

Irrigation management in a drought year

What drought means to the tree, and
how best to deal with it

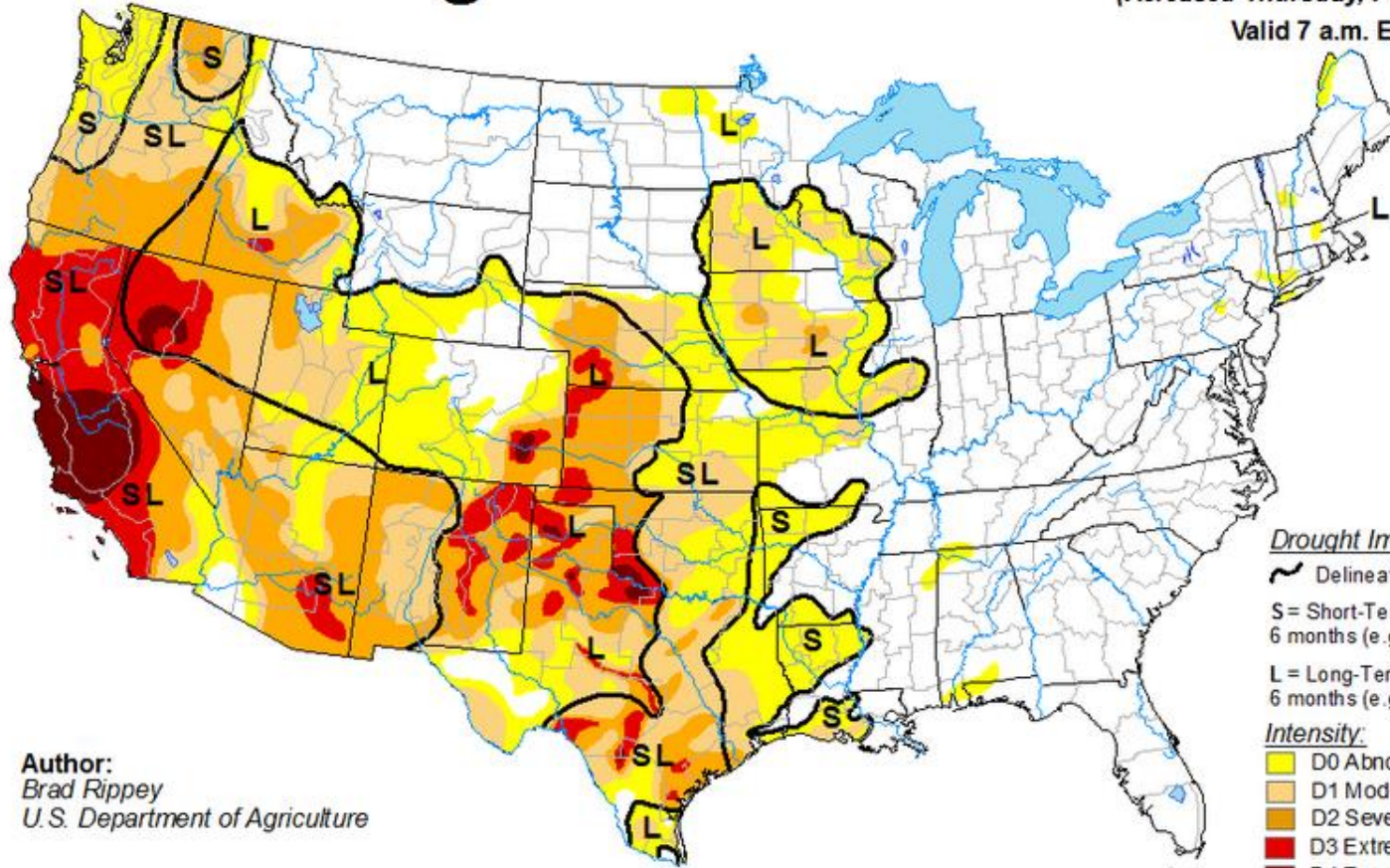
The current US Drought Monitor

U.S. Drought Monitor

February 25, 2014

(Released Thursday, Feb. 27, 2014)

Valid 7 a.m. EST



Author:
Brad Rippey
U.S. Department of Agriculture

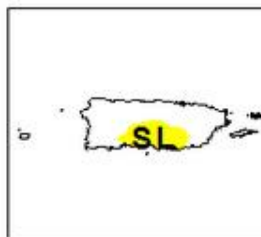
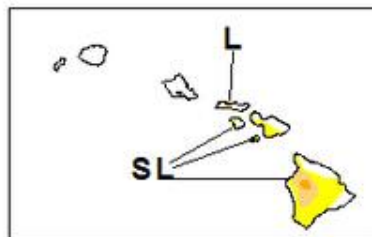
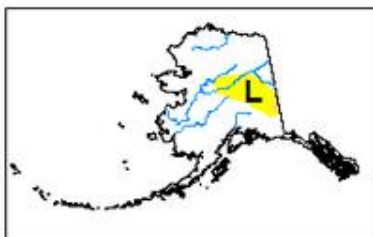
Drought Impact Types:

- ~ Delineates dominant impacts
- S = Short-Term, typically less than 6 months (e.g. agriculture, grasslands)
- L = Long-Term, typically greater than 6 months (e.g. hydrology, ecology)

Intensity:

- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.



<http://droughtmonitor.unl.edu/>

Saving water: some general recommendations

- 1) Control weeds.
- 2) Maintain irrigation system and try to improve uniformity.
- 3) Use a pressure chamber to identify areas of severe stress and adjust your irrigation approach before these areas become a problem.

Recommendations specific to almonds:

- 1) No evidence that heavy pruning or kaolin/whitewash sprays do any economic good to mitigate drought conditions.
- 2) Mild to moderate stress at the start of hull split is a good idea to speed up hull split and reduce hull rot.

An issue we don't have much (any?) data on:
The need for WINTER IRRIGATION

THE
Agricultural Journal
OF THE CAPE OF GOOD HOPE.

No. 6.

JUNE, 1907.

VOL. XXX.

Published Monthly in English and Dutch by the Department of Agriculture and distributed gratis to bona fide farmers in the Cape Colony on application through the Resident Magistrate of the District.

Winter Irrigation of Fruit Trees.

“They require only so much moisture from the ground as may serve to keep their tissues in a normal healthy state, and prevent mischief or death by their younger parts transpiring more than they receive.”

(E.P., 1907).

SACRAMENTO VALLEY WALNUT NEWS

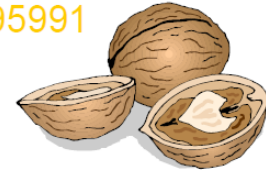


A Regional Newsletter of the UC Cooperative Extension Walnut Farm Advisors

Sutter/Yuba UCCE, 142A Garden Highway, Yuba City CA 95991

Tel: (530) 822-7515, Fax: (530) 673-5368

<http://cesutter.ucdavis.edu/> or
cesutteryuba@ucdavis.edu



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Issue 4: Winter 2008/2009

Winter Irrigation During Drought

Joseph H. Connell, UC Farm Advisor, Butte Co.

