Irrigation Principles for Almonds & Walnuts

Kat Pope

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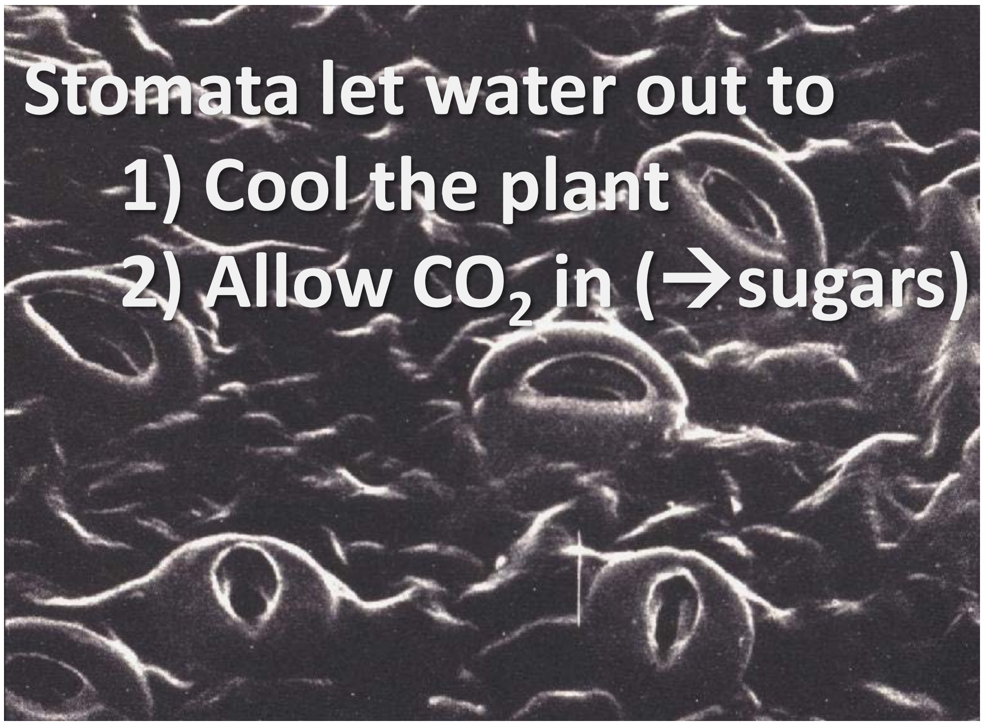
Sacramento, Solano & Yolo Counties

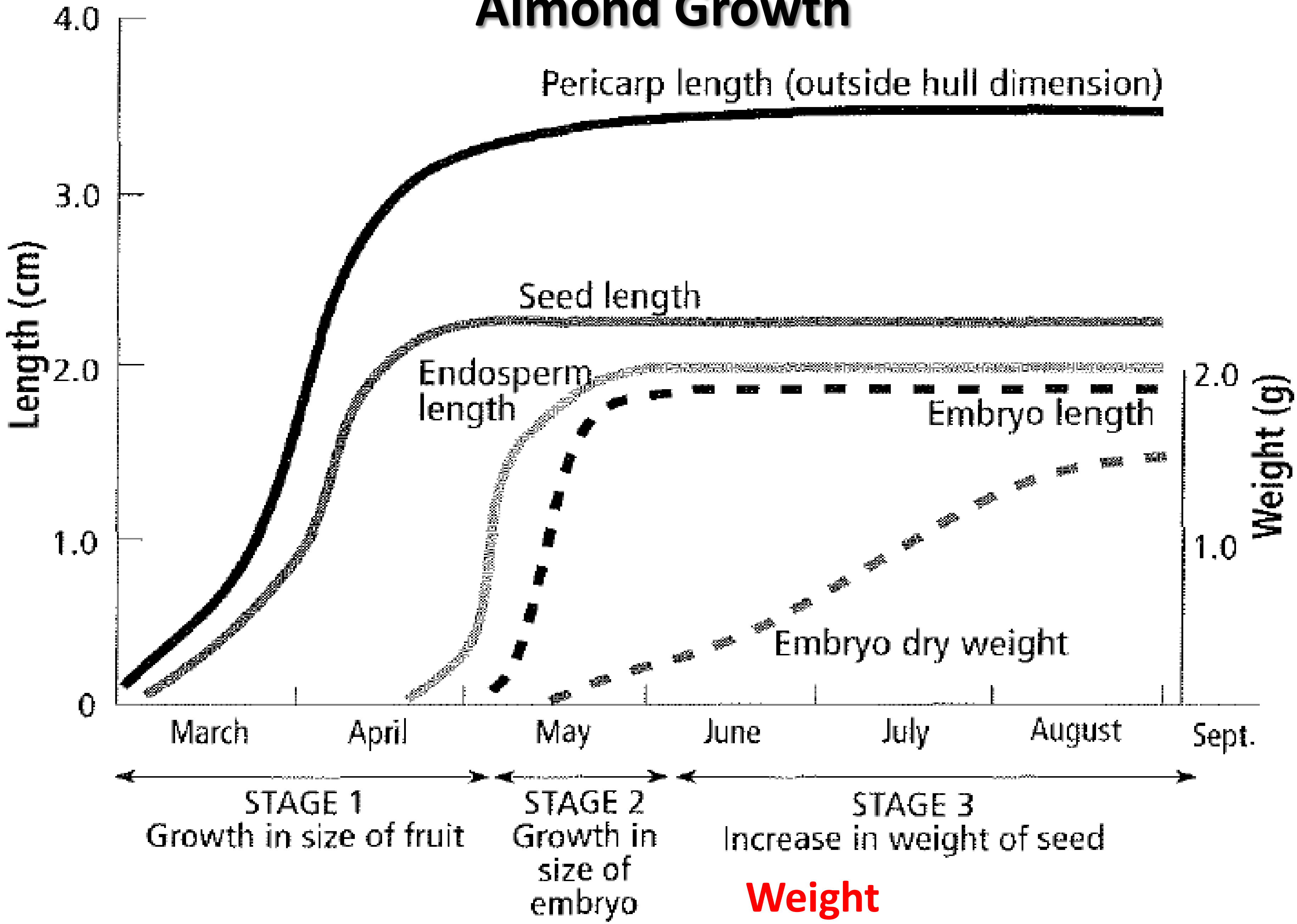
SID Workshop, 3/21/16

UC CE | University of California
Agriculture and Natural Resources | Cooperative Extension

