Irrigation Scheduling with ET in Nuts and Vines Workshop:

Almond and Pistachio Irrigation through Summer

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How much water does your crop need this week?

Evapotranspiration

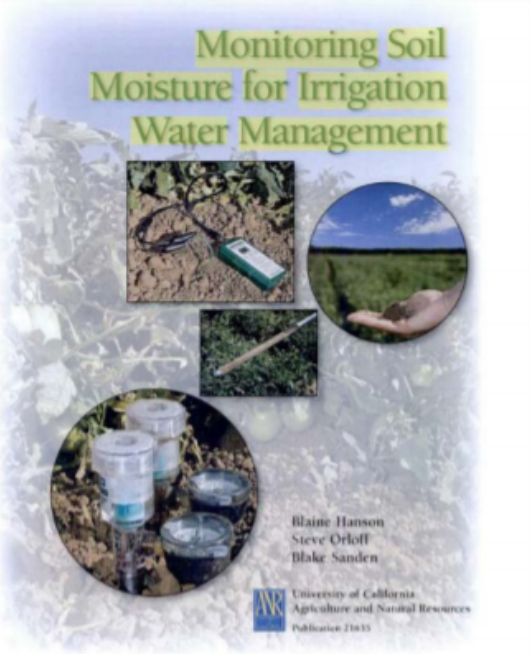
($ET_c = ET_0 \times K_C$ /irrigation efficiency)

Factors influencing **how much** and **when** water should be **applied**:

soil moisture and tree water status
system distribution uniformity (DU)
% wetted area of system
orchard age / root zone depth
soil water holding capacity
deficit irrigation goals

Soil moisture monitoring tools

Electrical Resistance



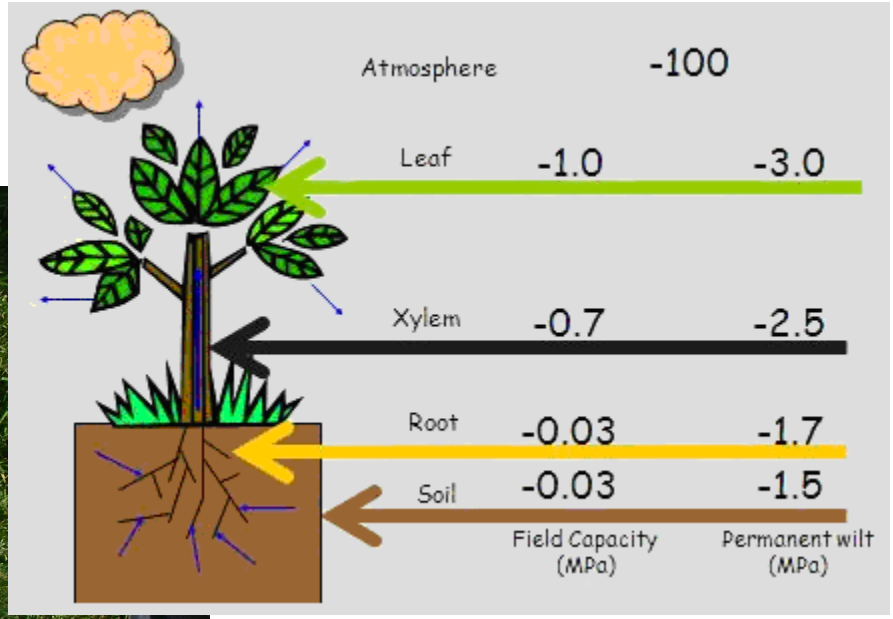
ANR Pub 21635

UC CE

D. Doll

Plant Based monitoring

- Pressure chamber



Midday Stem Water Potential (MSWP) or (SWP)- measures resistance in bars

Irrigation System Considerations: System Maintenance

Most systems start declining in performance after the first few years

Lack of annual maintenance

A 70% DU takes 20% more water to adequately irrigate than 90% DU

Ensure system can meet peak seasonal demand of 2”

Guidelines for DU Testing:

