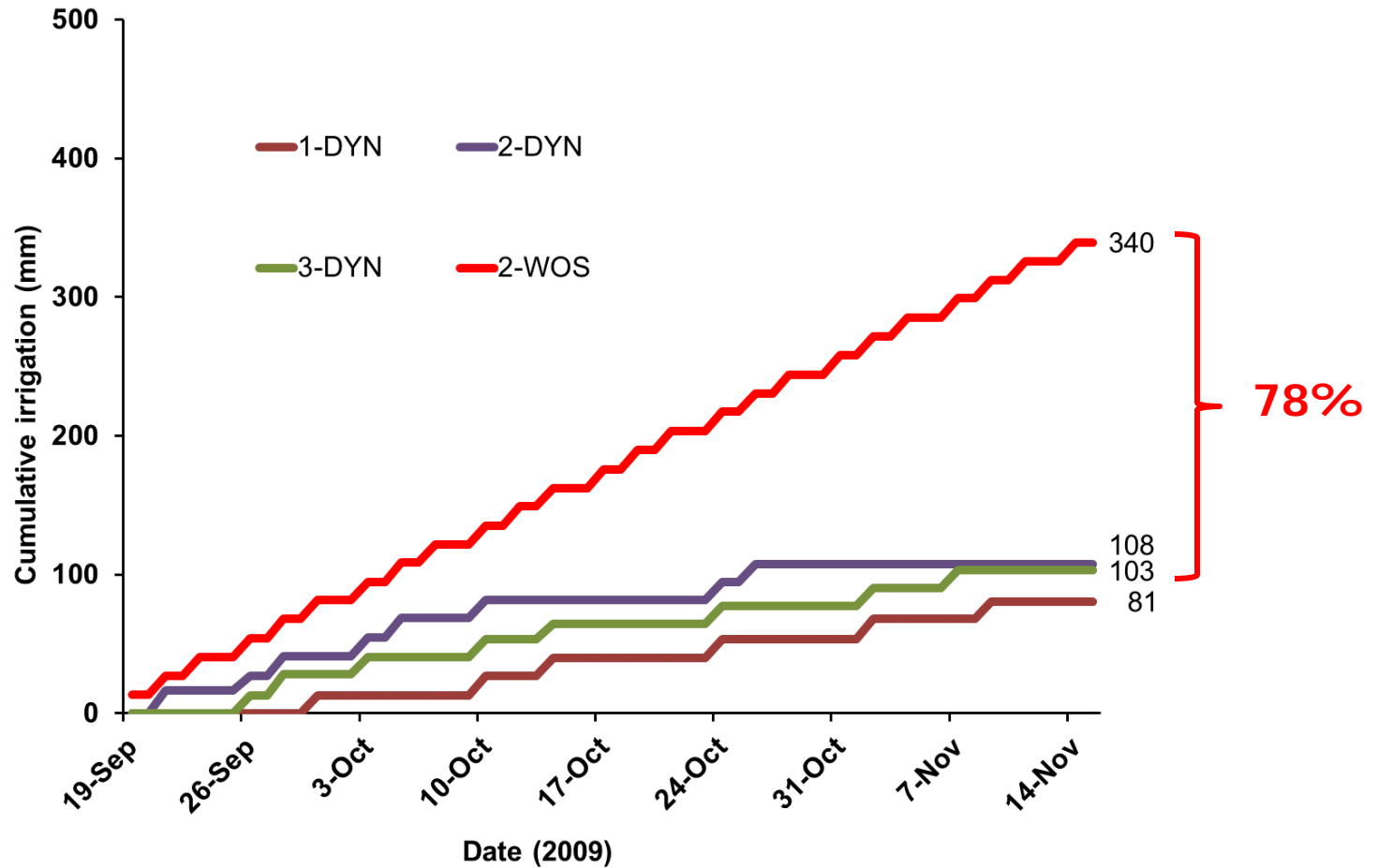


# Baseline

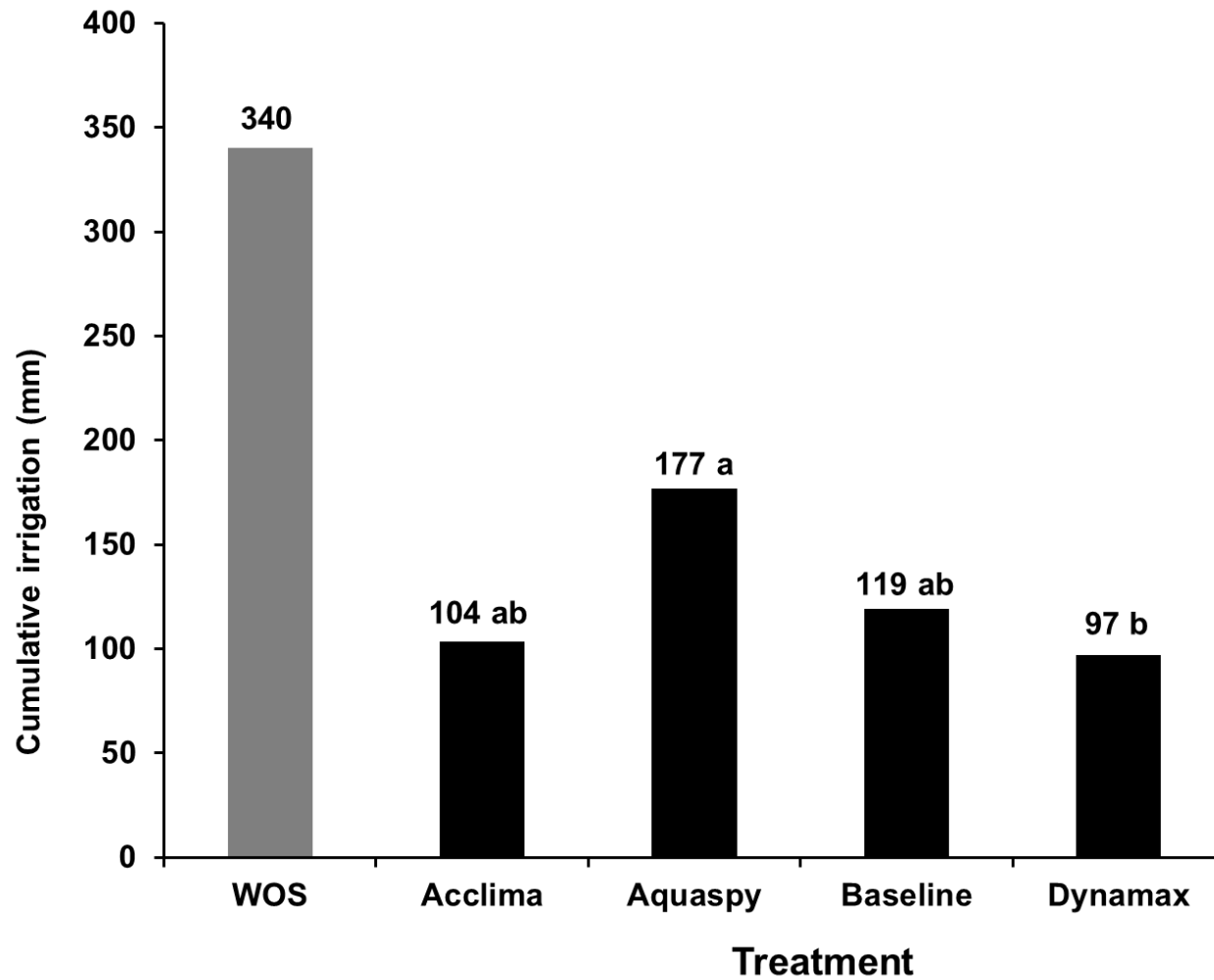




# Dynamax



## Average cumulative irrigation depth (2009)



Different letters on top of the columns indicate statistical difference at  $P < 0.05$  (Duncan's multiple range test).