Plants need water because…

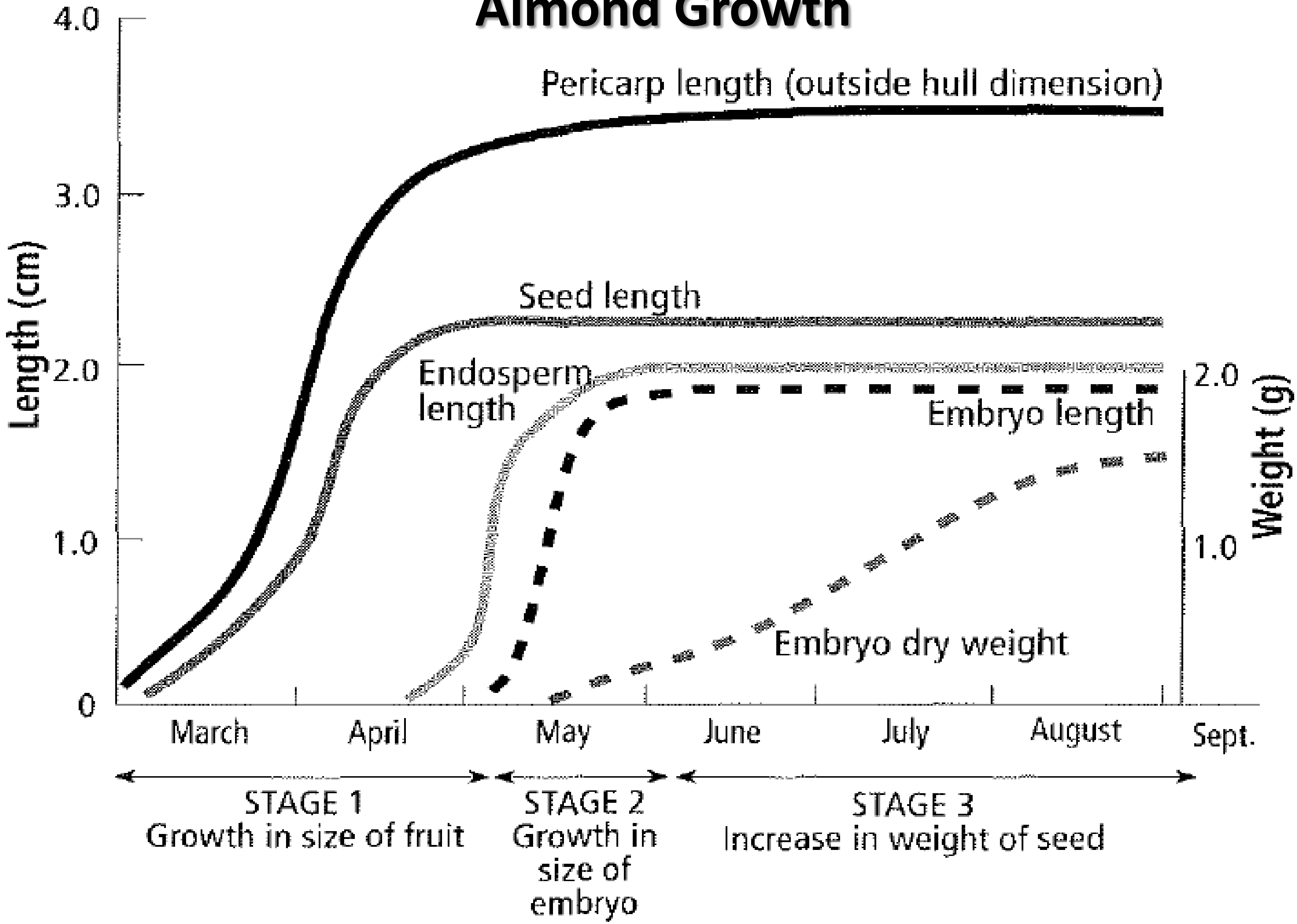


Almond Growth



Size **Shrivel** **Weight + Bud set**

Almond Growth



Stress at any period reduces vegetative growth, affects future yield!

Outcomes of Different Stress Timing

Full Irrigation	No water after June	50% Whole Season

Normal Size 15 nuts/18 grams Marketable	Normal Size, Shriveled: 15 nuts/13.5 grams Reduced Marketability	Small Size, Not Shriveled: 15 nuts/12.5 grams Marketable

Photos: D. Doll

Ways to avoid plant water stress

- Checkbook: ETc-based irrigation scheduling
- Ask the Soil if it's dry
- Ask the Tree if it's stressed

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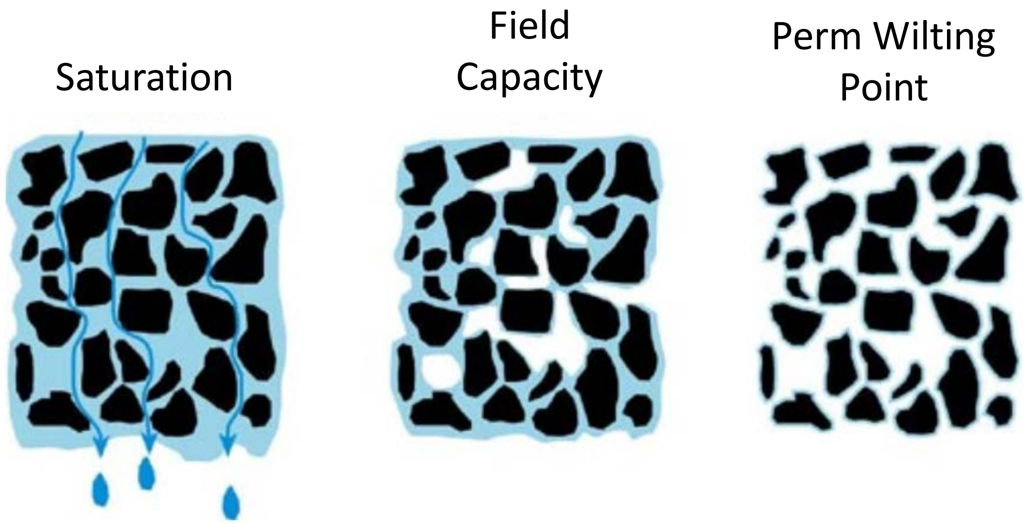
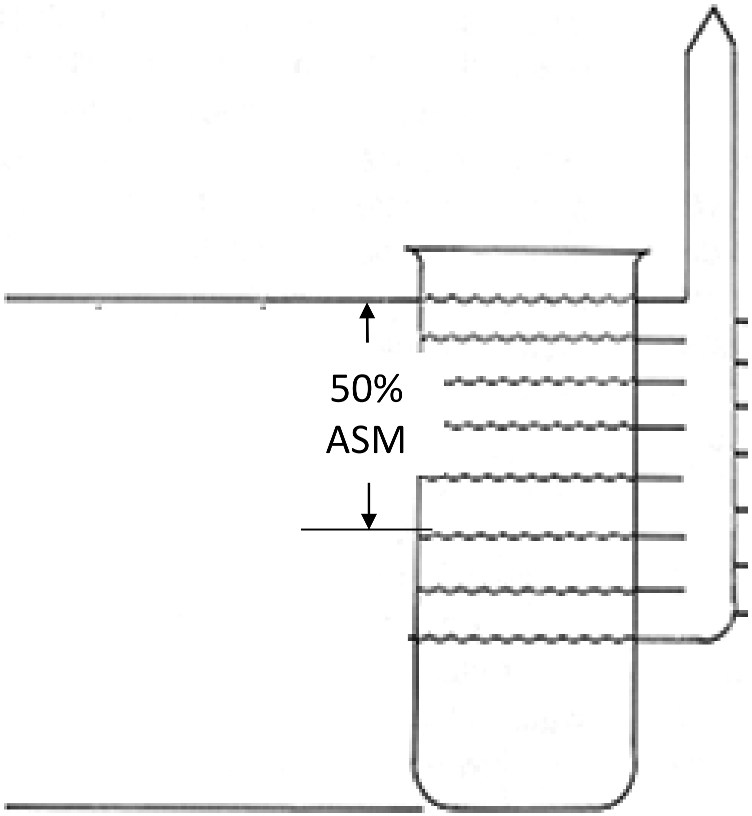
Irrigation Scheduling:
Watching what's used from account.
Refilling account before it's empty.