http://micromaintain.ucanr.edu/

Need to account for the extent of subbing under drip emitters…

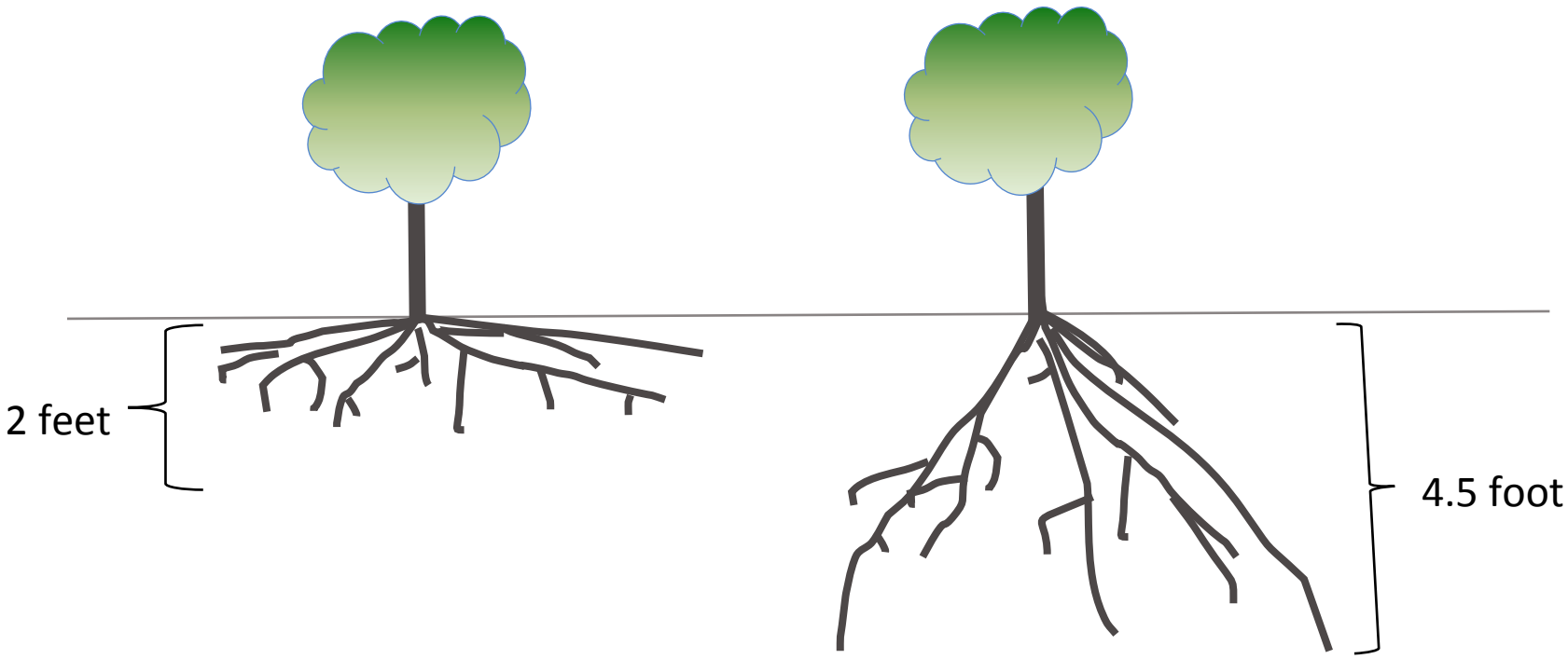
Irrigation System Considerations: Volume of Wetted Soil

Irrigation Type	% of wetted area	% of AWHC
Single line drip	20-30%	20-30%
Double line drip	20-50%	20-50%
Micro sprinkler	30-60%	30-60%

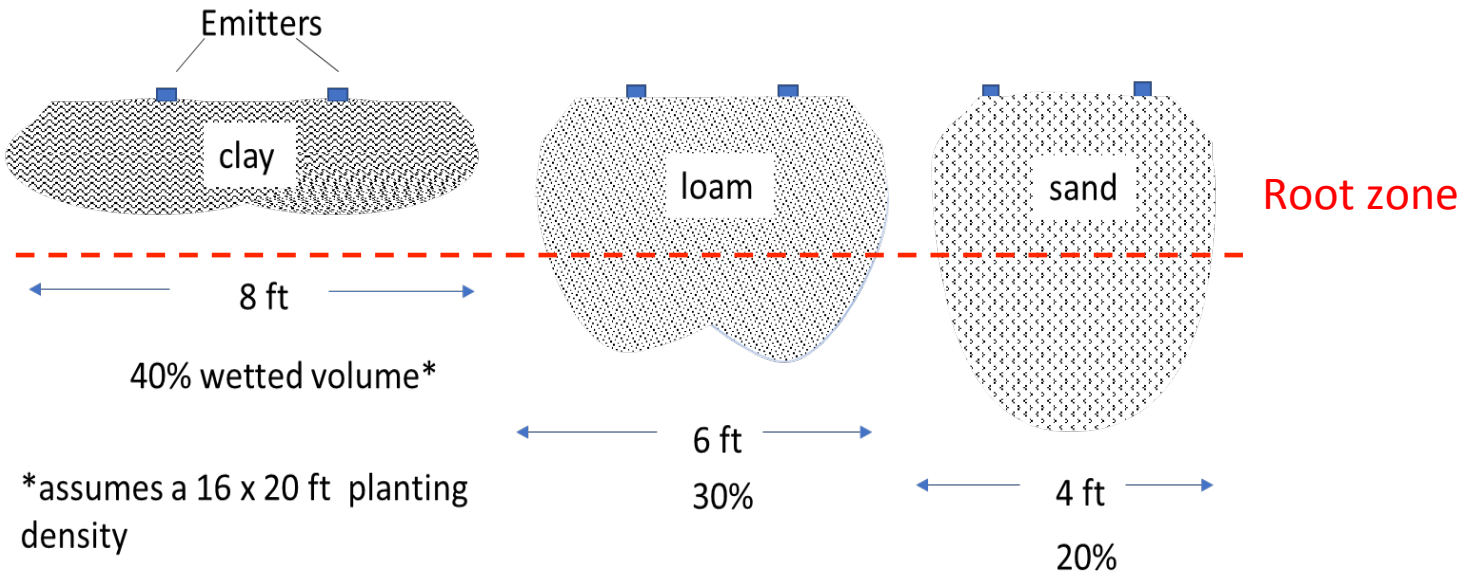
Easy to over-irrigate/lose water to deep percolation if not taken into account the % of wetted area