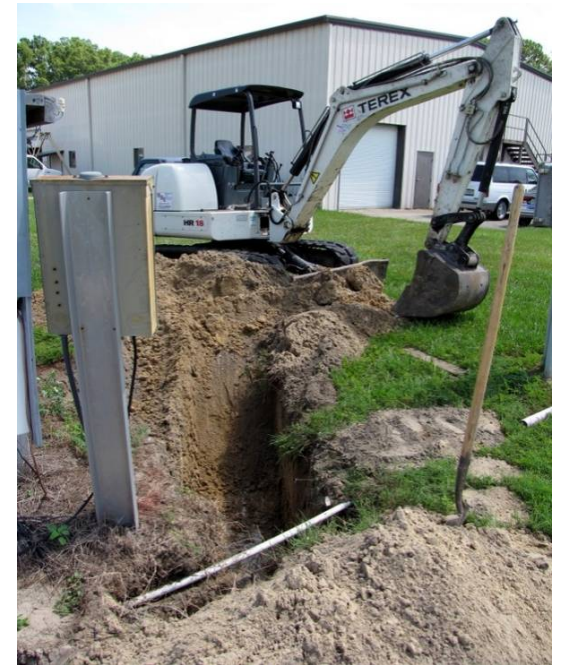
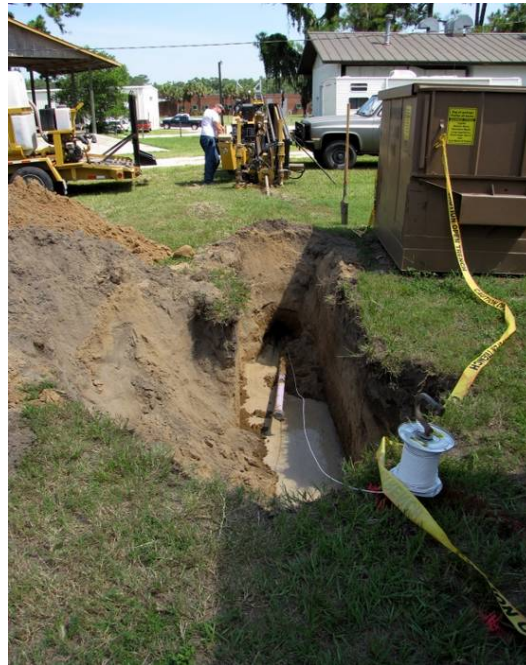
# Turfgrass quality

- Relatively dry weather:
  - No significant differences between treatments
  - $TQ \geq 6$