We know that during the winter months walnuts can be hurt by either too much or too little water. ...Cutting back on water earlier in the fall slows down the trees growth and helps harden them off. However, drought conditions during winter can make winter kill worse if we get cold temperatures as discussed in Carolyn DeBuse's article on winter freeze injury.

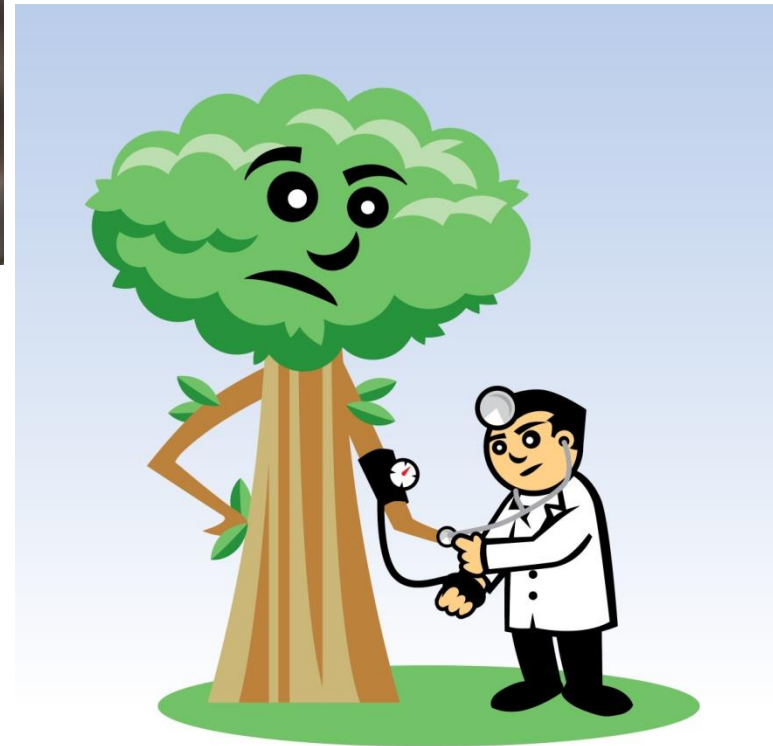
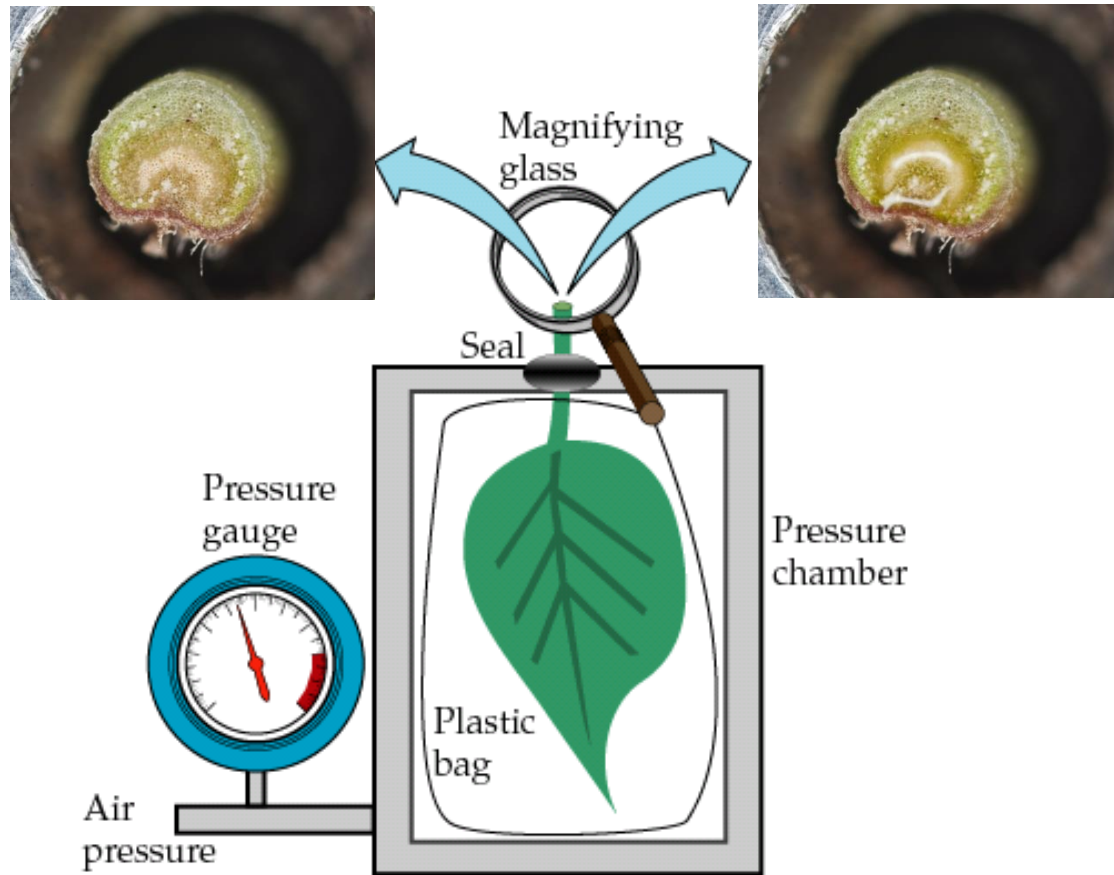
...The ultimate goal is to make sure the soil reservoir is completely refilled either by rain or winter irrigations by the time your walnut trees begin to wake up next March.