Going Out of the Account = Evapotranspiration

Account Supply = Storage, Precip & Irrigation

Supply: Available Soil Water Holding Capacity

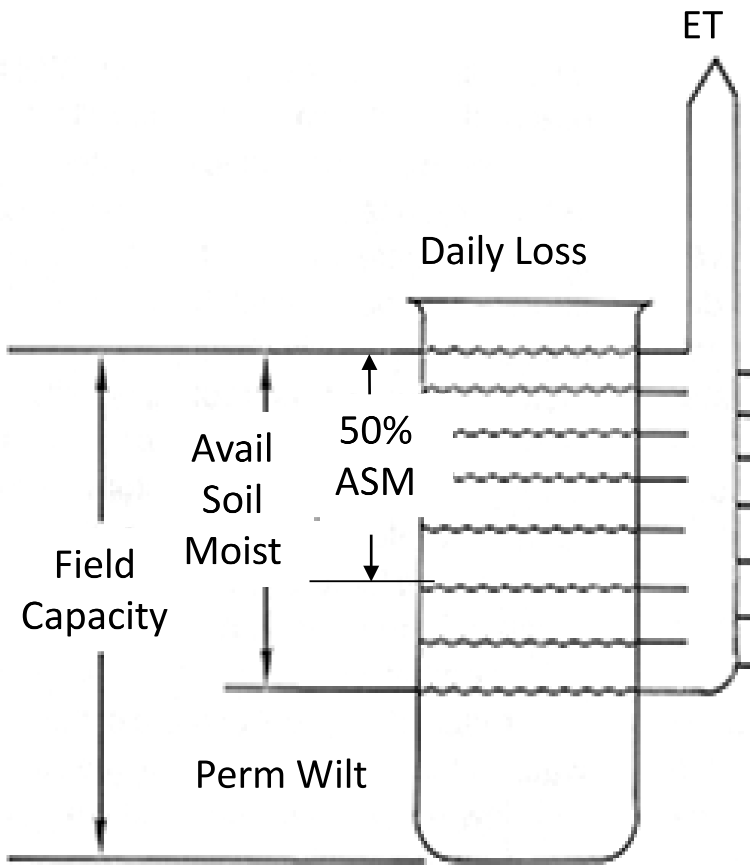




Figures: terragis.bees.unsw.edu.au

Supply: Available Soil Water Holding Capacity

Soil Text	Field Capac	Perm't Wilt Pt (15 b)	Avail Soil Moist	50% Avail
	in/ft	in/ft	in/ft	in/ft
Sand	1.2	0.5	0.7	0.35
Silt loam	3.6	1.8	1.8	0.9
Clay	4.8	2.6	2.2	1.1



Supply: Available Soil Water Holding Capacity

Photos: Blake Sanden

Ways to avoid plant water stress

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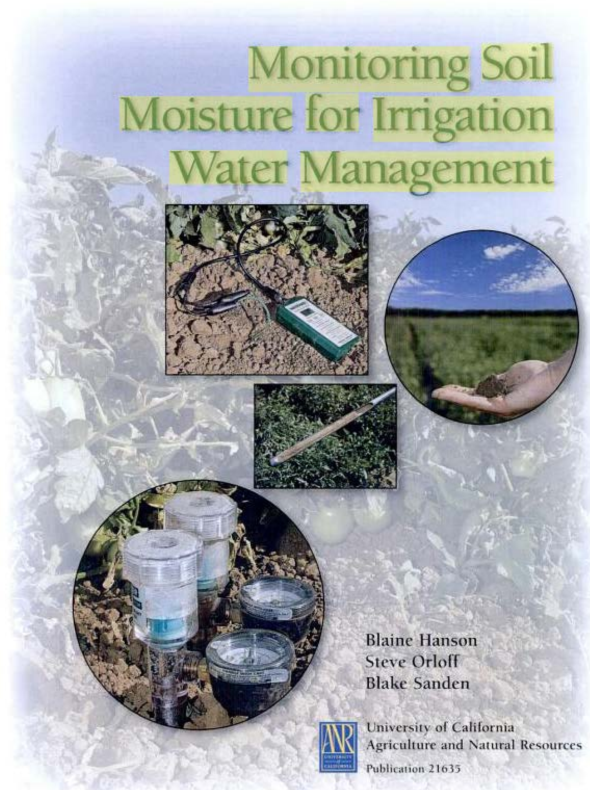
Soil Moisture Monitoring Tools


Feel Method

Electrical Resistance



Capacitance/ TDR


Neutron probe

Tensiometer

ANR Pub 21635

Soil Moisture Monitoring





	"Feel"	Tensiometers	Dielectric Sensors	Electrical Resistance	Neutron Probes
Basic Operation	Soil between fingers	Measures the suction	Measures dielectric constant	Measures resistance	Measures neutrons slowed by water
Requirement for Calibration	Experience	Minimal	Yes, soil dependent	Moderate	Yes, soil dependent
Monitoring Frequency	Manual, Once	Manual or Automatic	Automatic	Automatic	Manual, once
Zone of Measurement	Size of Auger bucket	2" off of sensor	About 1" from outside edge	1" off of sensor, less in heavy, wet soils	10" diameter
Replacement, Maintenance	None	Annual (check of vacuum and gauges), some require removal	Annual Maintenance	Annual, replacement every 3-7 years	Replace batteries, transport rules, annual radiation safety check
Affected by Salinity, Alkalinity	None	No	Yes , but depends on sensor type	Yes	No
Soil Type Most Suitable	All	All	Sand – Sandy Clay Loam (Non-cracking Soils)	Sandy Loam – Clay	All
Common Companies		Hortau, Irrometers	Decagon, Aquacheck, EnviroSCAN	Watermarks	Contracted Services

More information: http://ucmanagedrought.ucdavis.edu/

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Table: D. Doll

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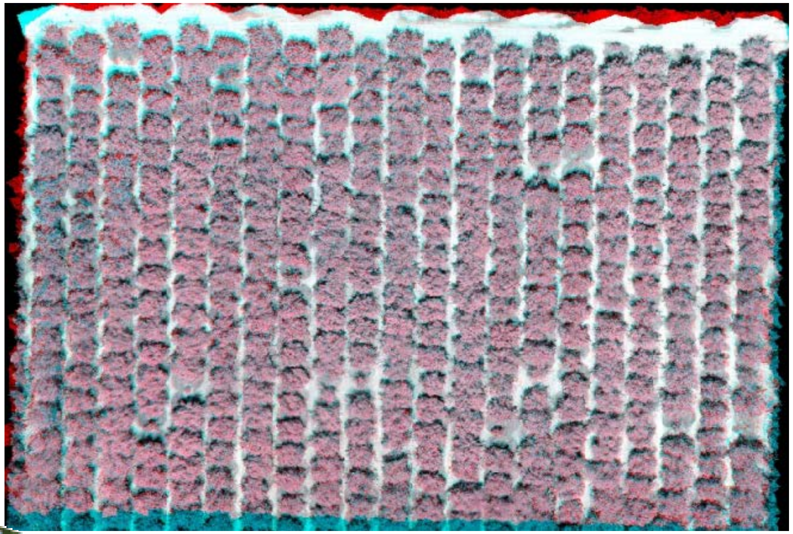
Plant Based Monitoring Tools

Pressure Chamber



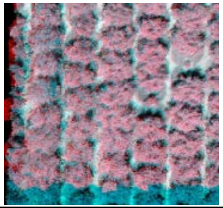
Aerial Imaging

Dendrometers

Sap Flow Sensors

Source: http://www.dynamax.com

Plant Based Monitoring



	"Look and Feel"	Sap Flow Sensors	Dendrometers	Pressure Chamber	Aerial Imaging
Basic Operation	Look at newer growth	Measures Sap "flow"	Measures Expansion, Contraction	Measures Stem Water Potential	Measures canopy temperature
Requirement for Calibration	Yes	Yes	Yes	No	Yes
Monitoring Frequency	Except when blinking	Continuous	Continuous	Manual	Manual
Zone of Measurement	Few trees	Single Tree	Single Tree	Single to few trees	Entire Orchard
Replacement, Maintenance	None	Yes, 2-3 years	Yes	Minimal	None
Major Challenges	Too Late	Not refined for Almonds	Lack of Calibration	Time involved	Not refined for Almonds

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Photo: dynamax.com
Table: D. Doll

