

Irrigation Principles for Almonds & Walnuts

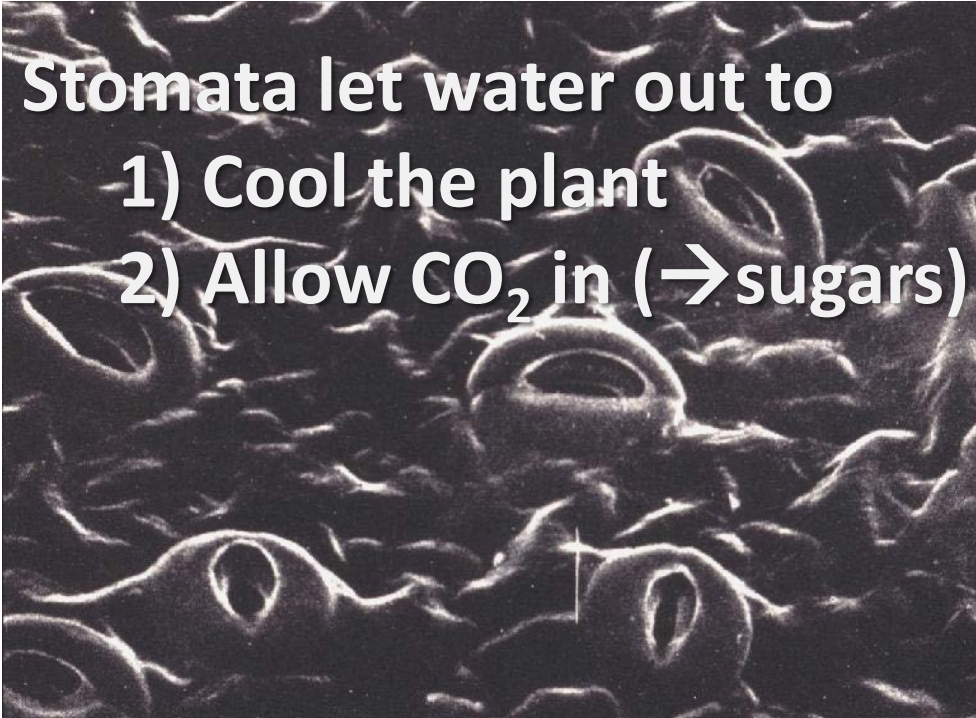
Kat Pope

UCCE Orchard Advisor

Sacramento, Solano & Yolo Counties


SID Workshop, 3/21/16

Plants need water because...