Pressure chamber method for measuring water stress

Like measuring the
“blood pressure” of the
plant

Below
balance
point

Above
balance
point





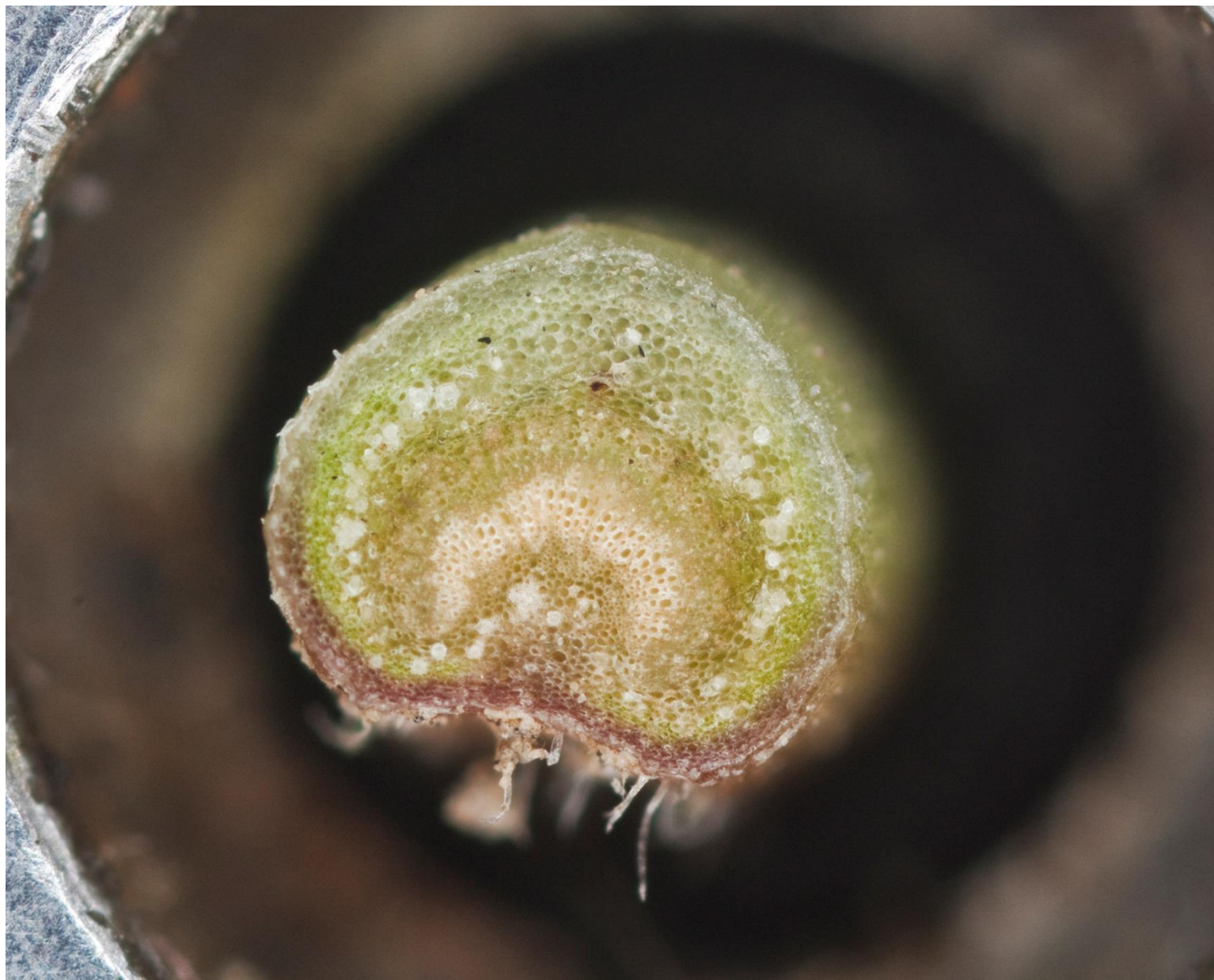
Stem Water Potential (SWP)















<http://www.chlorofilms.org/index.php/crpVideo/display/videoId/27>



Pressure Chamber Reading (- bars)	WALNUT
0 to -2.0	Not commonly observed
-2.0 to -4.0	Fully irrigated, low stress, commonly observed when orchards are irrigated according to estimates of real-time evapotranspiration (ETc), long term root and tree health may be a concern, especially on California Black rootstock.
-4.0 to -6.0	Low to mild stress, high rate of shoot growth visible, suggested level from leaf-out until mid June when nut sizing is completed.
-6.0 to -8.0	Mild to moderate stress, shoot growth in non-bearing and bearing trees has been observed to decline. These levels do not appear to affect kernel development.
-8.0 to -10.0	Moderate to high stress, shoot growth in non-bearing trees may stop, nut sizing may be reduced in bearing trees and bud development for next season may be negatively affected.
-10.0 to -12.0	High stress, temporary wilting of leaves has been observed. New shoot growth may be sparse or absent and some defoliation may be evident. Nut size likely to be reduced.
-12.0 to -14.0	Relative high levels of stress, moderate to severe defoliation, should be avoided.

Walnut canopy development effects

Midday light interception (%)

Over 8 years

minimal
-5 bars

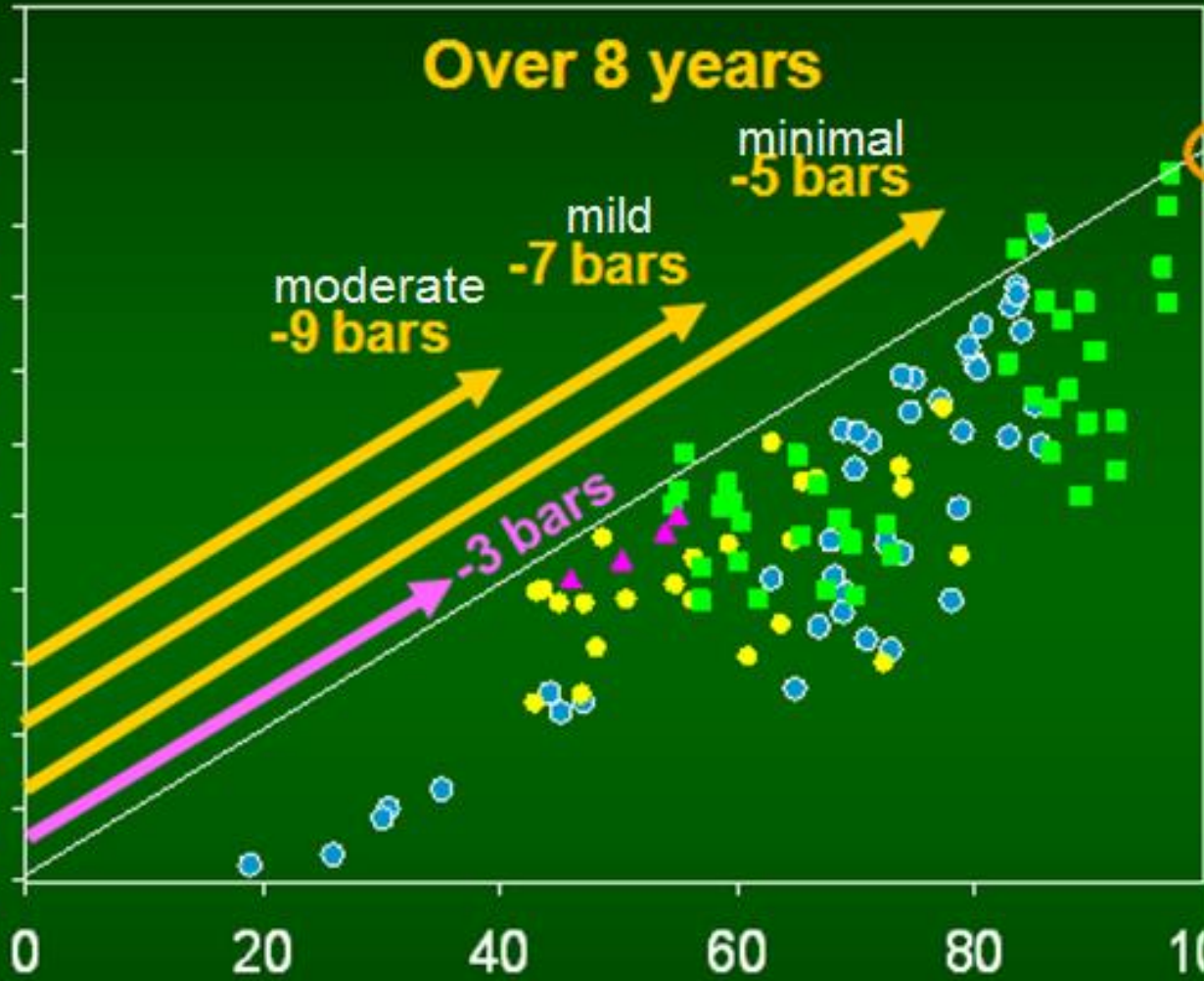
mild
-7 bars

moderate
-9 bars

-3 bars

Kernel yield (lbs/acre)