# RW Connection (2010)

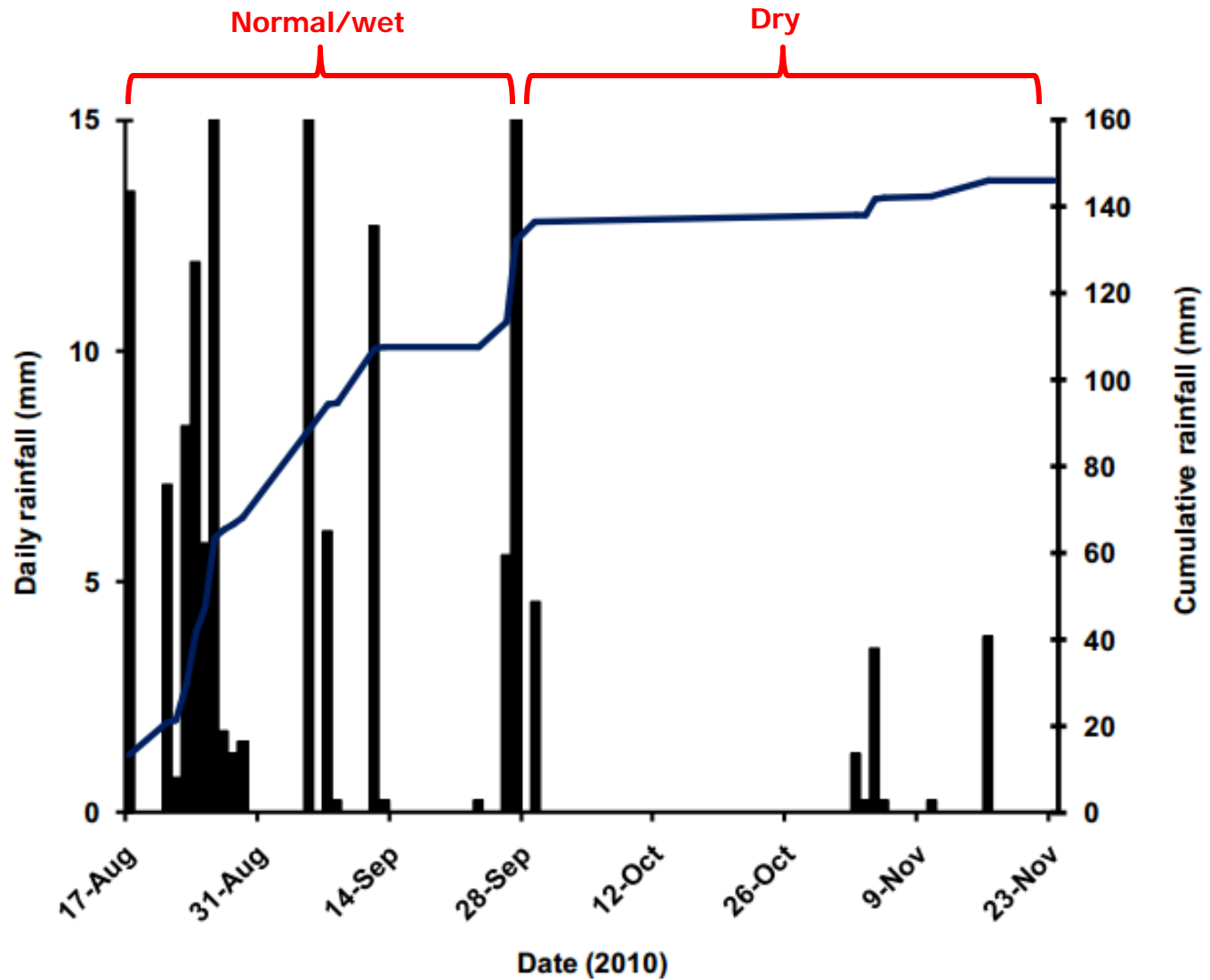




# Results

## 2010

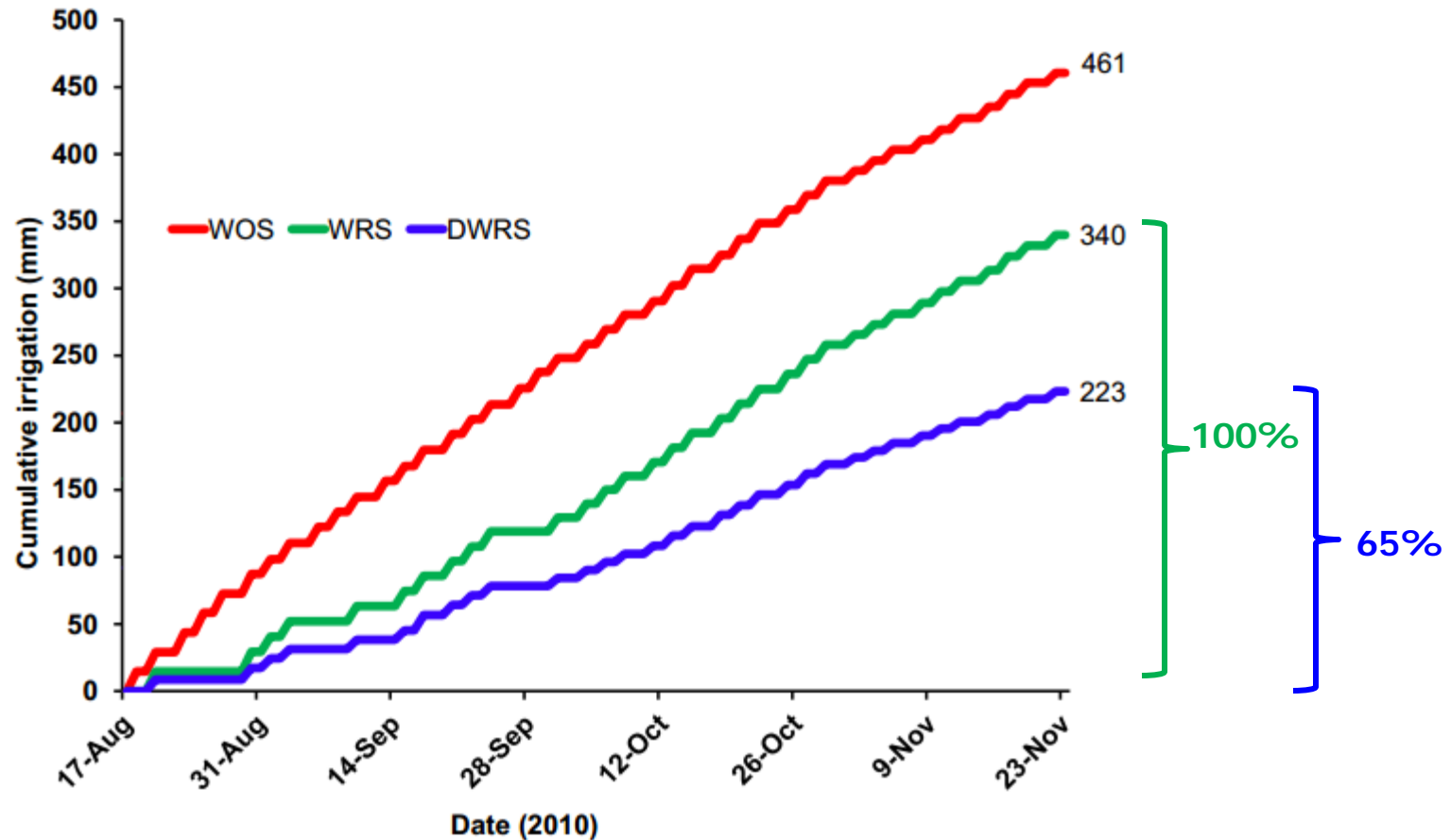
# Rainfall



Daily and cumulative rainfall, during 17 August through 23 November 2010.