Root Zone

- Rooting depth should be taken in to consideration



Need to consider the % of wetted area impacted by the system and soil type
Easy to over-irrigate/lose water to deep percolation



Available water

Type of Soil	Range in/ft	Average in/ ft
Very Course to course textured sand	0.5 to1.00	0.75
Moderately course sandy loams	1.00 to 1.50	1.25
Medium textured- fine sandy loam to silty clay loam	1.25 to 1.75	1.50
Fine and very fine- silty clay to clay	1.50 to 2.50	2.00
Peats and mucks	2.00 to 3.00	2.50

Estimate the available water and multiply by rooting depth

Example: Fine sandy loam at field capacity=
1.3 in/ft x 5 ft rooting depth= 6.5 in available water

Allowable depletion = 3.25 in

Irrigation scenario:

- ETc:
  - (1.87 inches*1.19)/0.93 = 2.39 inches
- AWHC:

  3.25 inches * 37% (orchard floor) = 1.2 inches

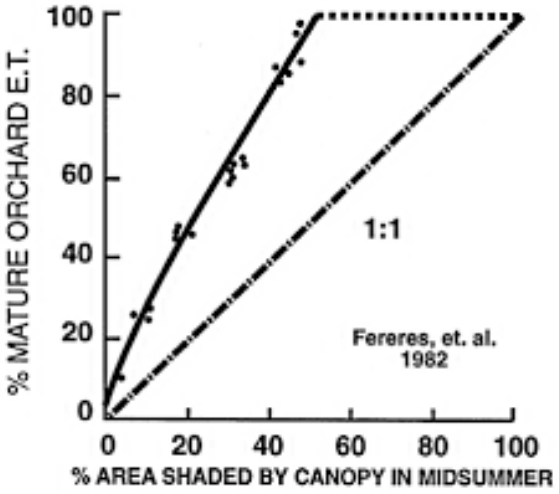
  Will need to irrigate twice to avoid percolation losses
- Water use per week:

  (396 ft^2 tree)(0.623 gal in-ft^2)(2.39 inches)= 589 gallons/week
- Pump Time:

  589 gallons/week ÷10 gallon per hr/tree = 59 Hours/Week

  Two sets of 30 hours

Estimating Young orchard ET



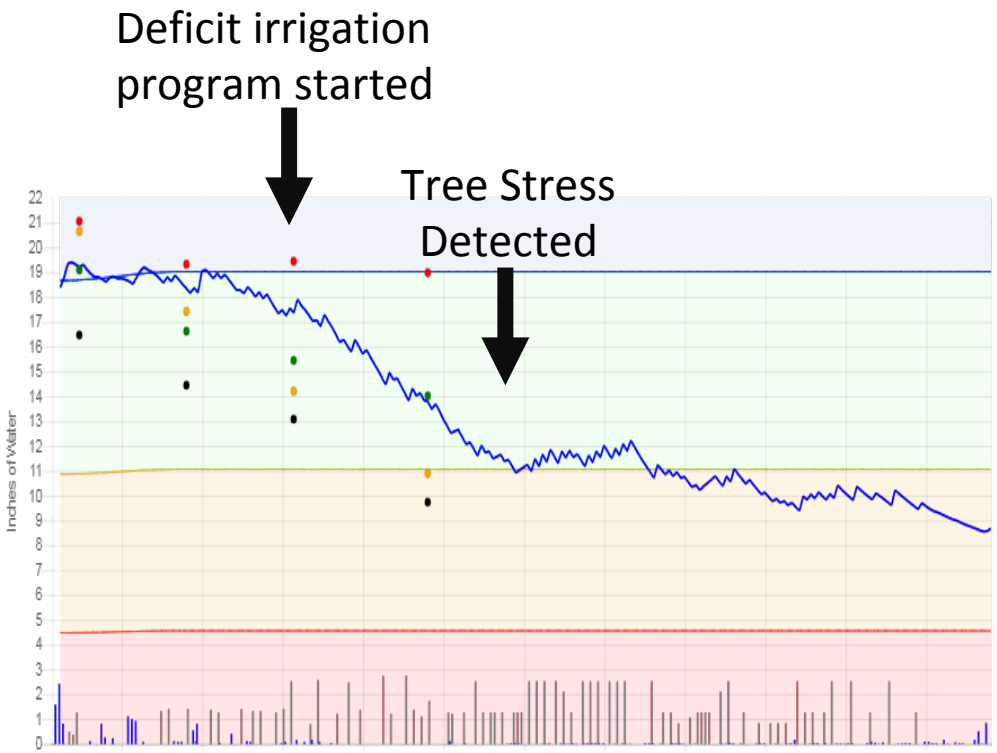
ETc for young trees is roughly double % canopy cover

Example: 3rd leaf orchard covering 35% of the orchard floor will use 70% of the water that a mature orchard would use.