6000
5500
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0



Walnut yield (tons/acre)

6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0

Midday light interception (%)

Resources to help with the pressure chamber

New 'baseline' website:

http://informatics.plantsciences.ucdavis.edu/Brooke_Jacobs/index.php

Irrigation Scheduling Using Stem Water Potential (SWP) Measurements



HOMEINTRODUCTIONDATA INTERPRETATIONMODEL DETAILSWEATHER MODELSPRINT

Calculating Stem Water Potential

In the box below select the CIMIS [weather station](#) closest to your orchard, or with the most similar climatic conditions. The map on the right can be used to zoom in on individual locations to help [select the best](#) station to calculate reference water potential. After selecting the appropriate station enter the date (within one week) and the time of pressure chamber readings. Temperature, relative humidity, and reference water potential values for almond, prune, walnut, and grape (both SWP and LWP) are displayed.

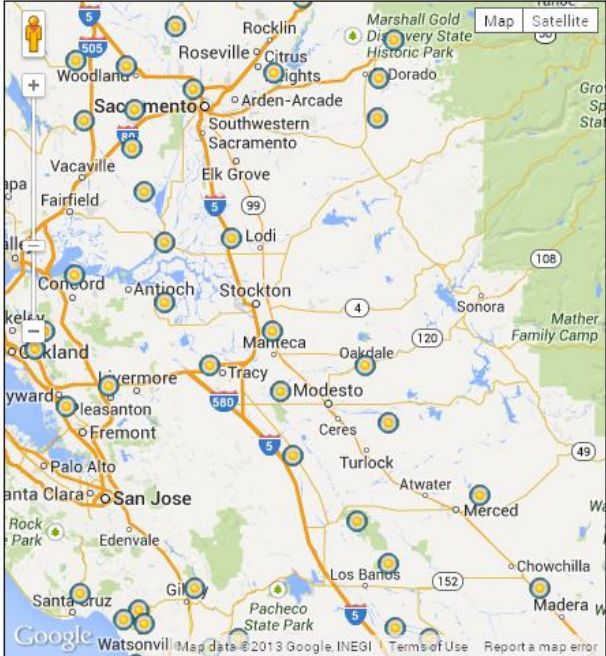
After selecting the appropriate station enter the date (must be within one week of the current date) and the time of [pressure chamber](#) readings. *Pacific standard time is used, subtract one hour from daylight savings time.*

Active station:

Date/Time:

update

CIMIS Weather Stations



Resources to help with the pressure chamber

New 'baseline' website:

http://informatics.plantsciences.ucdavis.edu/Brooke_Jacobs/index.php

Active station: ▼

Date/Time: ▼ ▼

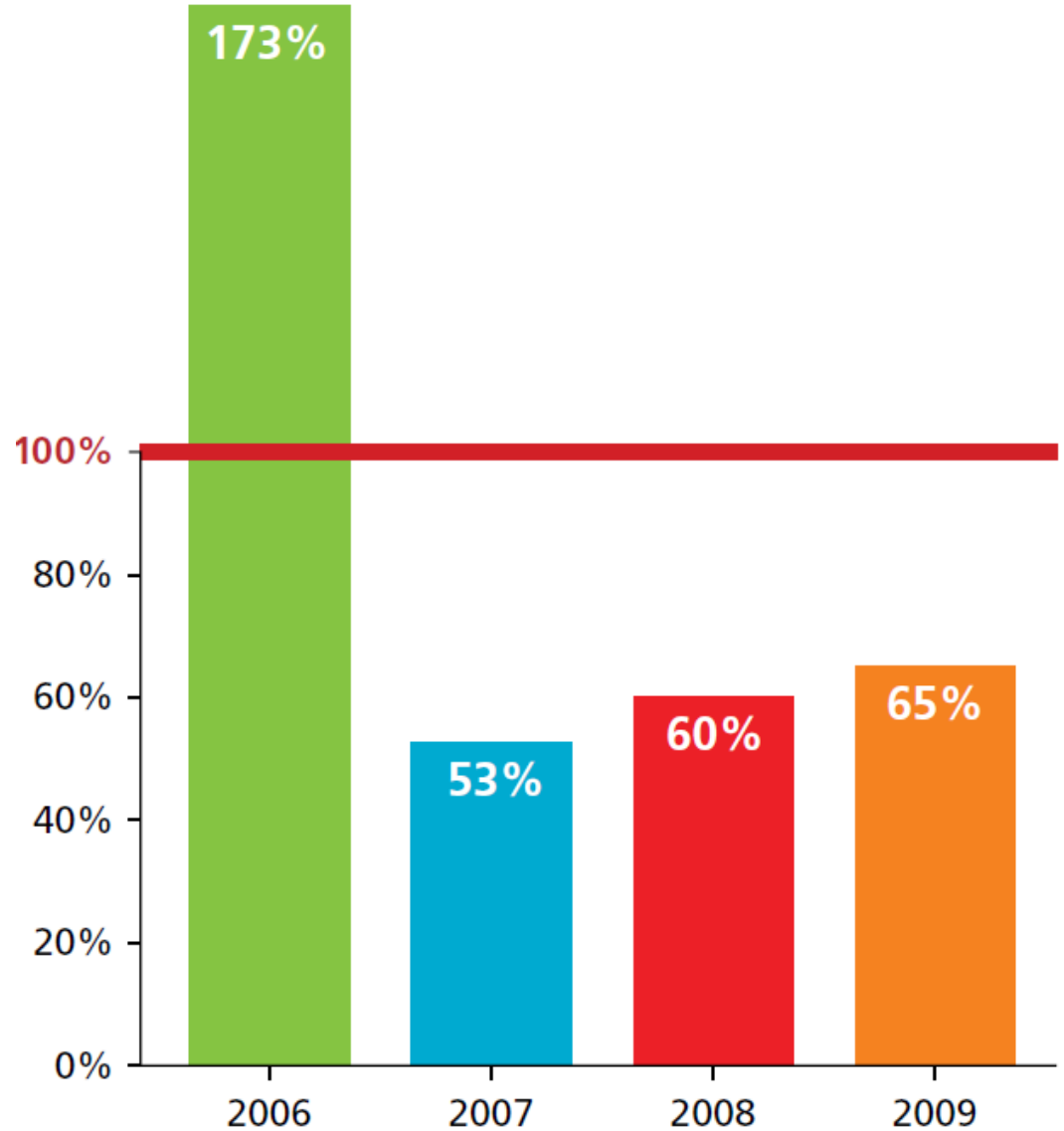


Time	Temperature (F)	Relative humidity	Almond/Prune	Walnut	Grape(SWP)	Grape(LWP)
12:00 PM	60.1	33.0	-5.5	-3.5	-3.1	-5.8
1:00 PM	63.5	27.0	-5.9	-3.7	-3.3	-6.1
2:00 PM	65.7	25.0	-6.0	-3.8	-3.4	-6.2
3:00 PM	67.7	24.0	-6.2	-3.9	-3.5	-6.3
4:00 PM	68.6	25.0	-6.2	-3.9	-3.5	-6.3