# Cumulative irrigation in 2010

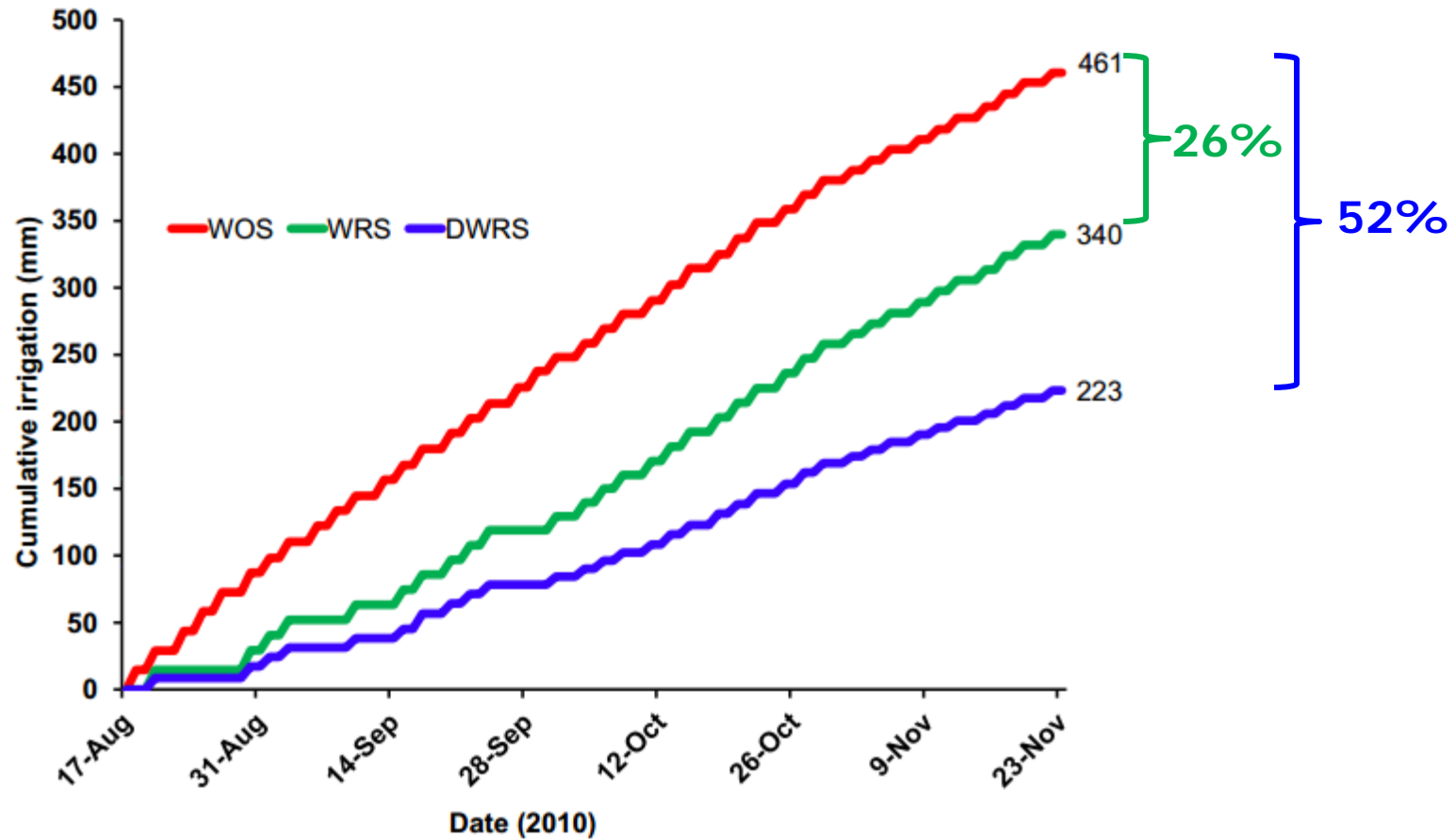
# Time-based



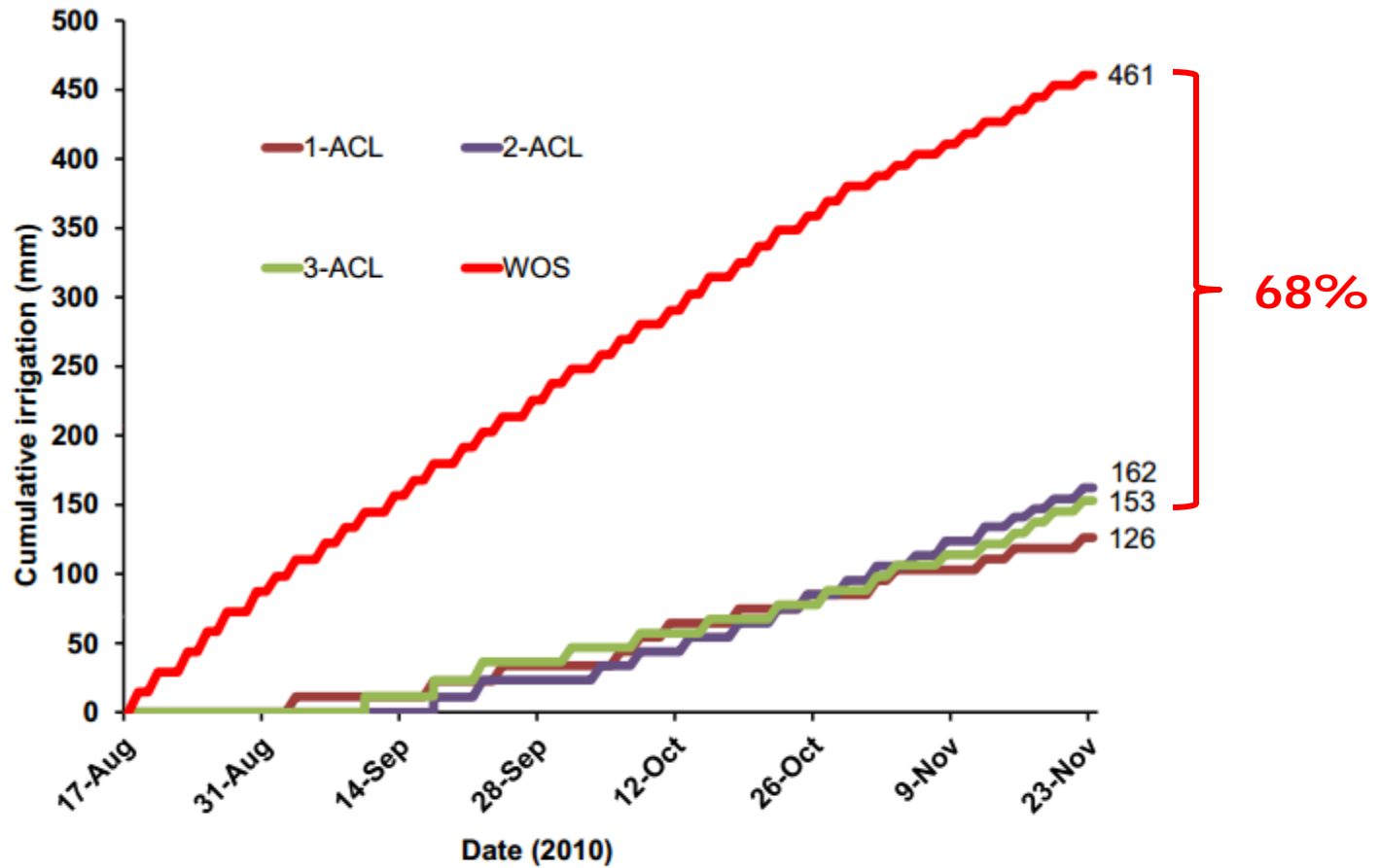