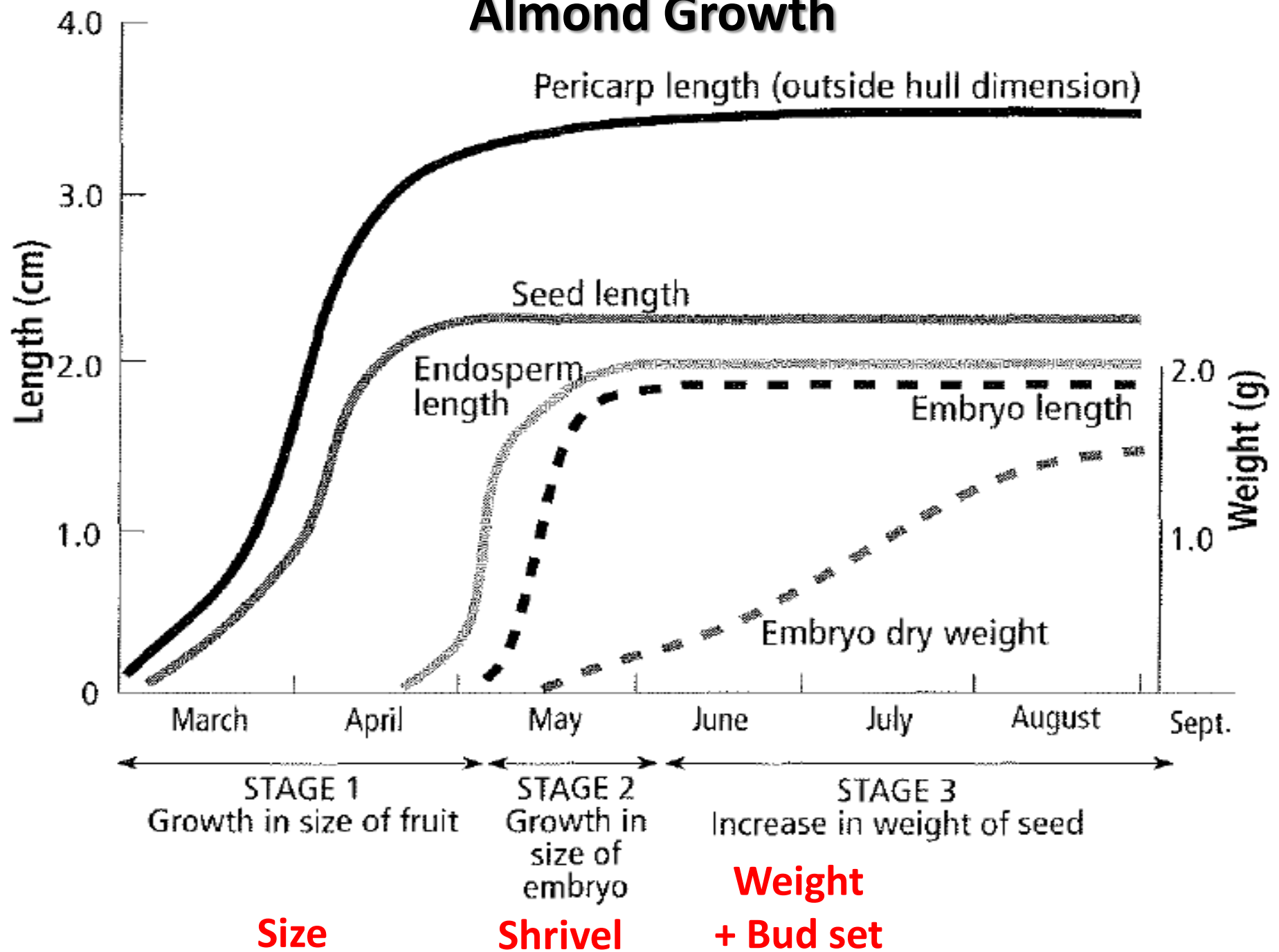
Stomata let water out to

- 1) Cool the plant
- 2) Allow CO_2 in (\rightarrow sugars)

