

Plant-based Irrigation Management in Walnuts

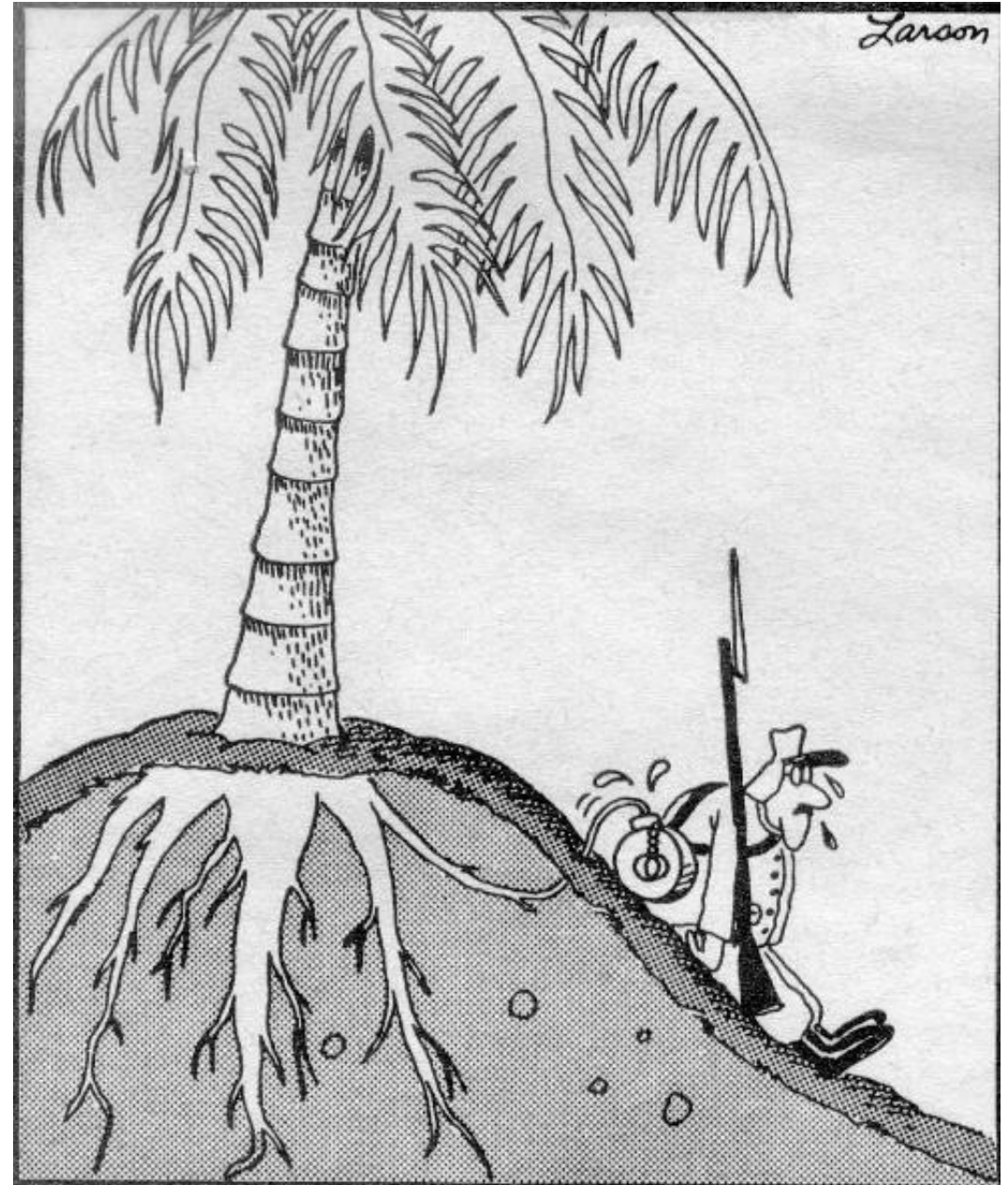
OR:

Don't irrigate when you are stressed, irrigate when the tree tells you that it can use the water.