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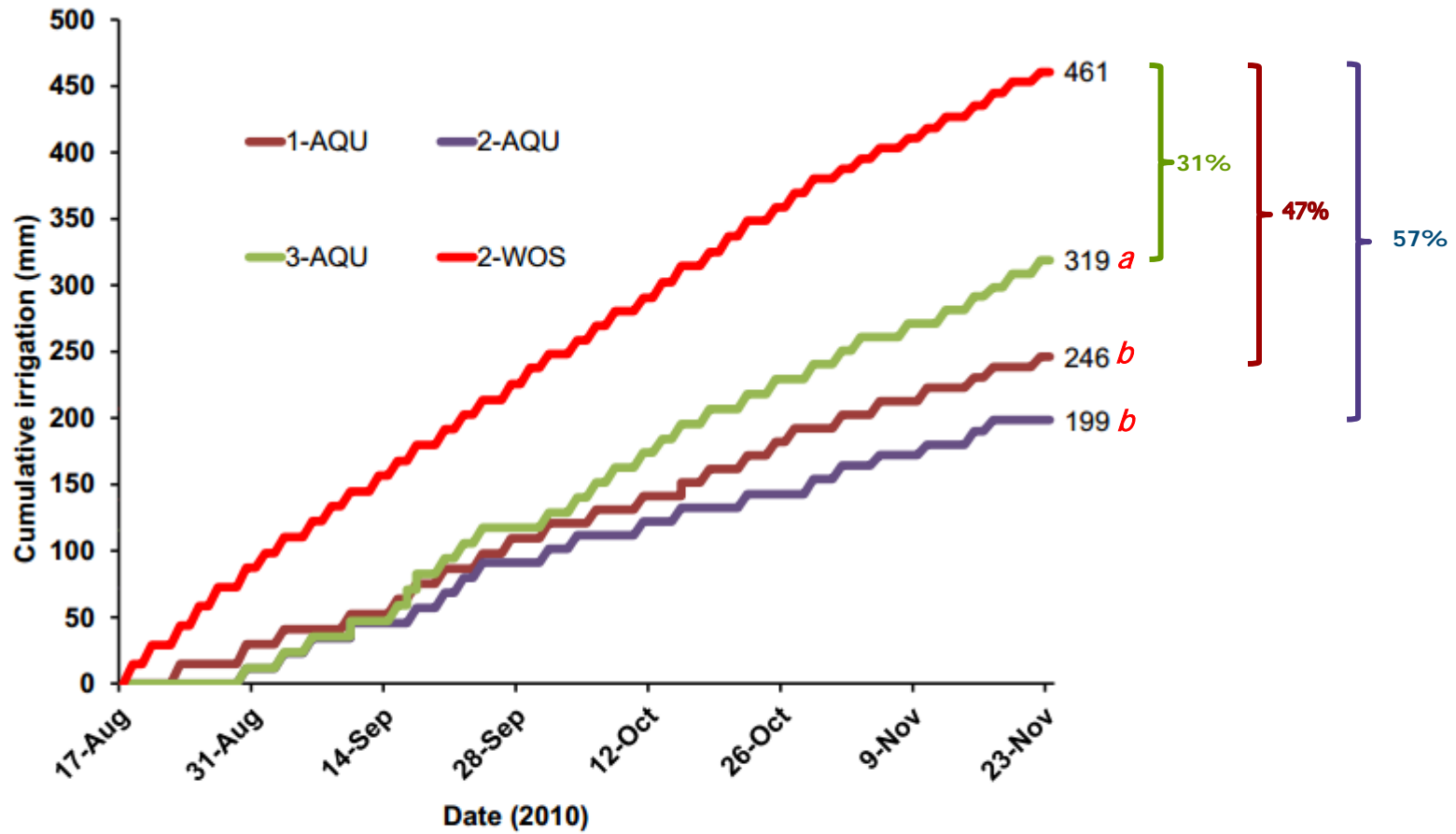
# Time-based