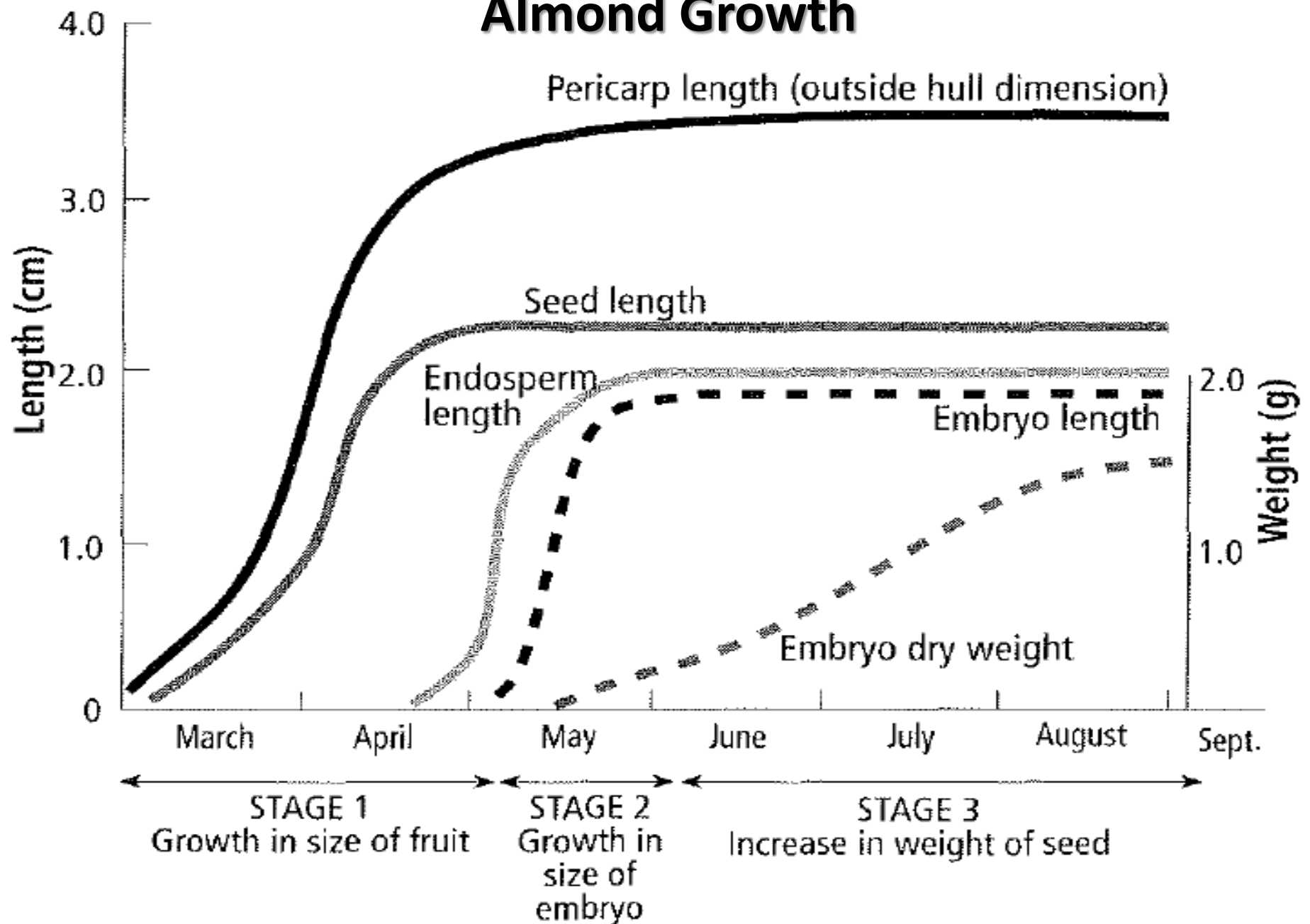


Water pressure
pushes cell walls out,
to make things grow

Almond Growth



Almond Growth



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

Outcomes of Different Stress Timing

Full Irrigation



Normal Size
15 nuts/18 grams
Marketable

**No water
after June**



Normal Size, Shriveled:
15 nuts/13.5 grams
Reduced Marketability

**50% Whole
Season**



Small Size, Not Shriveled:
15 nuts/12.5 grams
Marketable

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

Ways to avoid plant water stress

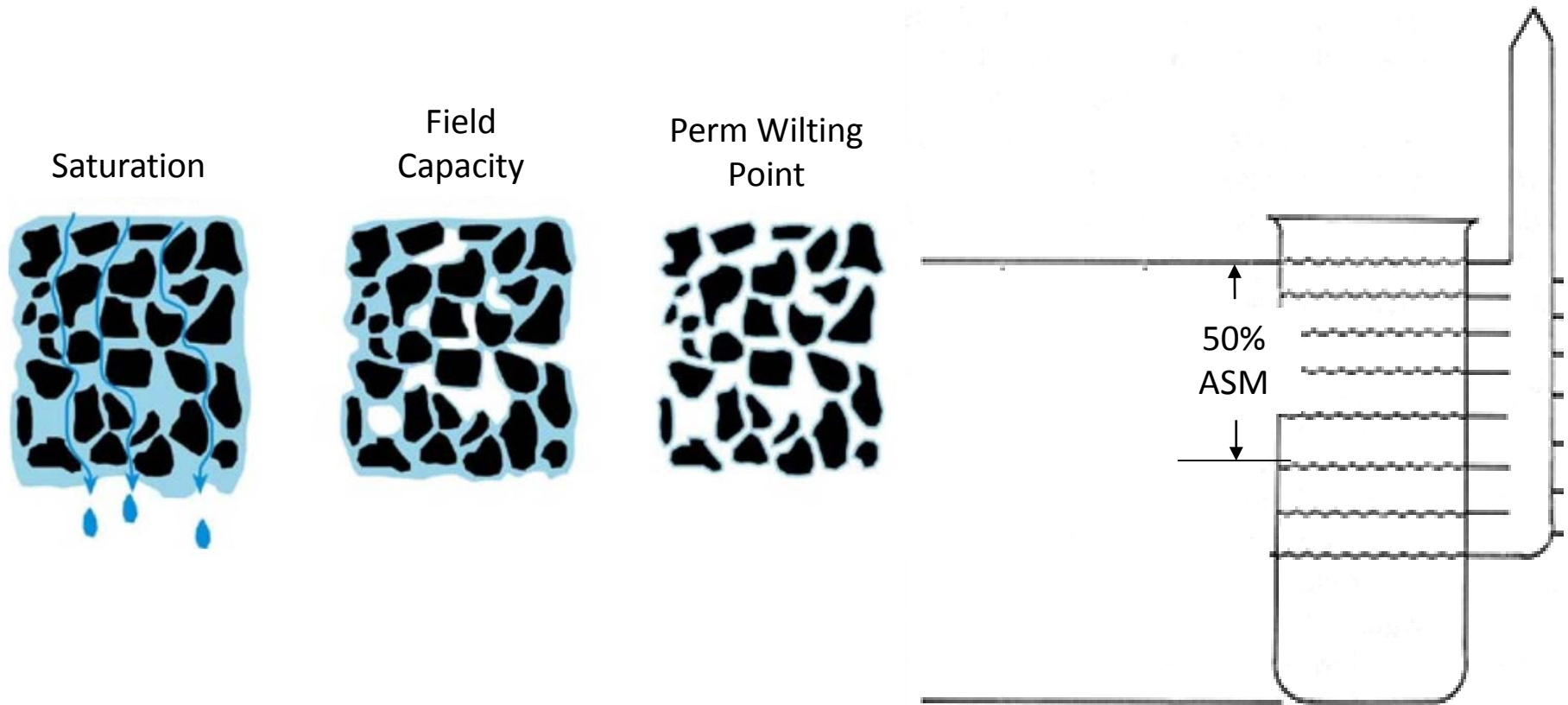
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Irrigation Scheduling:
Watching what's used from account.
Refilling account before it's empty.

Going Out of the Account = Evapotranspiration

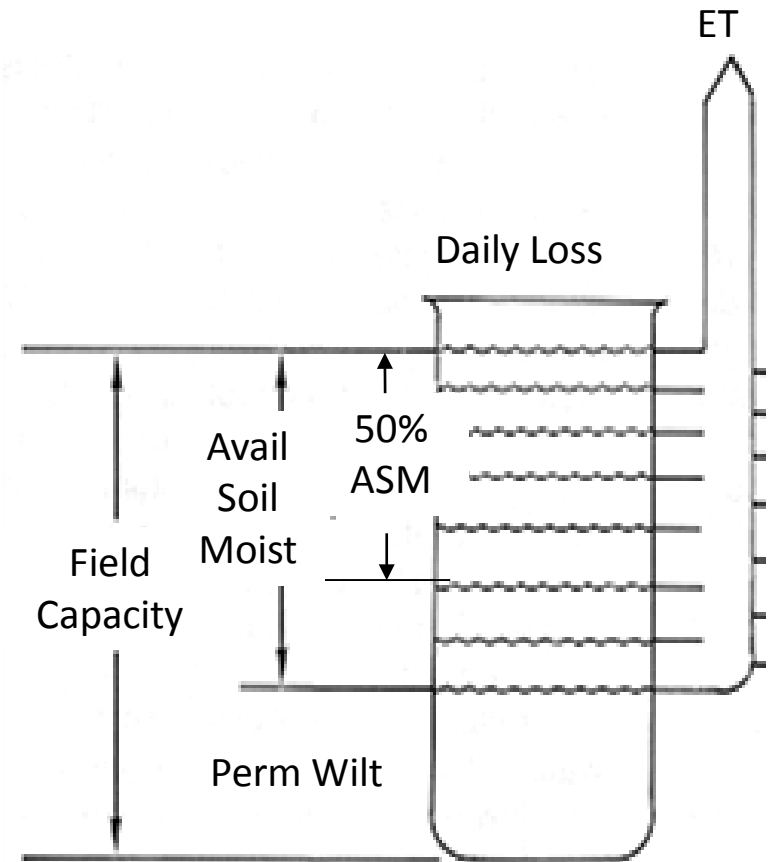
Account Supply = Storage, Precip & Irrigation