Ways to avoid plant water stress

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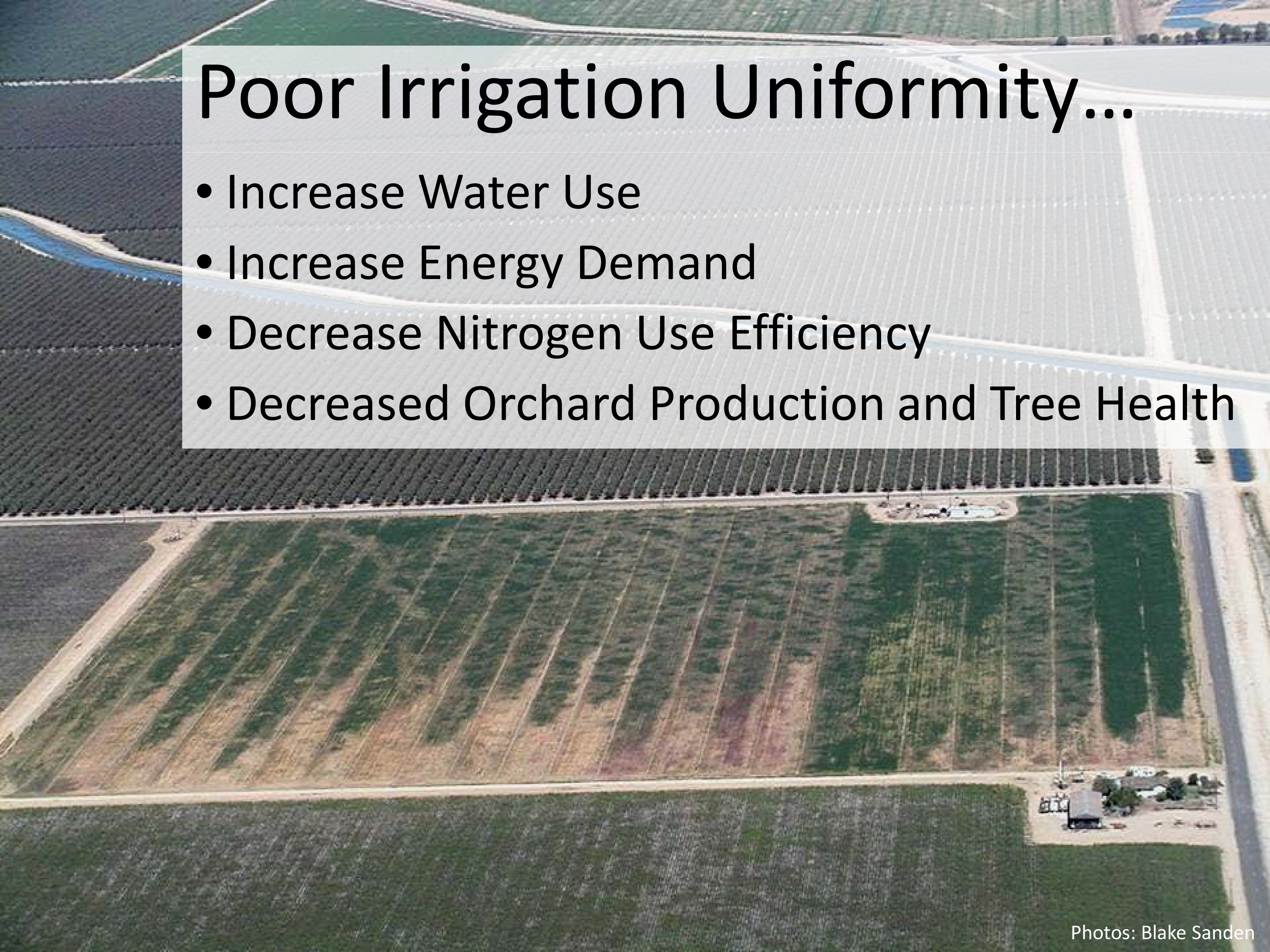
- Can have too much of a good thing. Over-irrigation can…
  - Decrease growth, and possibly yield
  - Endanger root health

System Maintenance

- You’re wasting your time with this stuff if your system is not applying water evenly over your field.

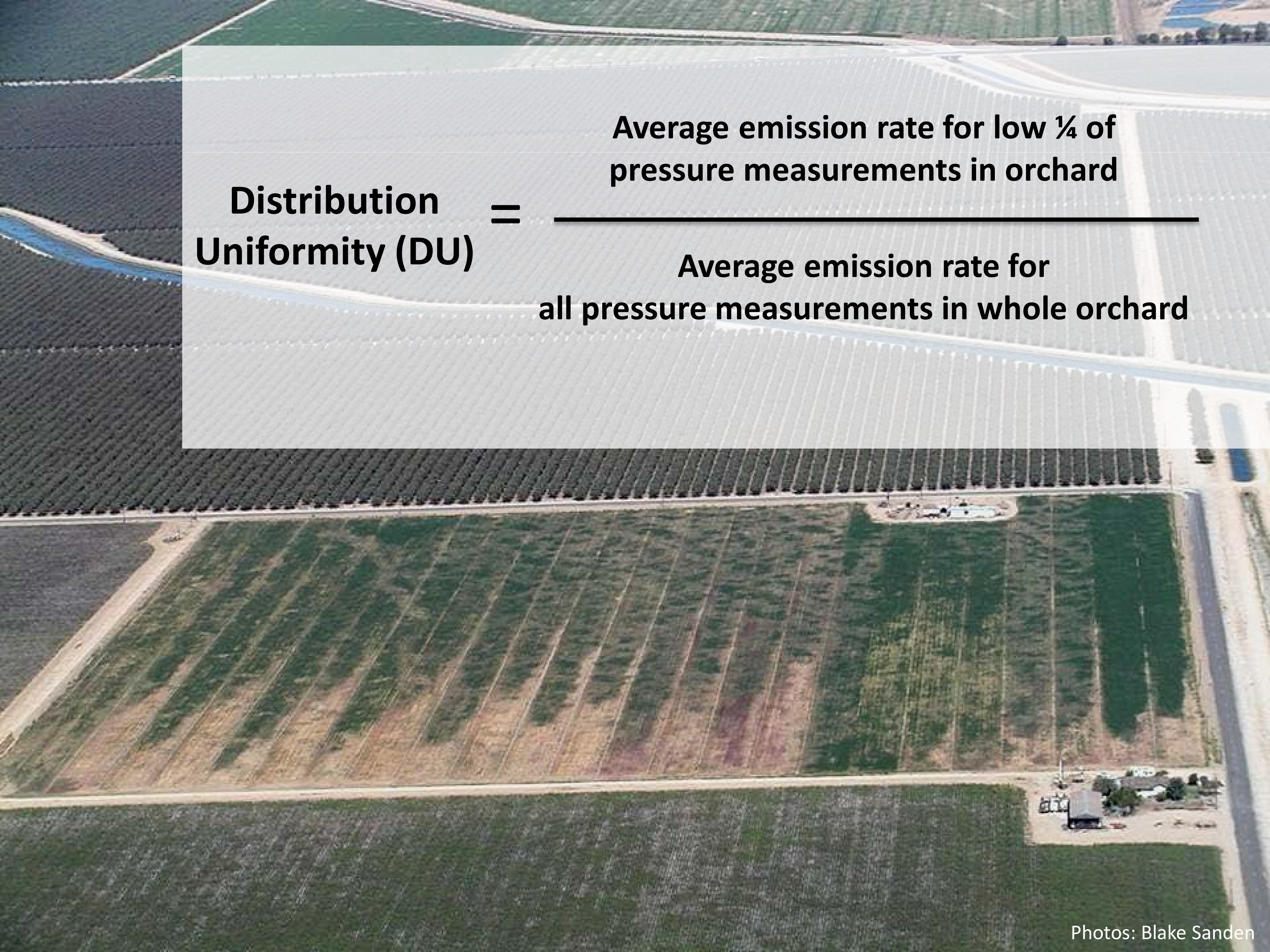
Poor Irrigation Uniformity…

- Increase Water Use
- Increase Energy Demand
- Decrease Nitrogen Use Efficiency
- Decreased Orchard Production and Tree Health



Photos: Blake Sanden

$$\text{Distribution Uniformity (DU)} = \frac{\text{Average emission rate for low ¼ of pressure measurements in orchard}}{\text{Average emission rate for all pressure measurements in whole orchard}}$$