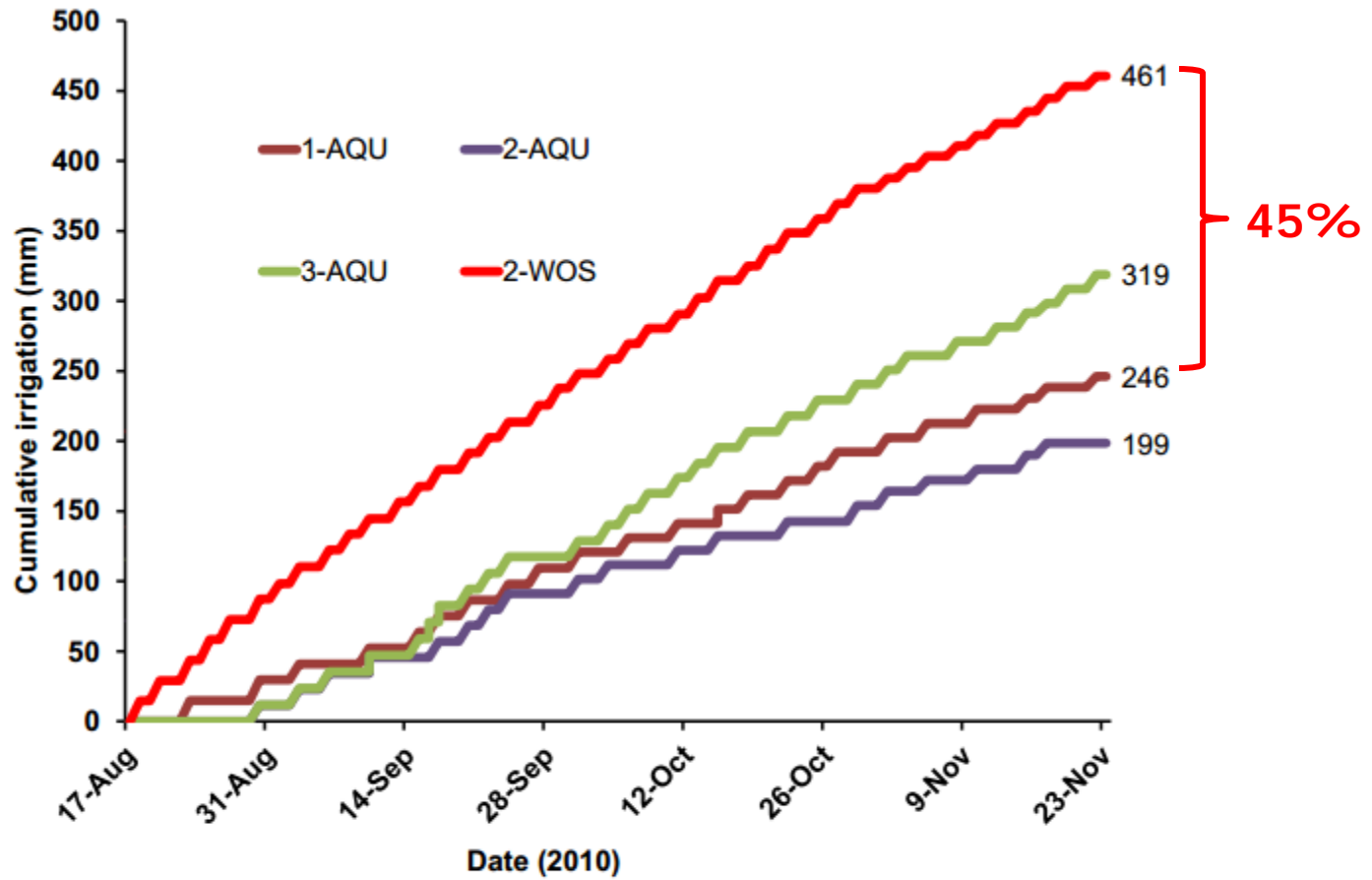
# Acclima



# AquaSpy

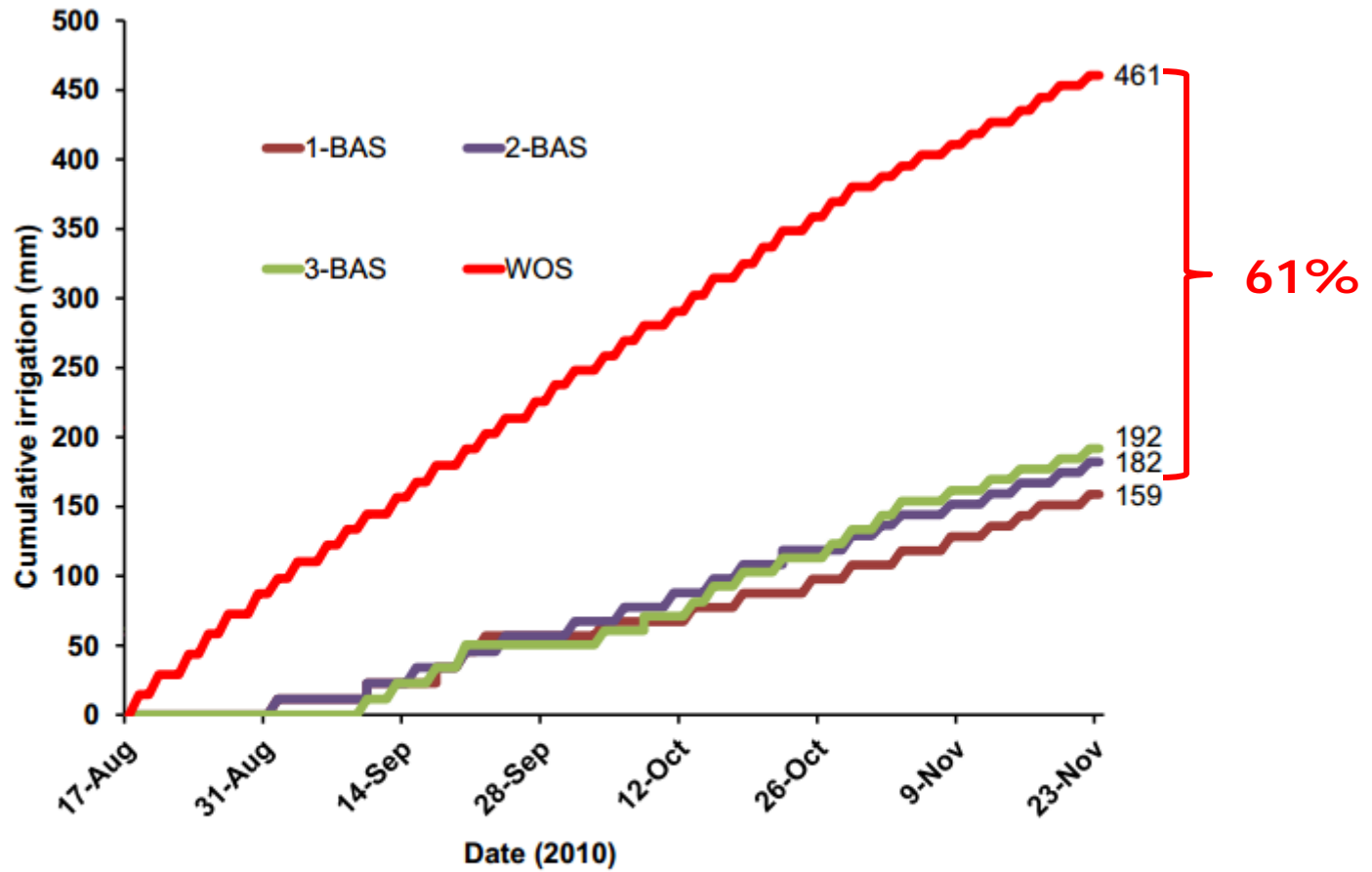


# AquaSpy

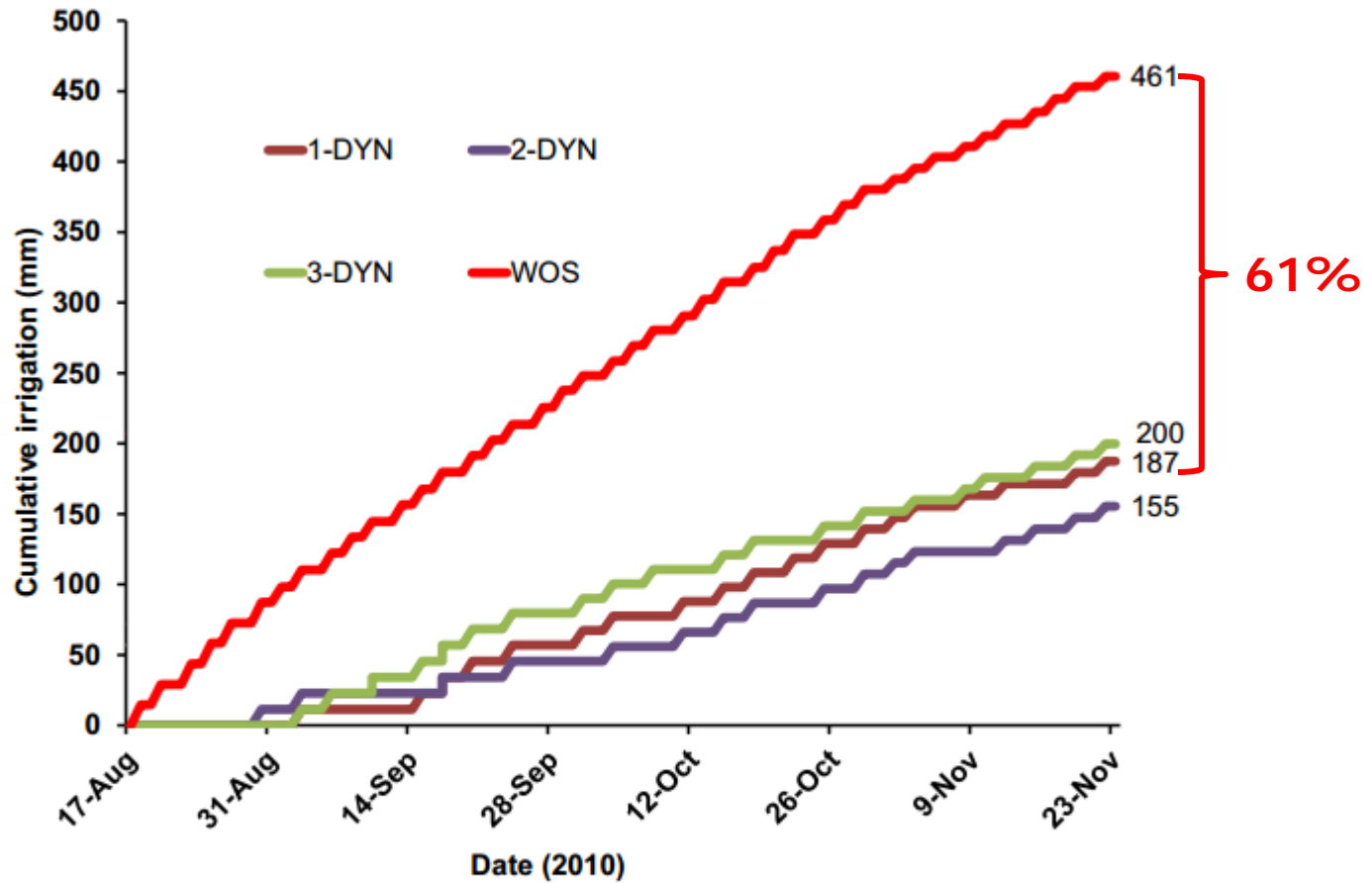




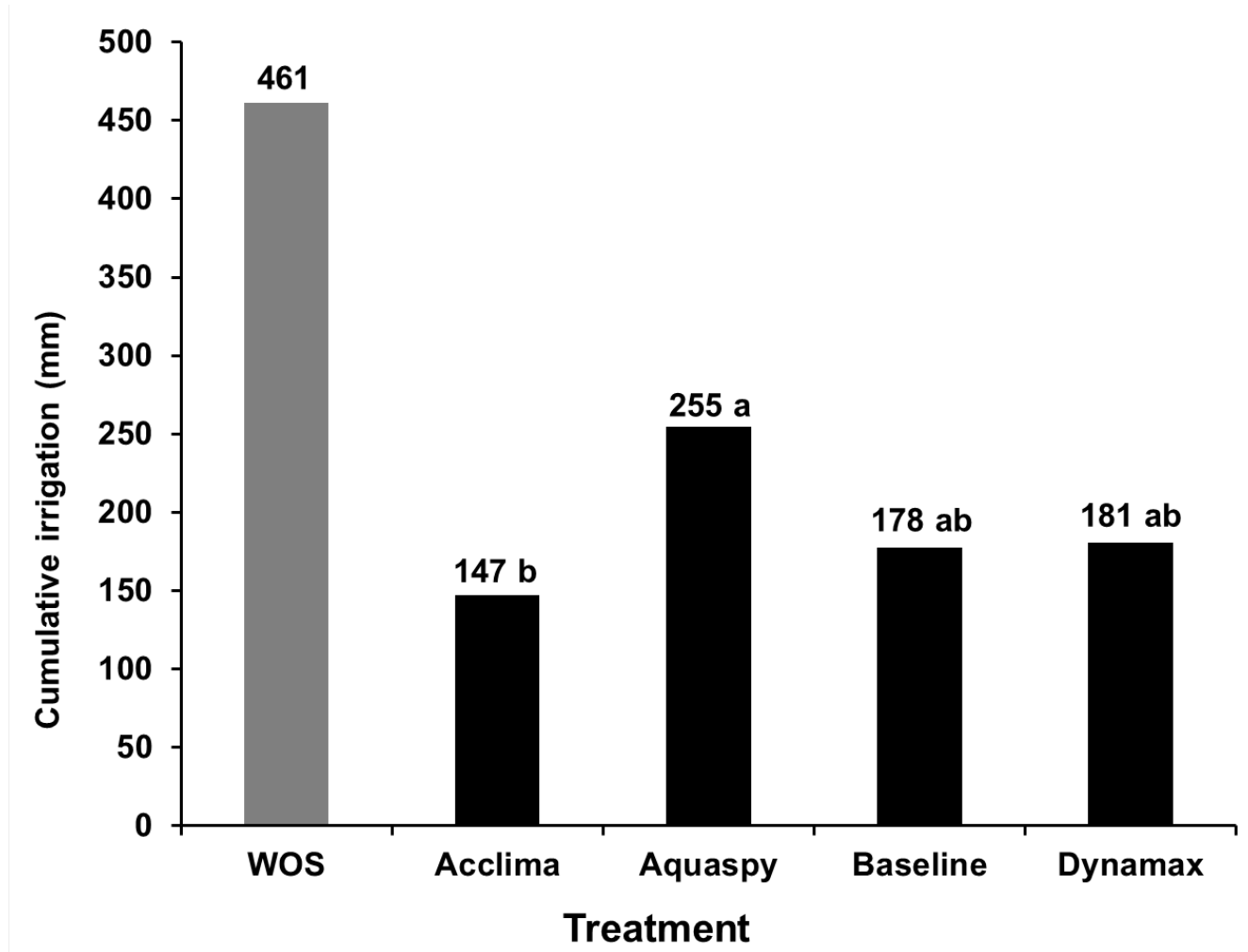
# Baseline



# Dynamax



## Average cumulative irrigation depth (2010)



Different letters on top of the columns indicate statistical difference at  $P < 0.05$  (Duncan's multiple range test).

# Turfgrass quality

- No significant differences between treatments
- $TQ \geq 6$





# Conclusions

- SMS bypassed cycles mostly during the rainy periods
- Behavior consistency between replicates:
  - BAS, DYN good consistency
  - ACL: one replicate was different in '09
  - AQU statistical difference between replicates ('09-'10)

# Conclusions

- Water savings:
  - **RS:** 21%
  - **SMSs:** 61%
  - RW < PW (long dry period)
  - RW results consistent with PW studies under plot conditions (44 – 72%)
- Turf quality above minimum acceptable ( $\geq 6$ )