Example: young tree ETc = (2.39 inches) (70%) ≈ 1.7 inches

Deficit Irrigation in tree crops

- Premise of deficit irrigation is to reduce stored soil moisture reserves so stress can be applied when needed
- Reducing water applications may not lead to immediate stress



Example of soil moisture status through season

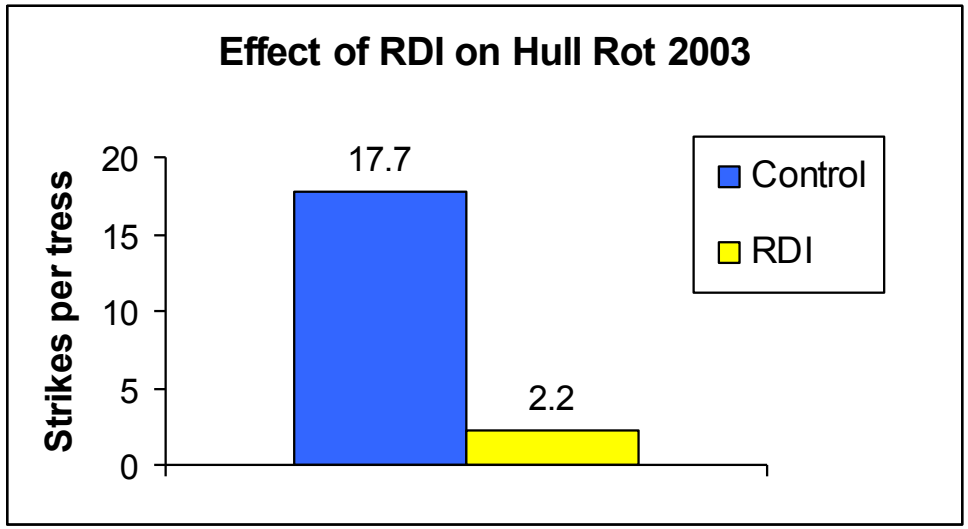
Image Courtesy of Irrigation for the Future

Irrigating Almonds Through the Summer

GOAL: To reduce hull-rot and ease the harvest process without impacting next year's crop.

Summer Irrigation: Why We Stress

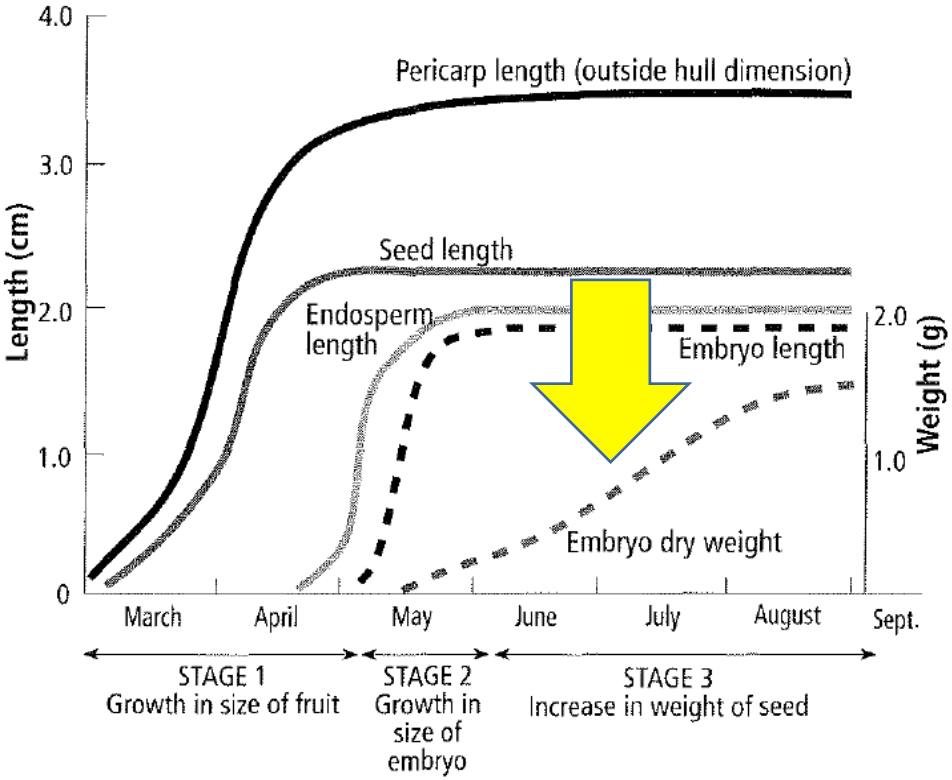
- Moderate levels of stress at the ONSET of hull-split can reduce hullrot
- Stress should be maintained for two weeks, then full irrigation
- This makes harvest easier



If no issues with hull-rot, keep stress reduced.