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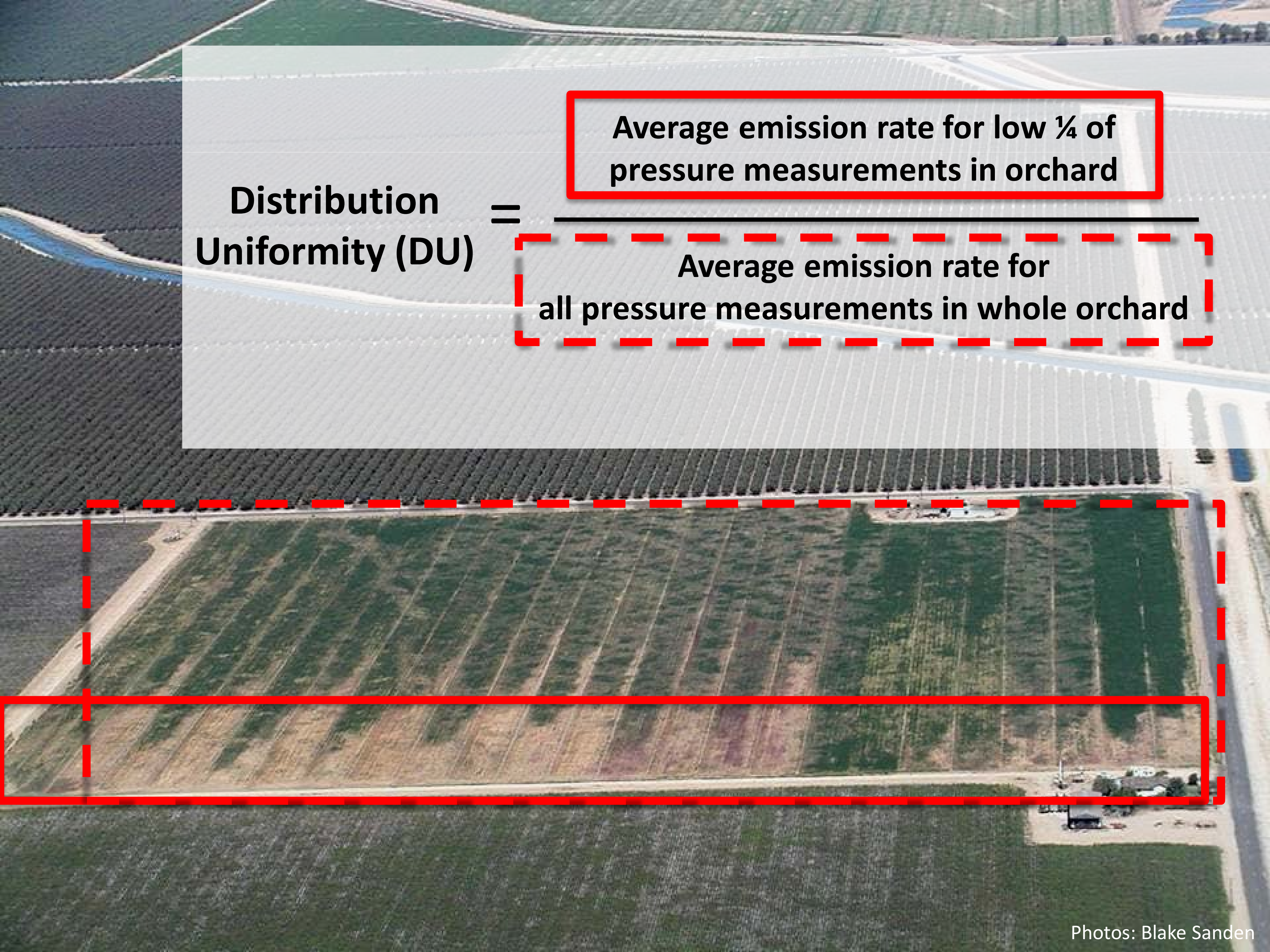

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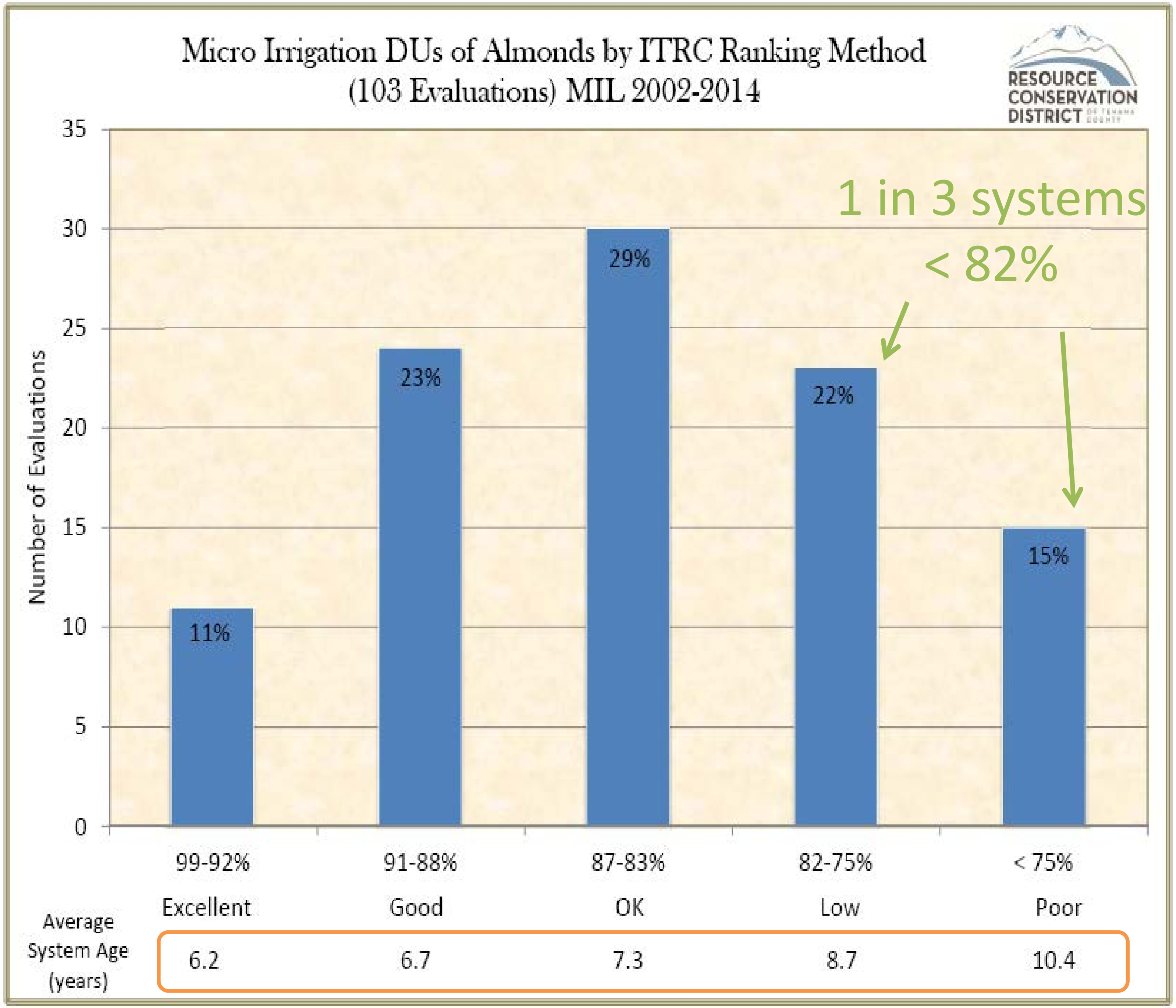
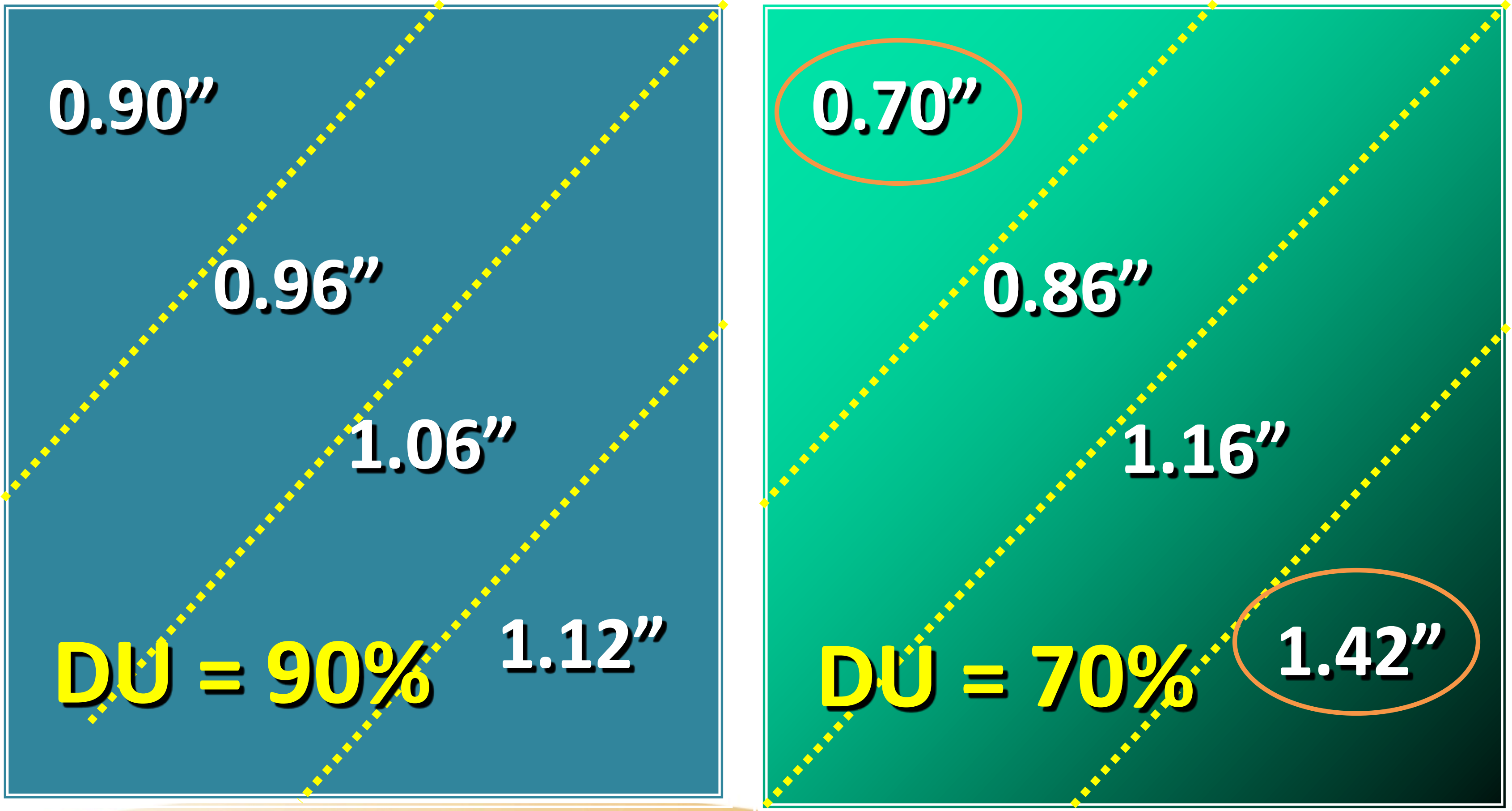