The drought of 2007-2009

(source: DWR 2010 report)

Percent of statewide
average runoff

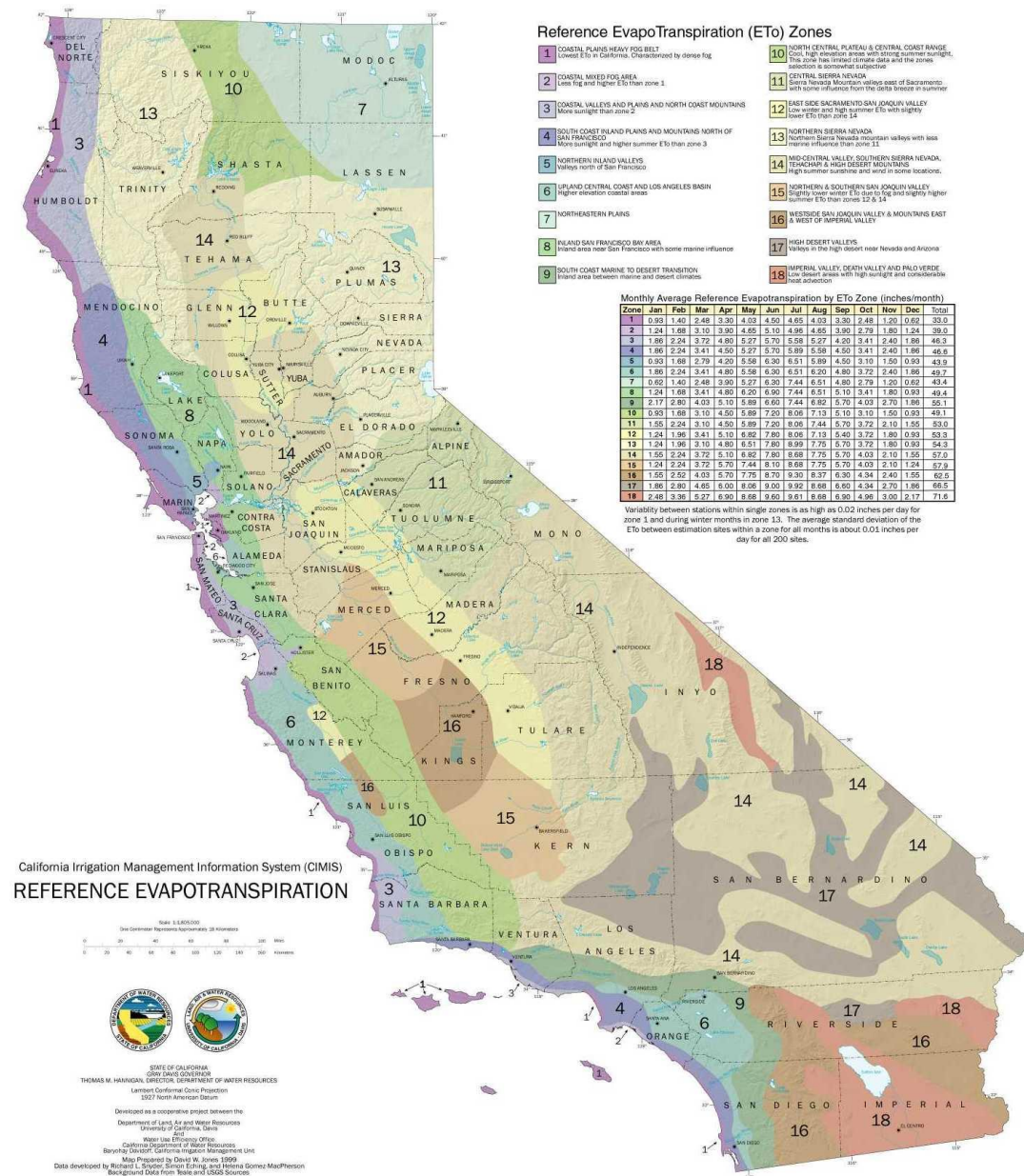


In California, “drought” means low winter rains.
We always have dry summers!

Almond “full” ETc (inches per month) for two locations
in a wet year (2006) and a dry year (2007)

Month	Tehama		Kings	
	2006 (Wet year)	2007 (Dry year)	2006 (Wet year)	2007 (Dry year)
Feb	1.0	0.7	1.1	0.9
Mar	1.6	2.5	1.8	2.7
Apr	3.2	4.0	3.4	4.2
May	6.5	7.1	6.6	7.1
June	8.4	8.9	8.0	8.3
July	9.4	8.9	8.6	8.5
Aug	8.0	8.3	8.0	7.9
Sep	6.1	5.5	5.9	5.8
Oct	3.8	3.2	3.1	3.3
Nov	0.9	1.8	1.3	1.6
Total	48.9	50.9	47.8	50.3