Summer Irrigation: But not too much stress

- Almond yield is affected by summer stress
  - Weight accumulation begins in June, ends just before harvest
  - Requires energy from photosynthesis
- also reduces vegetative growth impacting future yields



Irrigating up to harvest

- Gradually reduce water 20% at 1% hull-split. This will vary based on soil type and irrigation system
- After two weeks of moderate stress, resume full irrigation 100% ET Maintaining a longer stress will not force nuts to split, only will reduce kernel size

- Keep in mind that stored soil moisture reserves will be depleted and trees will stress easier

Irrigation: Preparing for harvest

- A moderate to severe stress level 20%-50% ET one week prior to harvest is usually sufficient to reduce barking
- Bark damage typically occurs in wettest areas of the field due to delayed ripening of the crop (POOR DU!)
- Stored soil moisture will indicate how long water should be off prior to shaking

Irrigation: Postharvest

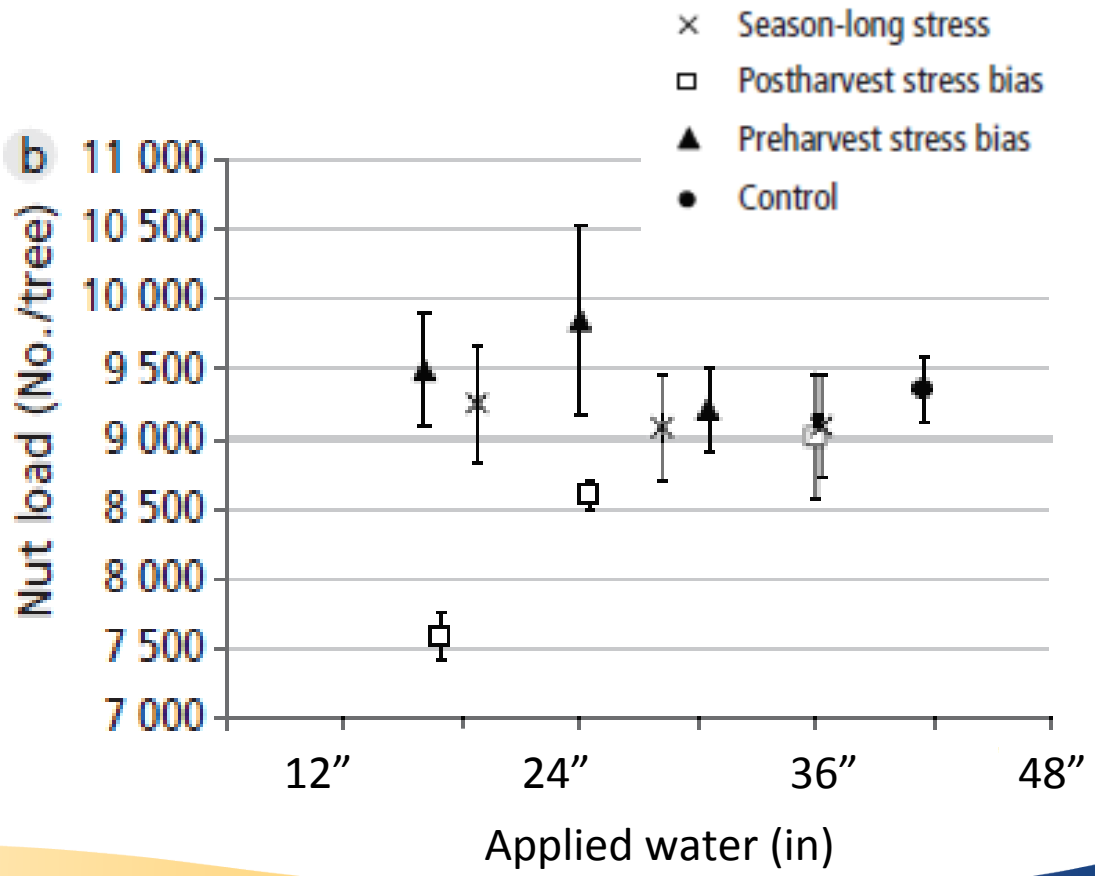
- Irrigate to match full demand as soon as possible
- maximal yields achieved with a target application of 8” of water by end of September
- If wetting nuts is a concern, make a single sweeper pass or run or install a single drip line
- Condition nuts on orchard floor for faster drying

Almond Water use – Next Season's Effects

Post-harvest Irrigation

Stress during the postharvest decreases nut counts the following year.