Micro Irrigation DUs of Almonds by ITRC Ranking Method
(103 Evaluations) MIL 2002-2014
RESOURCE CONSERVATION DISTRICT
Number of Evaluations
35
30
25
20
15
10
5
0
11%
23%
29%
22%
15%
1 in 3 systems
< 82%
99-92%
91-88%
87-83%
82-75%
< 75%
Excellent
Good
OK
Low
Poor
Average System Age (years)
6.2
6.7
7.3
8.7
10.4

Why Care about DU?

Example: Target application 1.0 inch water ***average***



Figures: Allan Fulton

Why Care about DU?

Example: Target application 1.0 inch water ***average***

	Water Applied in One Irrigation		Difference from Goal Over 30 Irrigations	
DU	High ¼ of orchard	Low ¼ of orchard	High ¼ of orchard	Low ¼ of orchard
	------------------ Inches applied -------------------			
90	1.12”	0.90”	3.6”	-3”
80	1.27”	0.80”	8.1”	-6”
70	1.42”	0.70”	12.6”	-9”

Figures: Allan Fulton

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Figures: Allan Fulton

Why Care about DU?

Example: Target 1.0 inch of water in low ¼ of orchard using a micro sprinkler system with 0.05 inch/hr application rate

DU	Hours to apply 1" low ¼ of orchard	Total hours 30 irrigation cycles	Hours irrigation (pump) time increased between DU's	Relative Increase %
100	20	600	Reference Point	----
90	22	660	60	10
80	24	720	120	20
70	26	780	180	30

Figures: Allan Fulton

How to Measure DU

Figures: Kevin Greer

Measuring system pressures – simpler than measuring flows

+

Plate Series	Plate Options	Recommended Nozzles	PSI 25	30	35	40	45	50
P2	P2 9° Red Radius 18-20′ (5.5-6.1 m) Stream Ht.14-23″ (36-58 cm)	Lt. Blue #40	—	—	.28	.30	.32	.34
		Lt. Purple #45	.29	.32	.35	.37	.39	.42
		Dk. Green #50	.36	.39	.43	.46	.48	.51
		.35 10FC	Within the recommended pressure range of 25-50 PSI (1 within a flow range of no more than 0% greater and 1					
P4	P4 9° White Radius 18-22′ (5.5-6.7 m) Stream Ht. 14-24″ (36-61 cm)	Dk. Green #50	—	—	.43	.46	.48	.51
		Lt. Yellow #55	.44	.48	.52	.55	.59	.62
		Lt. Red #60	.51	.56	.61	.65	.69	.73
	P4 15° Orange Radius: 23-25′ (7.0-7.6 m) Stream Ht. 40-50″ (102-127 cm)	.50 10FC	Within the recommended pressure range of pressure ra flow regulating within a flow range of no more than 0%					

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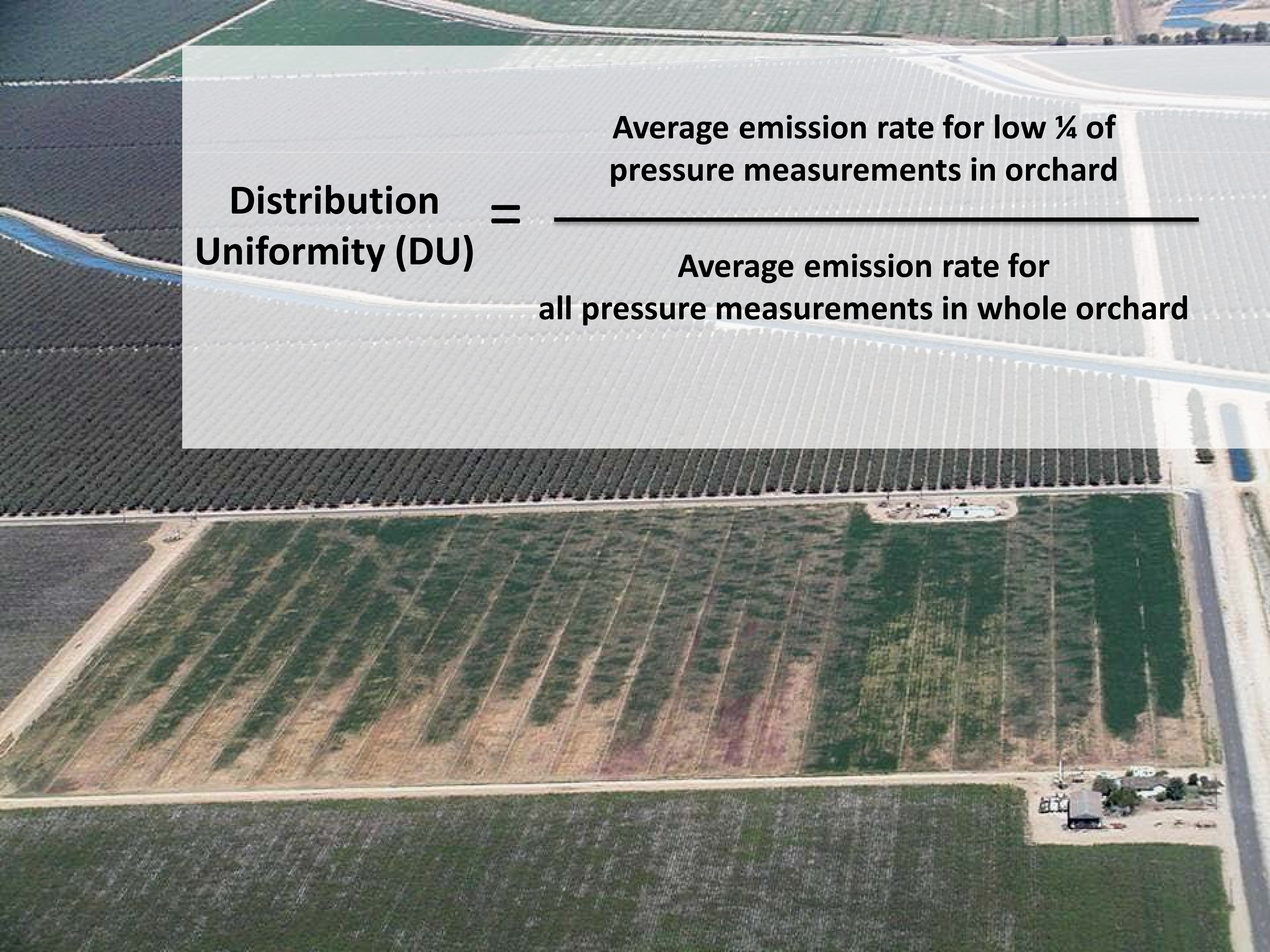
Photos: Kevin Greer
Table: Nelson Irrigation