Supply: Available Soil Water Holding Capacity



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



Ways to avoid plant water stress

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- Ask the Tree if it's stressed

Soil Moisture Monitoring Tools

Feel Method

Electrical Resistance



Monitoring Soil Moisture for Irrigation Water Management



Blaine Hanson
Steve Orloff
Blake Sanden

University of California
Agriculture and Natural Resources
Publication 21635

ANR Pub 21635

Tensiometer

UC Statewide IPM Program
© 2006 Regents, University of California

Neutron probe



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://ucmanageddrought.ucdavis.edu/>

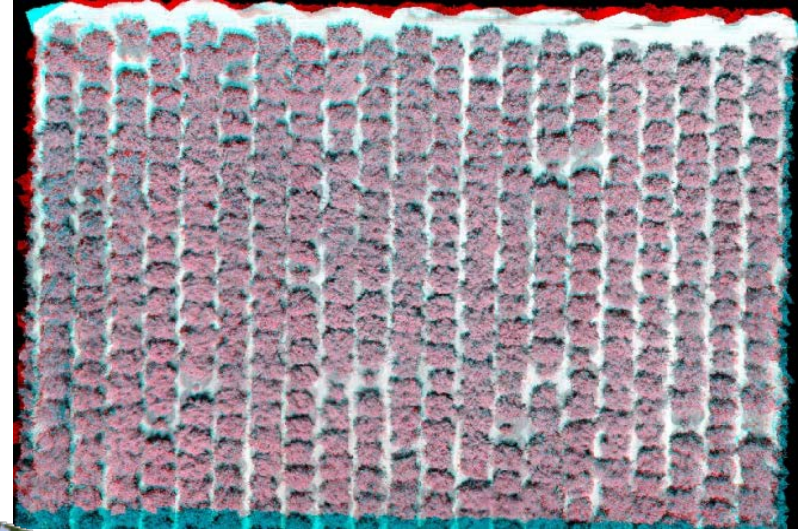
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Plant Based Monitoring Tools



Pressure Chamber



Aerial Imaging



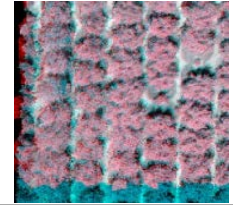
Dendrometers



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

Ways to avoid plant water stress

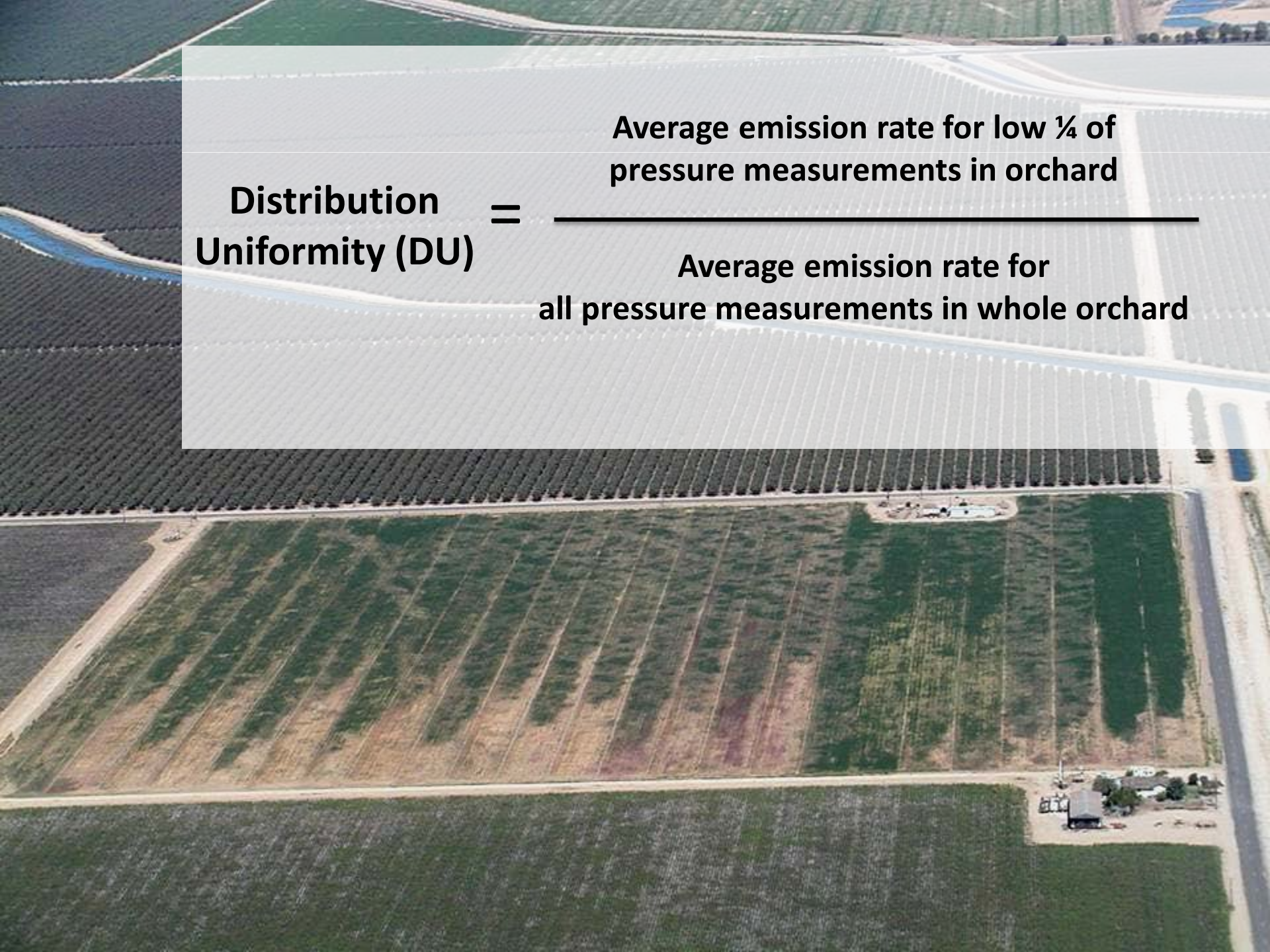
- Checkbook: ETc-based irrigation scheduling
- Ask the Soil if it's dry
- Ask the Tree if it's stressed
- Can have too much of a good thing. Over-irrigation can...
 - Decrease growth, and possibly yield
 - Endanger root health