Not enough carbohydrates to set the nut.



Basic Schedule

1. July 4th: 1% hullsplit, ~20% water reduction to until July 18th – Full irrigation resumed
2. 1-2 weeks prior to harvest, apply a 20% deficit.
3. Post harvest: Irrigate ASAP!

Irrigating Almonds Through the Summer

- Water stress decreases photosynthate which can lead to reduced growth and kernel size
- Stress through the summer should be carefully managed to reduce hull rot and speed harvest while minimally impacting kernel weights
- Strategies are not “one-size-fits-all” and soil, depth of profile and irrigation system should be considered
- As soon as harvest is complete, re-apply water to reduce tree stress, increasing energy for bud development

Managing Drought within Pistachios – Regulated Deficit Irrigation

University of California
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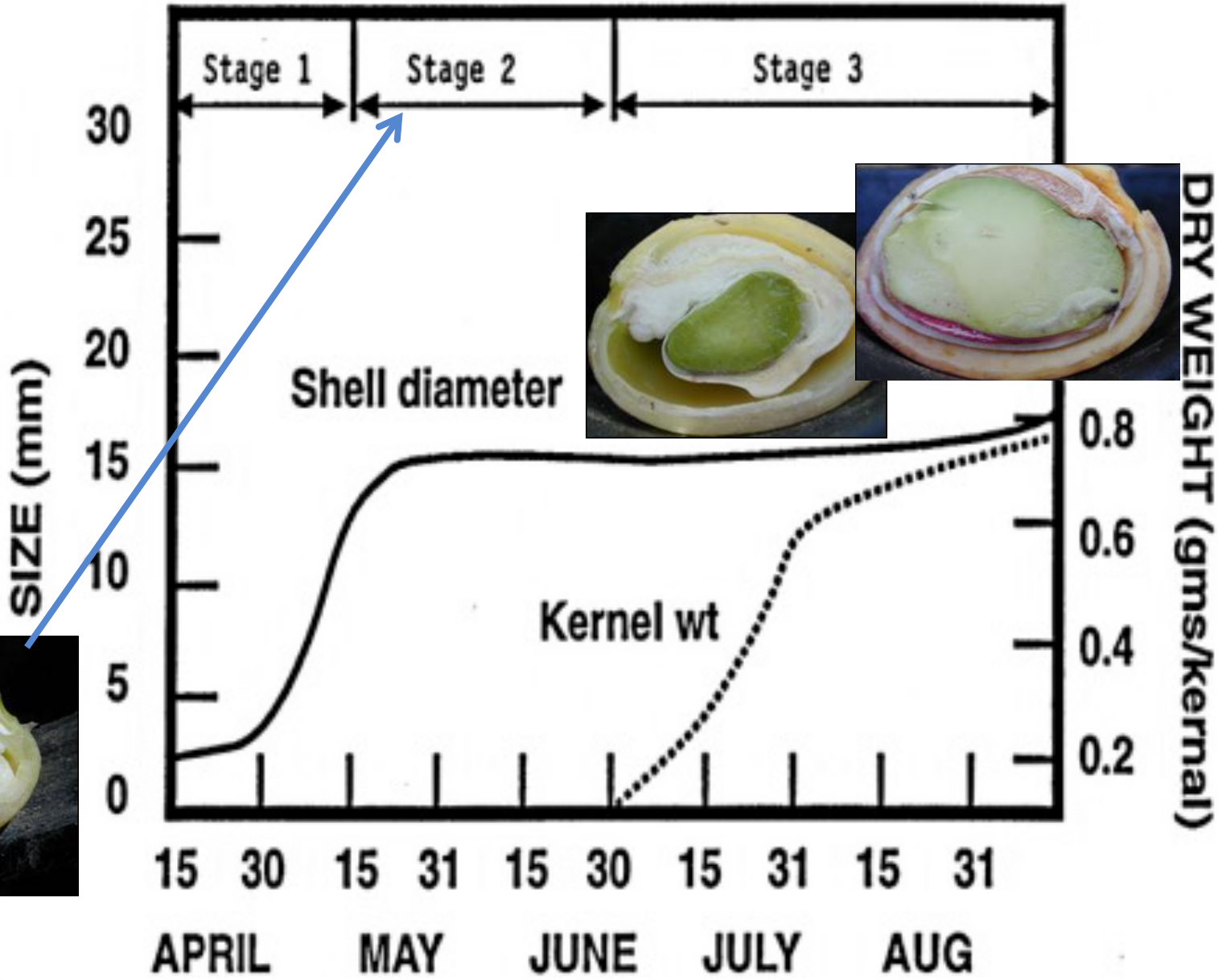
Regulated Deficit Irrigation (RDI)

Planned water deficits at specific crop developmental stages that control vegetative growth without negatively affecting production.