Or Actually Measure Flows

Photos: Larry Schwankl, Kevin Greer



$$\text{Distribution Uniformity (DU)} = \frac{\text{Average emission rate for low ¼ of pressure measurements in orchard}}{\text{Average emission rate for all pressure measurements in whole orchard}}$$

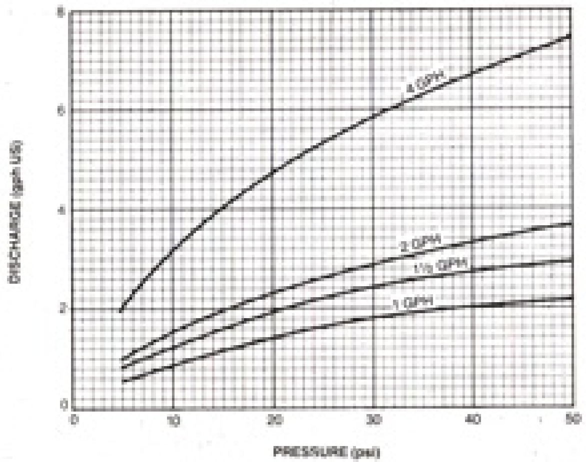
Factors Affecting DU?

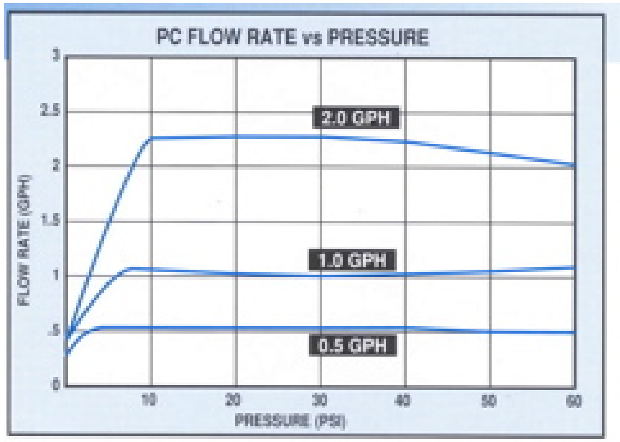
When designing a system:

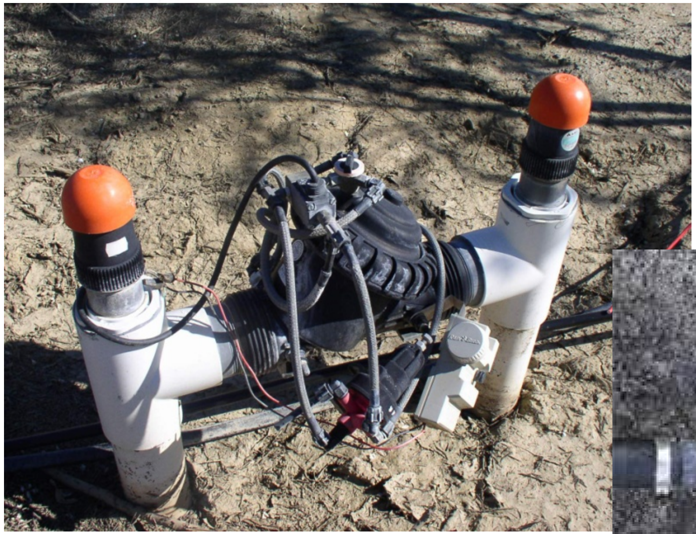
- Drip emitter, microsprinkler, or mini sprinkler features
- Pressure regulation or flow compensation
- Lateral lines – material, size, length, placement
- Mainline and sub-main pipe sizes
- Filtration and back flush system
- Pumping plant performance
- Ability to measure system flow and pressure

- Balancing these factors with cost

Maintaining Pressure, or Compensating for Change

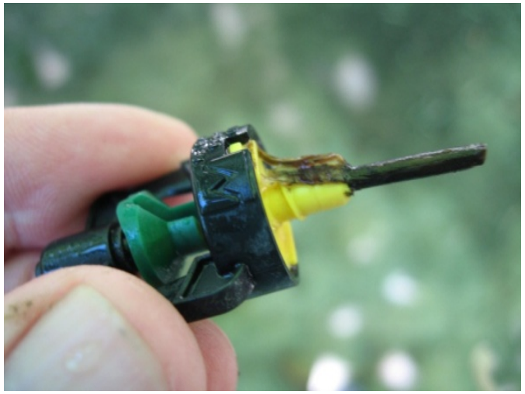






Figures: Allan Fulton

As the system ages: plugs, leaks, and breaks occur



Photos: Kevin Greer, Allan Fulton

Keys to maintaining high DU's (what works well)

- Check often (quick check at start up, thorough check including **hose flushing** monthly or more often, **check pressure regulator valves**)
- Balanced and sufficient pressures
- Be cautious with system additions or modification
- Sprinkler and emitter types – must match
- Nozzle sizes – must match
- Maintenance – Clean filters, keep in good condition
- Maintenance – fix breaks and leaks
- Maintenance - chemigation

Allan Fulton

Resources

YOUNG ORCHARD HANDBOOK

INTRODUCTION

This publication provides an overview of recent research and information to assistant in the management of young almond and walnut orchards. Proper management of an orchard in the first five years of its life will help optimize orchard health, growth and yield over the life of the orchard. This text is by no means exhaustive, and is meant as an introductory resource for understanding management steps to take in young orchards. Additional resources to consult for more detailed information are provided at the end of each chapter.