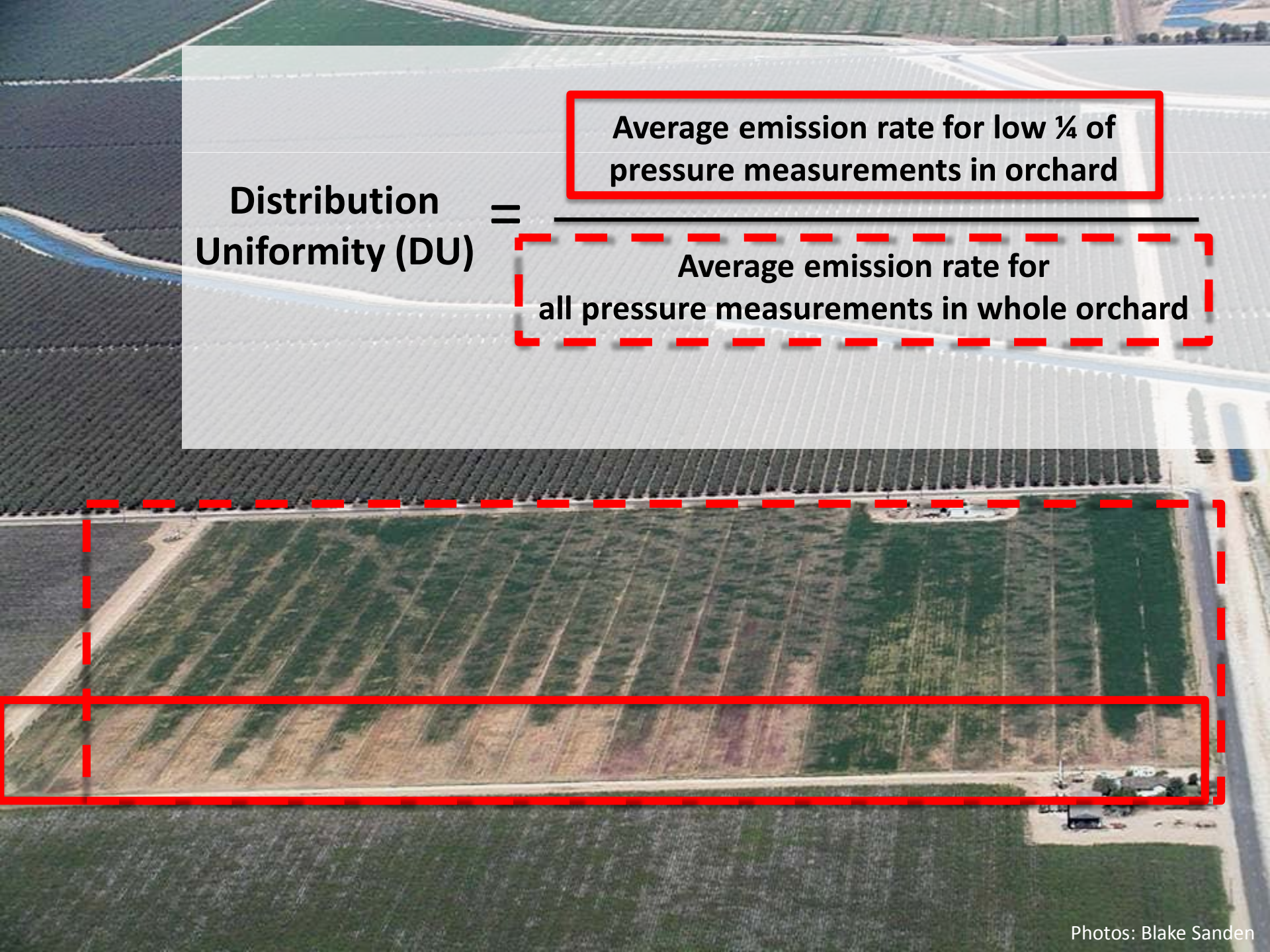
System Maintenance

- 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

An aerial photograph of an orchard with rows of trees. A semi-transparent white box is overlaid on the upper portion of the image, containing a mathematical formula for Distribution Uniformity (DU).
$$\text{Distribution Uniformity (DU)} = \frac{\text{Average emission rate for low } \frac{1}{4} \text{ of pressure measurements in orchard}}{\text{Average emission rate for all pressure measurements in whole orchard}}$$