Timing of Pistachio Nut Development

(Dave Goldhamer, Pistachio Production Manual 2008)



Regulated Deficit Irrigation Impacts on Yield (Dave Goldhamer, Kettleman City 1988-92)

Irrigation Treatment	Split Nut Weight (g/nut)	Blanks (% nut load)	Split Nuts (%)	Total Nut Load (No./ tree)	Removal by Harvester (% splits)	Dry Split Yield (lb/ac)	Water Use Efficiency (lb splits/ inch irrigation)
0% Stage 1	1.24 b*	21.5 ab	87.8 d	12252	85.5 bc	2828 d	91.7 bc
0% Stage 2	1.29 bc	22.0 ab	73.6 b	10881	91.4 bc	2239 bc	91.7 bc
0% Stage 3	1.18 a	27.6 c	43.6 a	11187	72.6 a	1014 a	64.8 a
0% Postharvest	1.30 bc	22.8 abc	78.8 bc	11411	88.8 bc	2451 bcd	77.6 ab
50% Stage 2; 25% PH	1.30 bc	21.2 ab	81.7 cd	10874	89.5 bc	2744 cd	106.1 c
Control	1.32 c	22.5 ab	79.5 bc	11457	88.8 bc	2714 cd	81.5 ab

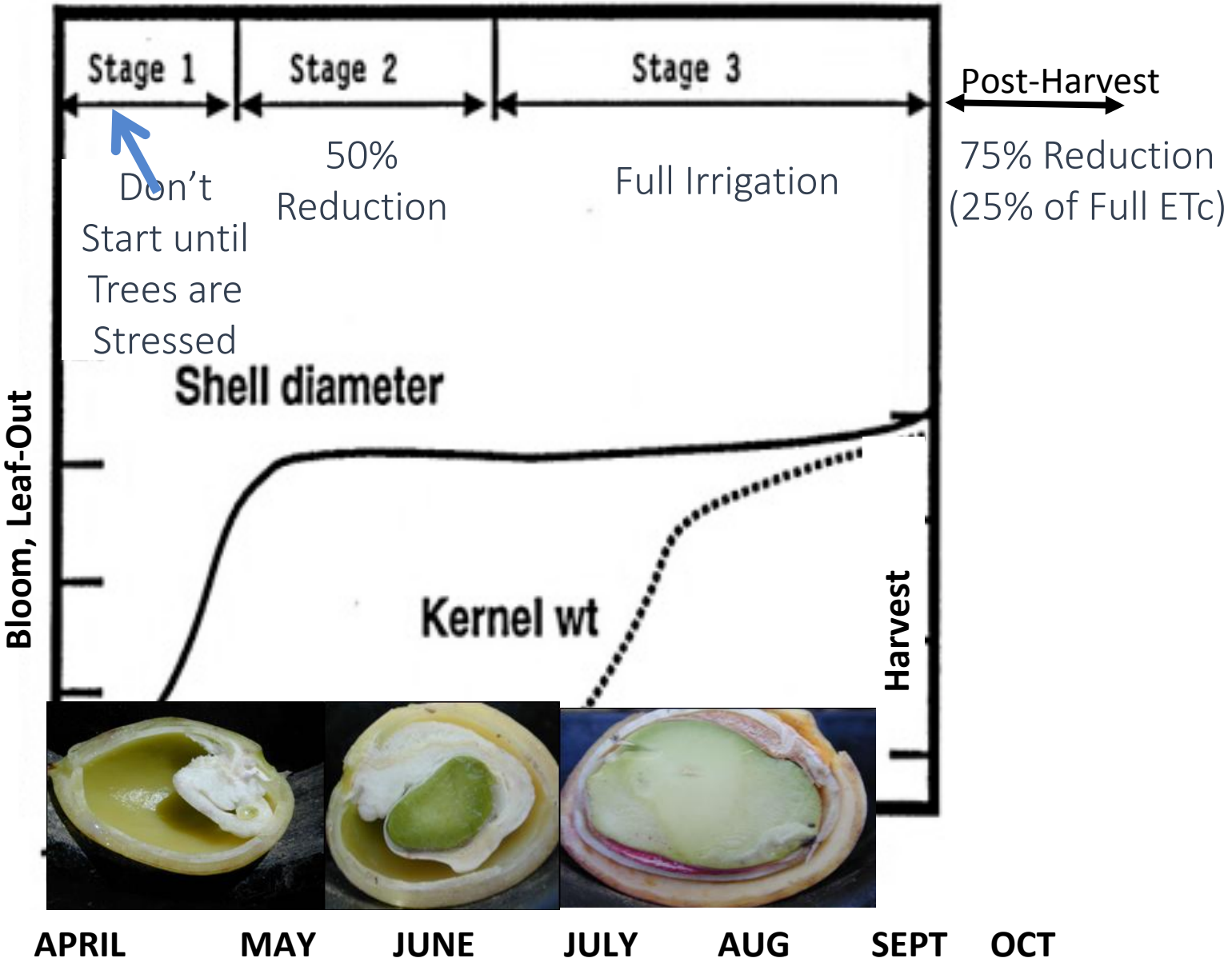
* Values followed by the same letter are not statistically different at p=0.05.