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DAVID DOLL, UC Cooperative Extension Farm Advisor, Merced County;

BRUCE LAMPINEN, UC Cooperative Extension Almond & Walnut Specialist;

and BRAD HANSON, UC Cooperative Extension Weed Specialist

WORKSHEET EXAMPLE APPLICATIONS OF IRRIGATION SCHEDULING STEPS AND EQUATIONS
Step 1) Know the Water Application Rate of Your Irrigation System
You'll Need: *Number of* drip or microspinkler emitters per tree *Trees per acre* *Gallons per hour for each emitter* *Gallons per acre-inch of water (27,154 gal/ac-in)* *Equation:* Emitters per tree x Trees per ac x Gal per hr ÷ Gal per ac-in = Inches applied per hour *Example: Orchard Design and Irrigation System Information* One minisprinkler per tree 120 trees per acre 8 gph flow rate at recommended operating pressure *Calculations:* $\frac{1}{emitter\ per\ tree} \times \frac{120}{trees\ per\ acre} \times \frac{8}{\frac{gal}{hr}/emitter} \times 27{,}154\ gal\ per\ acre-inch$ $= 0.035\ \frac{acre-inches}{hour}$
Step 2) Figure Out How Much Water Your Soil Can Store
You'll Need: *Inches of water storage per foot of soil – Based on soil type and 50% ASM from Table 1* *Root depth-* 1st leaf≈ <1 to 3', 2nd leaf≈2 to 4', 3rd leaf≈3 to 5' *Equation:* Inches/foot water storage x feet of root zone = inches stored water to use before tree stress *Example - March planted bare root almond trees, June 1, sandy loam* $\frac{0.7}{inches\ water\ per\ foot\ of\ soil} \times \frac{1}{feet\ of\ root\ depth} = \frac{0.7}{inches\ water\ to\ tree\ stress}$
Example - 3rd leaf, vigorous growing almond trees irrigated July 1, sandy loam $\frac{0.7}{inches\ water\ per\ foot\ of\ soil} \times \frac{4}{feet\ of\ root\ depth} = \frac{2.8}{inches\ water\ to\ tree\ stress}$

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ceyolo.ucanr.edu/Fruit_and_Nuts

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ET Irrigation Scheduling Emails

WEEKLY SOIL MOISTURE LOSS IN INCHES

(Estimated Crop Evapotranspiration)

10/16/15 through 10/22/15

Crops	**Woodland**			**Crops**	**Davis**		
	Past Week of Water Use	Accum'd Seasonal Water Use	Next Week's Estimated ETc		Past Week of Water Use	Accum'd Seasonal Water Use	Next Week's Estimated ETc
Almonds (2-13) *	0.84	49.67	0.61	Almonds (2-13) *	0.82	50.62	0.61
Prunes (3-15) *	0.56	42.46	0.40	Prunes (3-15) *	0.55	43.40	0.40
Walnuts (4-1) *	0.48	40.70	0.39	Walnuts (4-1) *	0.49	41.76	0.39
Past 7 days Precipitation (in)		0.00		**Past 7 days Precipitation (in)**		0.00	
Accum'd In-Season Precip (in)		1.39		**Accum'd In-Season Precip (in)**		1.44	

Crops	**Dixon**			**Crops**	**Verona (near Knight's Landing)**		
	Past Week of Water Use	Accum'd Seasonal Water Use	Next Week's Estimated ETc		Past Week of Water Use	Accum'd Seasonal Water Use	Next Week's Estimated ETc
Almonds (2-13) *	0.79	49.40	0.61	Almonds (2-13) *	0.65	44.38	0.61
Prunes (3-15) *	0.51	42.31	0.40	Prunes (3-15) *	0.43	37.98	0.40
Walnuts (4-1) *	0.47	40.63	0.39	Walnuts (4-1) *	0.39	36.40	0.39
Past 7 days Precipitation (in)		0.00		**Past 7 days Precipitation (in)**		0.00	
Accum'd In-Season Precip (in)		1.27		**Accum'd In-Season Precip (in)**		1.45	

ET Irrigation Scheduling Emails

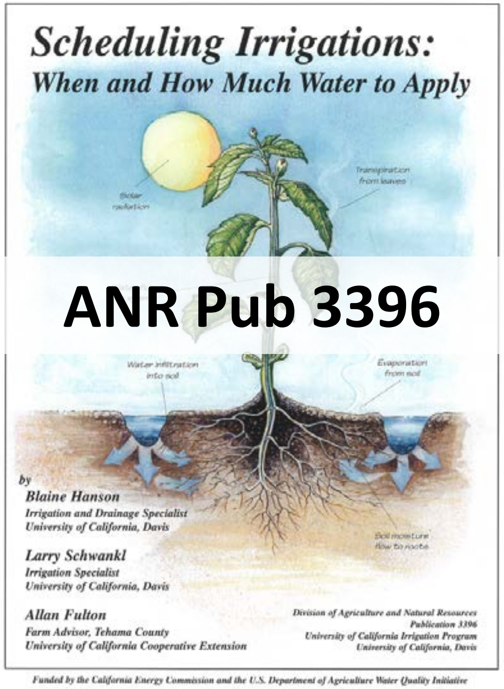
PAST WEEKLY APPLIED WATER IN INCHES, ADJUSTED FOR EFFICIENCY [1]

Crops	Woodland			Crops	Davis		
System Efficiency:	70%	80%	90%	System Efficiency:	70%	80%	90%
Almonds	1.20	1.05	0.93	Almonds	1.17	1.03	0.91
Prunes	0.80	0.70	0.62	Prunes	0.79	0.69	0.61
Walnuts	0.69	0.60	0.53	Walnuts	0.70	0.61	0.54

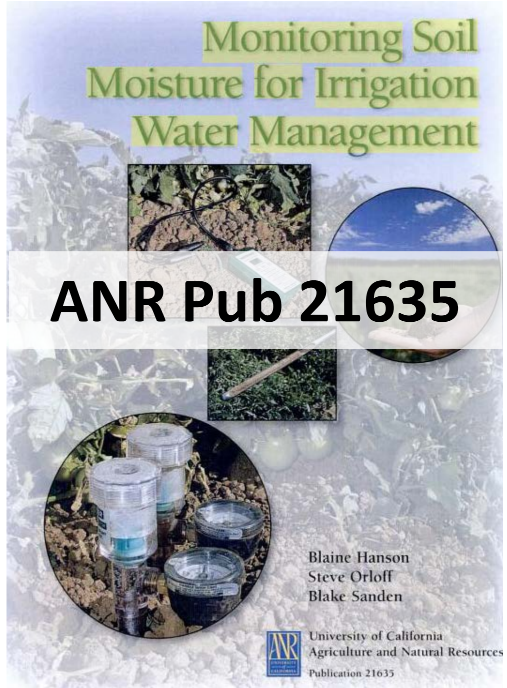
Crops	Dixon			Crops	Verona		
System Efficiency:	70%	80%	90%	System Efficiency:	70%	80%	90%
Almonds	1.13	0.99	0.88	Almonds	0.93	0.81	0.72
Prunes	0.73	0.64	0.57	Prunes	0.61	0.54	0.48
Walnuts	0.67	0.59	0.52	Walnuts	0.56	0.49	0.43

[1] The amount of water required by a specific irrigation system to satisfy evapotranspiration. Typical ranges in irrigation system efficiency are: Drip, 80%-95%; Micro-sprinkler, 80%-90%; Sprinkler, 70%-85%.

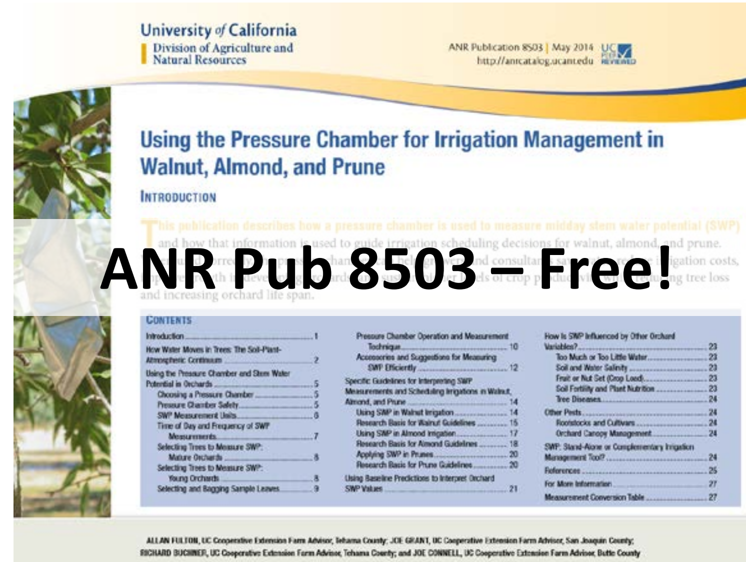
For further information concerning all counties receiving this report, contact the Sacramento-Solano-Yolo Orchard Systems Advisor at kspope@ucanr.edu



ANR Pub 3396



ANR Pub 21635



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