Start your plan using 'average' year values

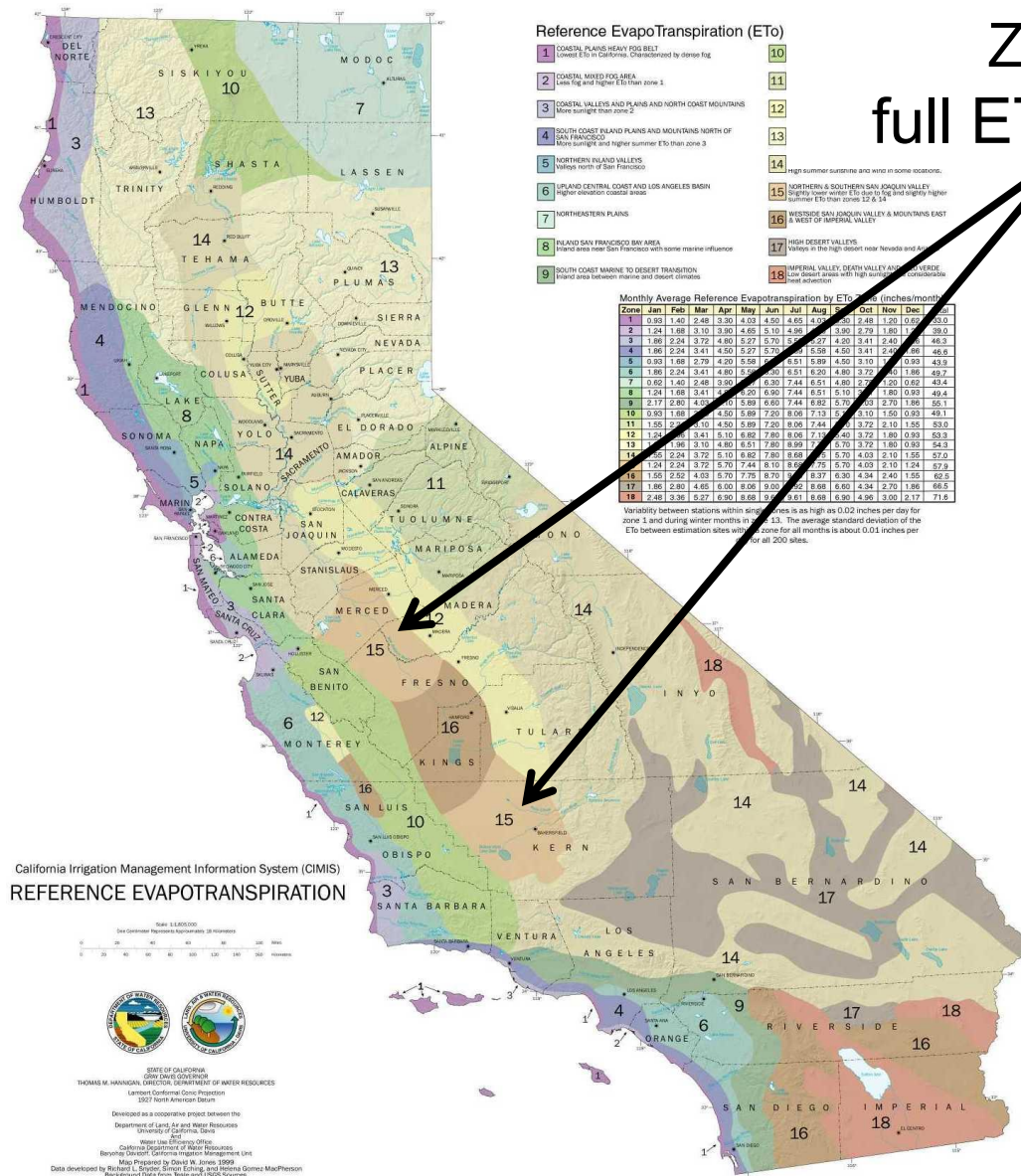


Reference ET (ET_o) map
from DWR
<http://wwwcimis.water.ca.gov>

“BASIC IRRIGATION
SCHEDULING (BIS)” excel file
from
http://biomet.ucdavis.edu/irrigation_scheduling/bis/BIS.htm

Apply the same % of full ET across the season to reach your target total

Zone 15:
full ET total = 53"



Month	Full ET		70% ET
	"/week	Hr/wk*	Hr/wk
Feb	0.25	6	4
Mar	0.60	14	10
Apr	1.15	28	19
May	1.78	43	30
June	2.15	52	36
July	2.40	58	40
Aug	2.15	52	36
Sep	1.50	36	25
Oct	0.90	22	15
Nov	0.35	8	6
Dec	0.13	3	2
Season Total		53"	37"

* At 1"/24h

Simple approach to drought (i.e., a fixed level of deficit all season)

Month	NORMAL	70%
	Hr/wk	Hr/wk
Feb	6	4
Mar	14	10
Apr	28	19
May	43	30
Jun	52	36
Jul	58	40
Aug	52	36
Sep	36	25
Oct	22	15
Nov	8	6
Dec	3	2

Practical issues that may impact the simple approach

- 1) Frost protection?
(might allow later start of irrigation in spring)
- 2) Lack of flexibility in water deliveries, run times, or run days?
(may cause feast/famine problems)
- 3) Salinity management?

3 arguments against a 'simple approach'

1) What about 'stress sensitive' stages?

- bloom?
- post harvest?

2) Am I 'wasting water' if I just give small amounts?

3) Don't I need to maintain irrigation at 100% ET early on to avoid the depletion of deep soil water?

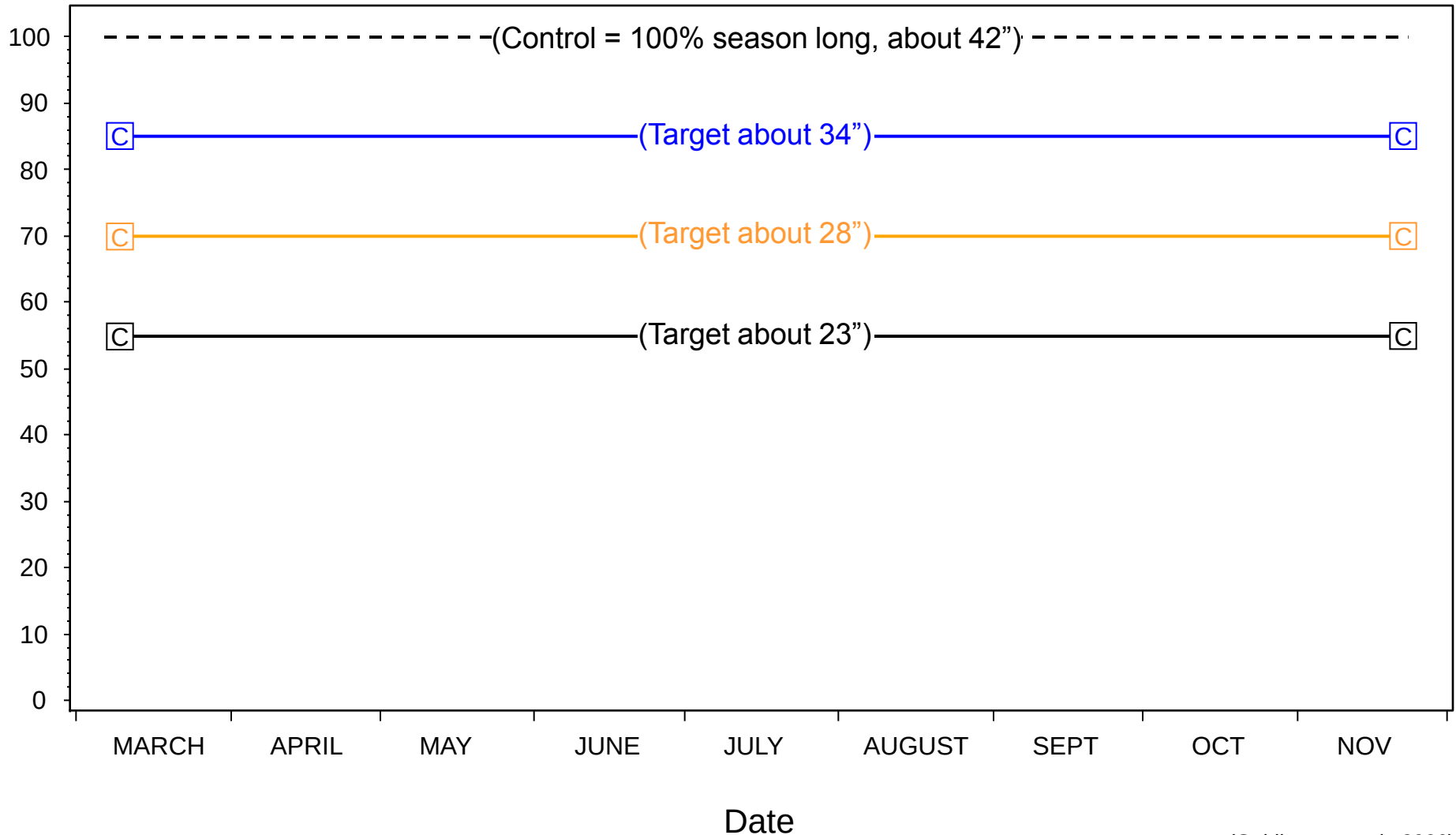
(Specific to cherry: the importance of fruit sizing coupled with a long postharvest period probably means that deficit irrigation should probably focus on the postharvest period)

1) Stress sensitive stages in Almond?