Stage 2 RDI irrigation schedule

(D. Goldhamer, 2008)

Growth Stage	Phenology	Period		Refer-ence ETo (inches)	Kc	Normal ETc (inches)	RDI Level (%)	RDI ETc (inches)
	Bloom	Apr	1-15	2.36	0.07	0.17	100	0.17
Stage 1	Leafout	Apr	16-30	2.36	0.43	1.01	100	1.01
	Shell Expansion	May	1-15	3.19	0.68	2.17	100	2.17
	Shell Hardening	May	16-31	3.4	0.93	3.16	50	1.58
Stage 2	Shell Hardening	Jun	1-15	3.84	1.09	4.19	50	2.09
	Shell Hardening	Jun	16-30	3.84	1.17	4.49	50	2.25
	Nut Filling	Jul	1-15	4.13	1.19	4.92	100	4.92
	Nut Filling	Jul	16-31	4.41	1.19	5.25	100	5.25
Stage 3	Nuf Fill/Shell Split	Aug	1-15	3.54	1.19	4.21	100	4.21
	Shell Splitting	Aug	16-31	3.78	1.12	4.23	100	4.23
	Hull Slip	Sept	1-15	2.66	0.99	2.63	100	2.63
	Harvest	Sept	16-30	2.66	0.87	2.31	25	0.58
	Postharvest	Oct	1-15	1.71	0.67	1.15	25	0.29
Post-harvest	Postharvest	Oct	16-31	1.83	0.5	0.91	25	0.23
	Postharvest	Nov	1-15	0.8	0.35	0.28	25	0.07
					Totals	41.1		31.7

Timing of Pistachio Nut Development



Pistachio Irrigation Conclusions

- Pistachio trees are extremely drought tolerant.
- % splits and individual nut weight are the most sensitive to stress.
- Depending on soil type, salinity, irrigation system and management mature pistachios can use 30 to 50 inches of water over the season.
- Real time soil moisture/plant stress monitoring over the season is essential to maximize yield/efficiency and minimize disease.
- During mid May thru early July and postharvest pistachios are most tolerant of stress: potentially allowing for full yield with only 80-85% of full season ET.
- Successful RDI programs require full winter recharge of soil profile and understanding of soil water holding capacity and salinity.

Thank You!

Questions?

Weekly "Checkbook" Irrigation (http://cekern.ucdavis.edu/Irrigation_Management

click SSJV IRRIGATION CHECKBOOK SCHEDULER

Field (no.)_____ PISTACHIO 44.3 INCHES "NORMAL YEAR" ET

VIGOR FACTOR	SOIL TYPE:	FIELD CAPACITY (in/ft):	REFILL POINT (in/ft):	ROOTING DEPTH (ft):	ROW SPACING:	IRRIG. SYSTEM:	NORMAL RUN TIME (hrs):	WETTED VOLUME (%):	Total Avail @ 100% (in):	AREA/ TREE (sq ft):	DESIGN FLOW (gph/ tree):	WET AREA APPLIC (in):	NUMBER of SETS:	TOTAL AREA APPLIC (in):	
100%	Milham/ Panoche sandy clay loam	2.6	0.9	6	18' X 22'	4, 1 gph drips	24	35%	10.2	396	6	1.67	1	0.58	
	Week Ending:	4/7	4/14	4/21	4/28	5/5	5/12	5/19	5/26	6/2	6/9	6/16	6/23	6/30	TOTAL ET
	"Normal Yr" ET:	0.08	0.26	0.42	0.74	0.95	1.16	1.39	1.61	1.85	2.00	2.18	2.25	2.25	17.16
	Block ET (in/week):	0.08	0.26	0.42	0.74	0.95	1.16	1.39	1.61	1.85	2.00	2.18	2.25	2.25	
	Run Time to Refill for Week (hrs):	3.4	10.8	17.4	30.6	39.3	47.9	57.0	66.1	75.9	82.4	89.7	92.8	92.8	TOTAL Irrig (in)
	Actual Run (hrs):			24	24	24	24	48	72	72	72	96	96	96	15.75
	Cumulative Deficit or Surplus (hrs):	-3.4	-14.3	3.7	-2.9	-22.6	-46.5	-67.8	-45.5	-40.6	-51.1	-52.5	-49.2	-55.5	
	Estimated Soil Moisture Depletion or Excess (in):	-0.24	-0.99	0.26	-0.20	-1.57	-3.23	-4.71	-3.16	-2.82	-3.55	-3.64	-3.42	-3.85	Soil Moisture Depletion (in)
	Estimated Soil Moisture (% available):	98%	90%	103%	98%	85%	68%	54%	69%	72%	65%	64%	66%	62%	-3.85
	Actual Soil Moisture (% available):		98%		95%		60%	65%	75%		60%		60%		