**Distribution
Uniformity (DU)**

=

**Average emission rate for low ¼ of
pressure measurements in orchard**

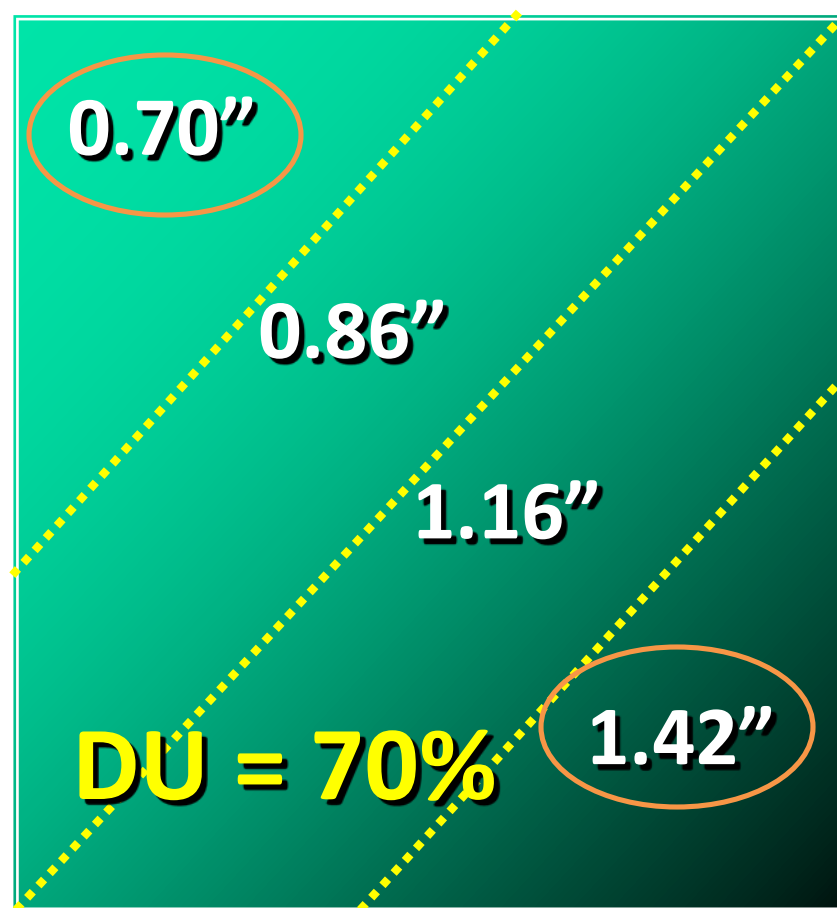
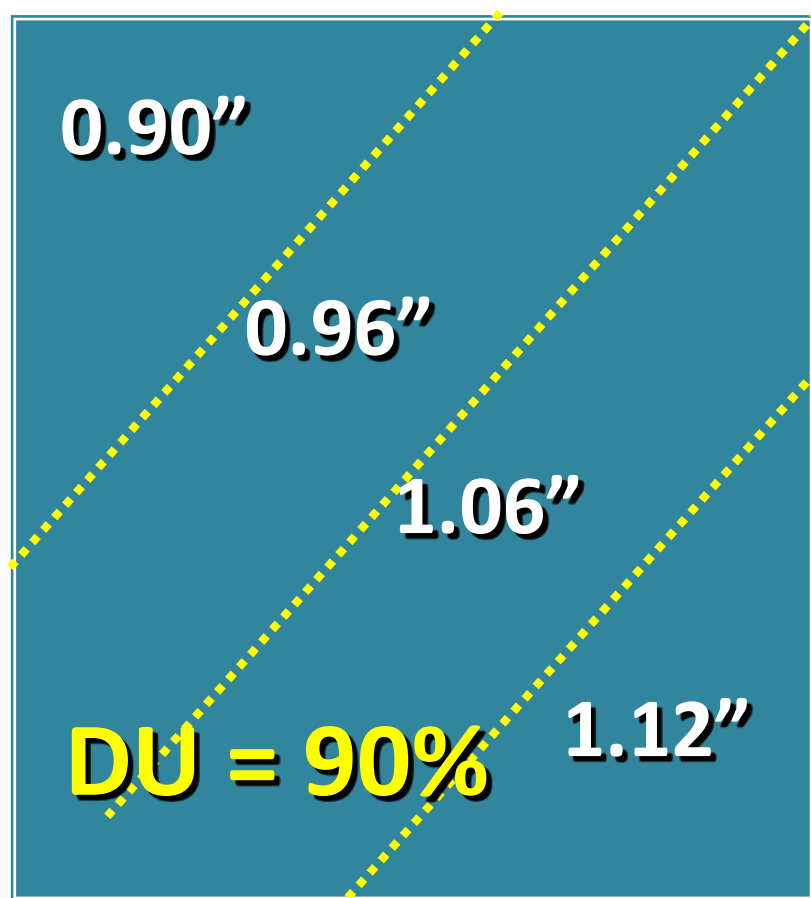
**Average emission rate for
all pressure measurements in whole orchard**

Micro Irrigation DUs of Almonds by ITRC Ranking Method (103 Evaluations) MIL 2002-2014



Why Care about DU?