- 1993 -1996 study (Goldhamer et al, 2006), Southern SJV, 18 year-old orchard
- 3' root zone, 7.5" average rainfall during study (no pre-irrigation)
- Control (100% Etc = 42")
- 3 levels of irrigation deficit (34", 28", 23") (80%, 67%, 55%)
- 3 patterns of deficit   

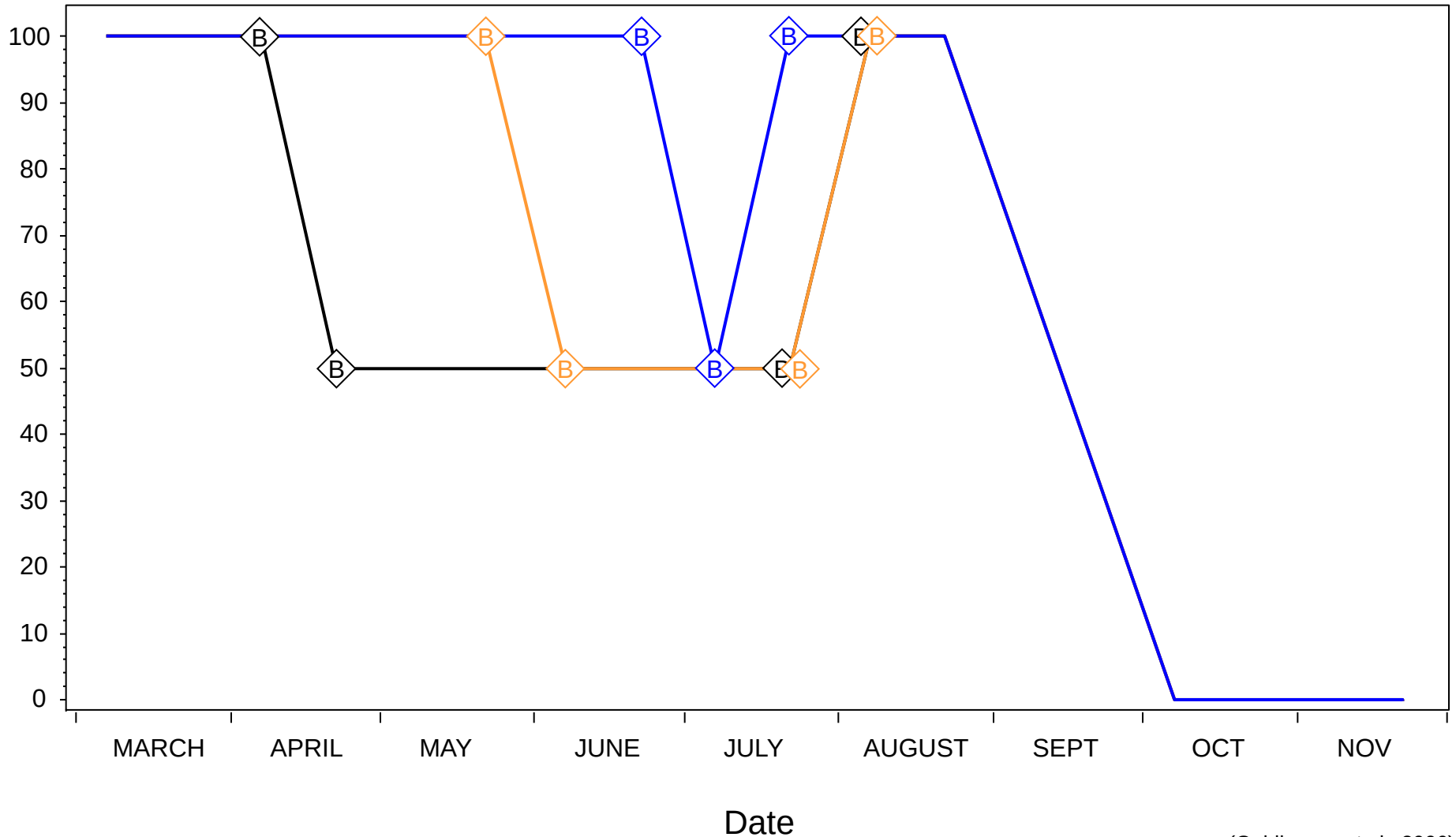
1) Stress sensitive stages in Almond?

“C” pattern: Equal irrigation deficit all season



1) Stress sensitive stages in Almond?

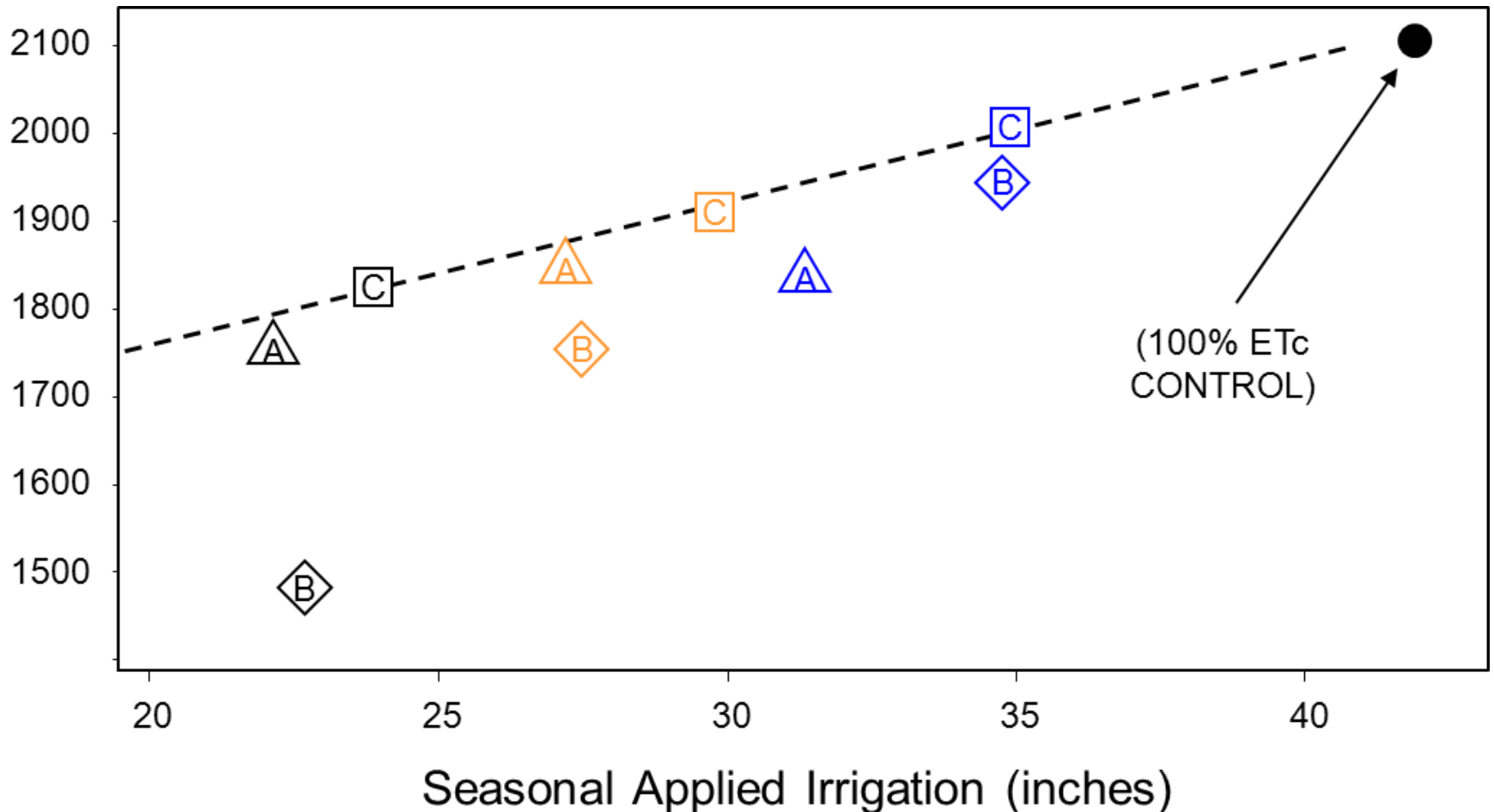
“B” pattern: Some deficit early, most deficit post-harvest