# Conclusions

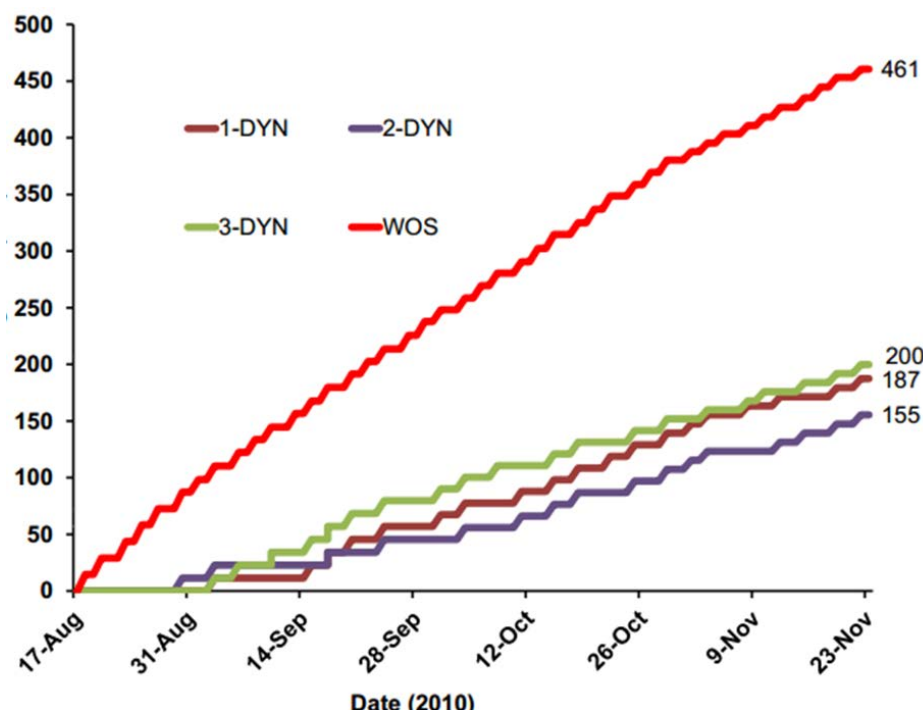
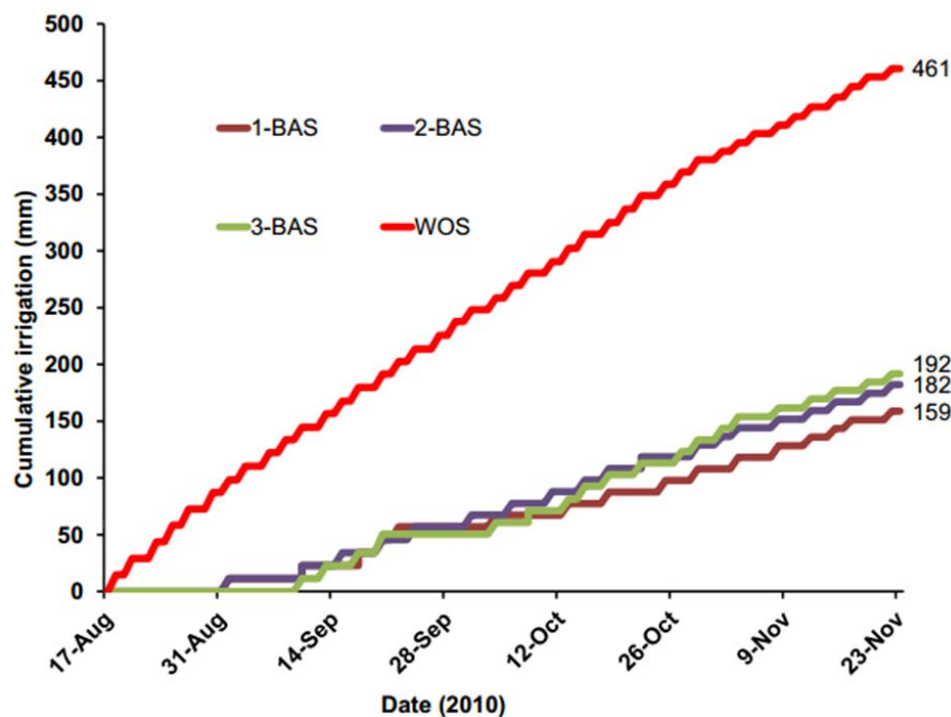
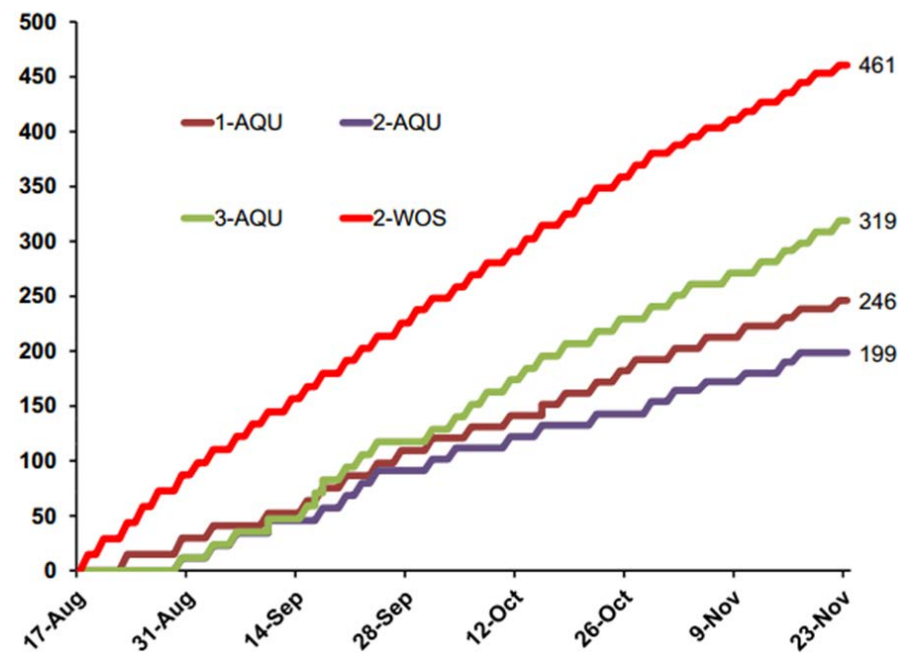
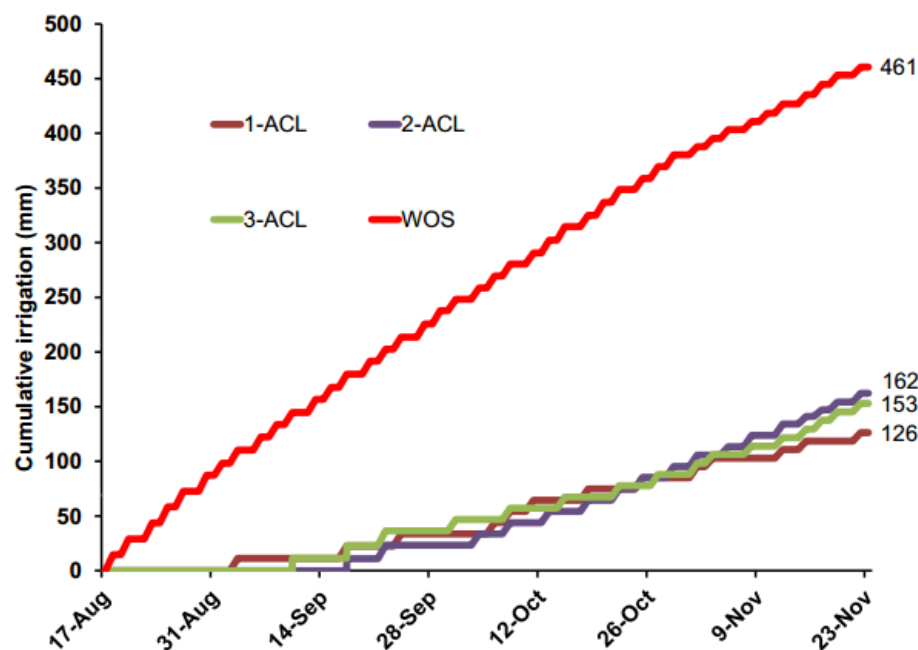
- **SMSs are useful for conserving water on turf irrigated with RW (medium-high salinity)**



**Questions?**









## Scheduled irrigation cycles bypassed by treatments (2009)

Treatment	Total Bypassed		Average Bypassed (%)
	(#)	(%)	
Time-based			
WOS	0	0	
WRS	4	16	
DWRS	4	16	
SMS-based			
1-ACL	19	76	
2-ACL	19	76	69
3-ACL	14	56	
1-AQU	6	24	
2-AQU	15	60	41
3-AQU	10	40	
1-BAS	17	68	
2-BAS	15	60	64
3-BAS	16	64	
1-DYN	19	76	
2-DYN	17	68	71
3-DYN	17	68	
Average of SMS <sup>2</sup> -based		61	

## Scheduled irrigation cycles bypassed (2010)

Treatment	Total Bypassed		Average Bypassed (%)
	(#)	(%)	
Time-based			
WOS	0	0	
WRS	9	21	
DWRS	9	21	
SMS-based			
1-ACL	29	69	
2-ACL	25	60	63
3-ACL	26	62	
1-AQU	19	45	
2-AQU	23	55	44
3-AQU	13	31	
1-BAS	27	64	
2-BAS	23	55	58
3-BAS	23	55	
1-DYN	23	55	
2-DYN	26	62	56
3-DYN	22	52	
Average of SMS <sup>z</sup> -based		55	