Example: Target application 1.0 inch water *average*



Why Care about DU?

Example: Target application 1.0 inch water *average*

DU	Water Applied in One Irrigation		Difference from Goal Over 30 Irrigations	
	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"

Why Care about DU?

Example: Target application 1.0 inch water *average*

DU	Water Applied in One Irrigation		Difference from Goal Over 30 Irrigations	
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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

How to Measure DU











Measuring system pressures – simpler than measuring flows



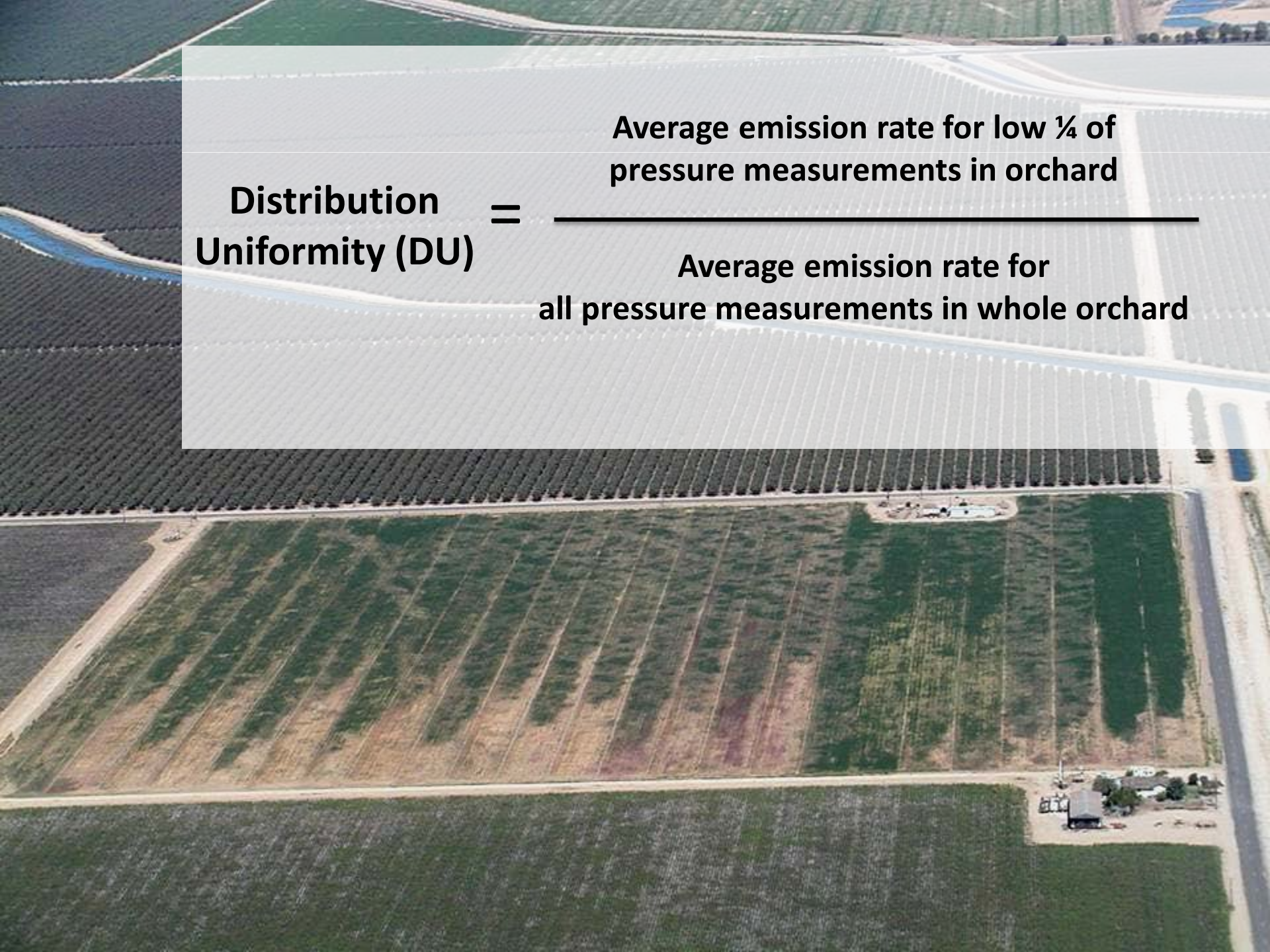
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Plate Series	Plate Options	Recommended Nozzles	PSI					
			25	30	35	40	45	50
P2	P2 9° Red Radius 18-20' (5.5-6.1 m) Stream Ht. 14-23" (36-58 cm) 	 Lt. Blue #40	—	—	.28	.30	.32	.34
		 Lt. Purple #45	.29	.32	.35	.37	.39	.42
		 Dk. Green #50	.36	.39	.43	.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) P4 15° Orange Radius: 23-25' (7.0-7.6 m) Stream Ht. 40-50" (102-127 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
		.50 10FC	Within the recommended pressure range of pressure rat flow regulating within a flow range of no more than 0%					