1) Stress sensitive stages in Almond?

Mean Kernel Yield (lbs/ac) 1993-1996

An **even deficit** over the season always gave the best result



2 & 3) Wasting water & deep moisture?

1 year almond drought study,
2009

Water from			
Irrigation	Rain	Soil	Total
0"	2.1"	5.5"	7.6"
3.6"	2.1"	6.7"	12.4"
7.2"	2.1"	5.9"	15.2"
30.8"	2.1"	(?)	(32.9")

A small amount of irrigation (3.6") spread evenly over the season resulted in **more use** of deep water than did **no irrigation**.





June 29, 2009

Control tree

- 9 bars SWP



June 29, 2009

10" tree

- 25 bars SWP



June 29, 2009

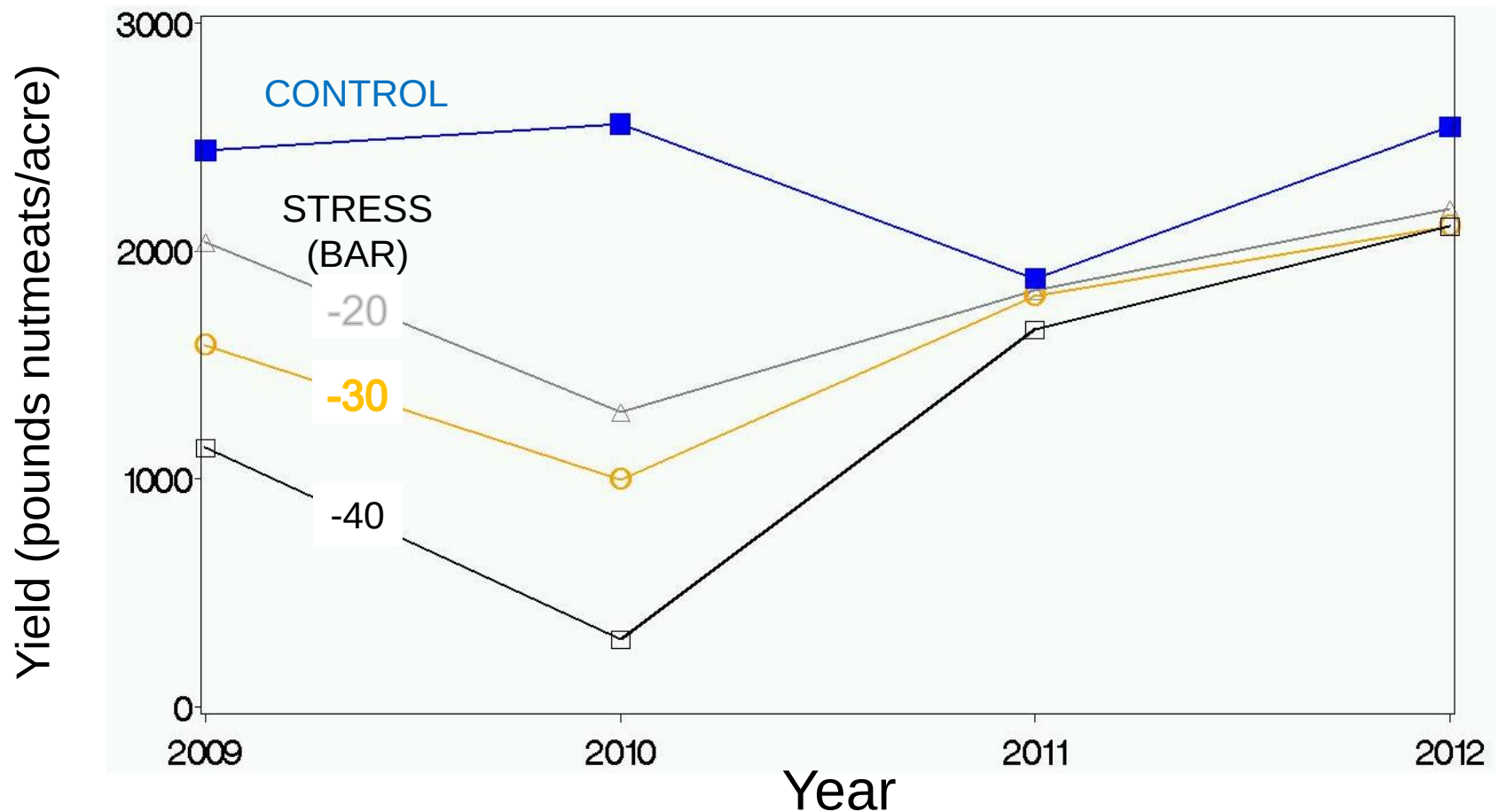
0" tree

- 40 bars SWP



**This tree had
reached -63
bars on July
14, 2009, and
by July 28
was
completely
defoliated.
But notably,
did not die!**

Yield: The biggest reduction occurred in the year following the stress (i.e. carryover effect)



Example of field variability in a hull rot deficit irrigation test



Bottom line - conclusions

- 1) Control weeds, maintain irrigation system and irrigate at a proportion of 'normal' (best to use full ET_c as 'normal') throughout the season.
- 2) Under deficit irrigation, expect to see differences due to soils.
- 3) Use the pressure chamber to determine when to start irrigating (tentative: wait for at or below baseline values before starting) and for 'early warning' from soils which will present a significant problem later on.
- 4) Expect a reduced nut/fruit size this year, and reduced bloom and set next year, depending on the degree of deficit.

**Thanks for your attention, and thanks to
funding and/or cooperation from:**

**Almond Board of California
USDA-SCRI
Nickels Estate**

Colleagues: Bruce Lampinen, Larry Schwankl,
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Andres Olivos, Gerardo Spinelli, Hector Munoz,
and anybody else I forgot!