Or Actually Measure Flows



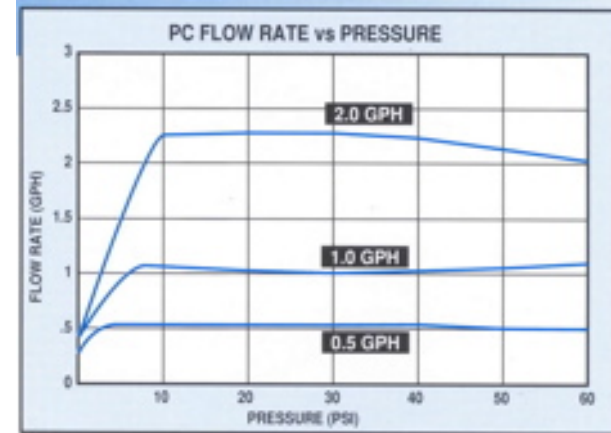
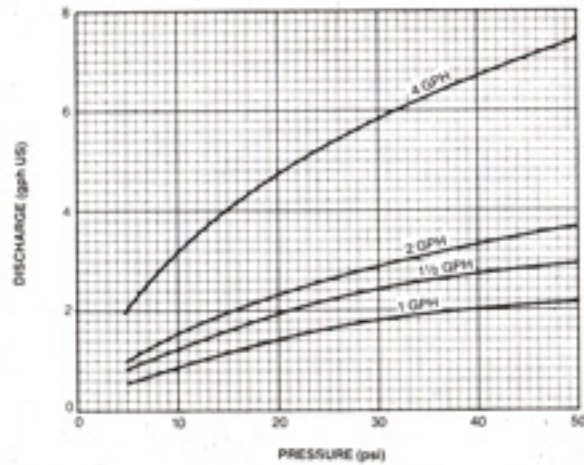
An aerial photograph of an orchard with rows of trees. A semi-transparent white box is overlaid on the top half of the image, containing a formula for Distribution Uniformity (DU).
$$\text{Distribution Uniformity (DU)} = \frac{\text{Average emission rate for low } \frac{1}{4} \text{ of pressure measurements in orchard}}{\text{Average emission rate for all pressure measurements in whole orchard}}$$

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



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



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

Resources

YOUNG ORCHARD HANDBOOK

INTRODUCTION

This publication provides an overview of recent research and information to assist 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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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 microsprinkler 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:

$$\frac{1}{\text{emitter per tree}} \times \frac{120}{\text{trees per acre}} \times \frac{8}{\frac{\text{gal}}{\text{hr}}/\text{emitter}} \times 27,154 \text{ gal per acre - inch}$$

$$= 0.035 \frac{\text{acre - inches}}{\text{hour}}$$

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

$$\frac{0.7}{\text{inches water per foot of soil}} \times \frac{1}{\text{feet of root depth}} = \frac{0.7}{\text{inches water to tree stress}}$$

Example - 3rd leaf, vigorous growing almond trees irrigated July 1, sandy loam

$$\frac{0.7}{\text{inches water per foot of soil}} \times \frac{4}{\text{feet of root depth}} = \frac{2.8}{\text{inches water to tree stress}}$$

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ceyolo.ucanr.edu/Fruit_and_Nuts

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)		1.37		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

Scheduling Irrigations: When and How Much Water to Apply



ANR Pub 3396



by
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Division of Agriculture and Natural Resources
Publication 3396
University of California Irrigation Program
University of California, Davis

Funded by the California Energy Commission and the U.S. Department of Agriculture Water Quality Initiative

Monitoring Soil Moisture for Irrigation Water Management



ANR Pub 21635



Blaine Hanson
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Blake Sanden

University of California
Agriculture and Natural Resources
Publication 21635

University of California
Division of Agriculture and
Natural Resources

ANR Publication 8503 | May 2014
<http://anrcatalog.ucdavis.edu>

Using the Pressure Chamber for Irrigation Management in Walnut, Almond, and Prune

INTRODUCTION

This publication describes how a pressure chamber is used to measure midday stem water potential (SWP) and how that information is used to make irrigation scheduling decisions for walnut, almond and prune. It also discusses the benefits of using SWP to make irrigation scheduling decisions, including reduced irrigation costs, increased crop yield, and increased orchard life span.

ANR Pub 8503 Free!

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Agriculture Irrigation Water Management

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» Irrigation Scheduling
Additional drought information resources

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Agriculture Irrigation Water Management

Deficit irrigation strategies may be available to make the best use of limited water supplies. Click here for more information on deficit irrigation strategies for corn.

Quality [Irrigation Scheduling](#) can be critical to efficient irrigation water use. Evapotranspiration (ET) irrigation scheduling, soil moisture monitoring, and plant-based irrigation scheduling are all discussed.

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Maintenance of Microirrigation Systems

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Predicting clogging problems (II)

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Maintenance of Microirrigation Systems

Predicting Clogging Problems

Solutions to Existing Clogging Problems

"I Have a Clogging Problem and I Want to

Microirrigation systems include microsprinklers for tree crops, drip emitters for trees, vines, and some row crops, and drip tape for row and field crops. Microirrigation systems apply water to the soil through emitters that are designed to deliver water in a uniform manner. Microirrigation systems are more efficient than other irrigation methods. This uniformity results in potentially higher yields, higher revenue, and reduced irrigation operating costs.

Uniformity, a performance characteristic of irrigation systems, is a measure of the evenness of the applied water throughout the irrigation system. Distribution uniformity (DU), sometimes called emission uniformity (EU), is an index that

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