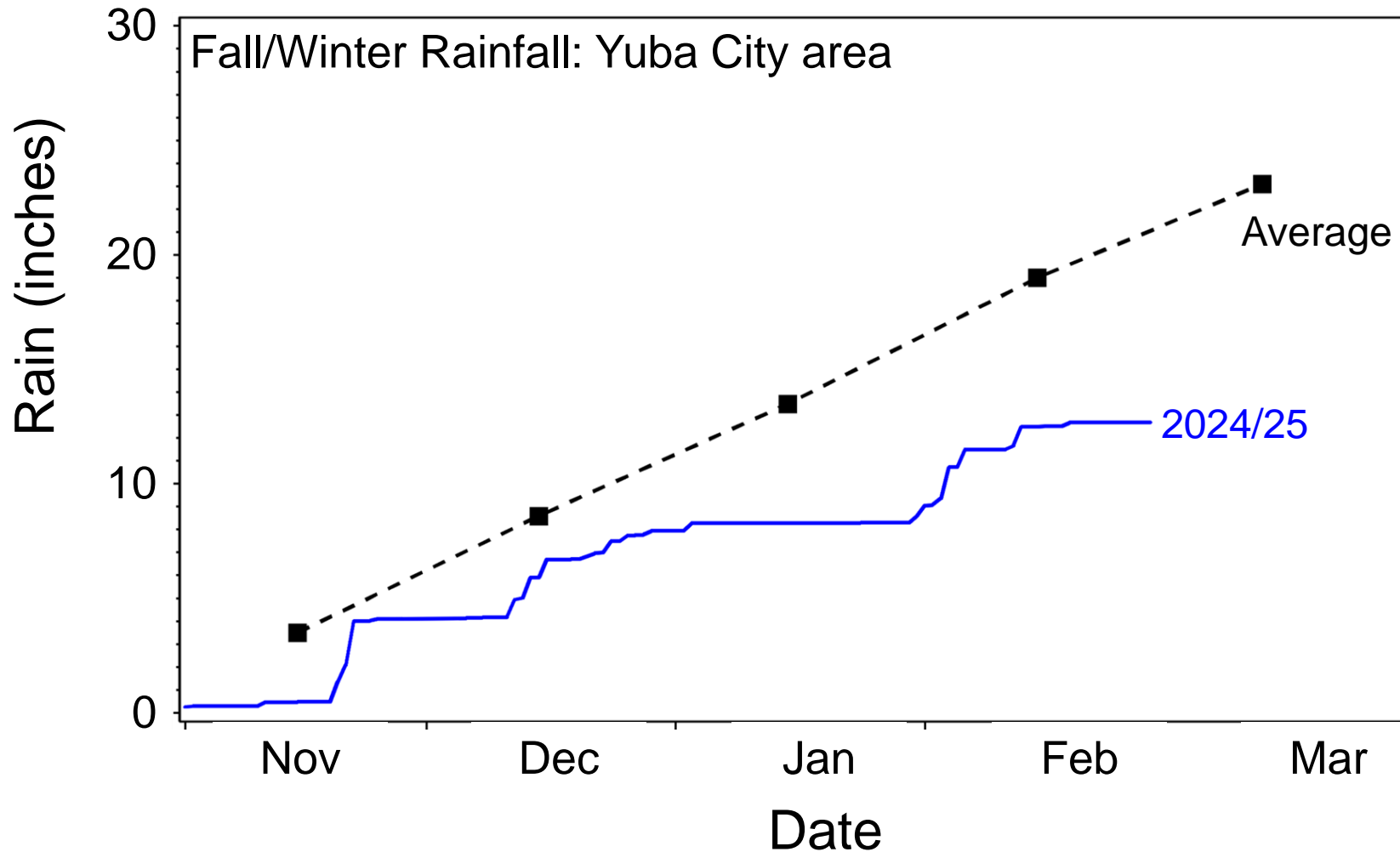
CWB/CWC supported project

Project team:

Ken Shackel, Bruce Lampinen, Allan Fulton,
Hal Crain, Joe Grosskopf, Kat Jarvis-
Shehan, Tony and Mike Turkovich.



Rainfall: where are we so far this year?



Next questions:

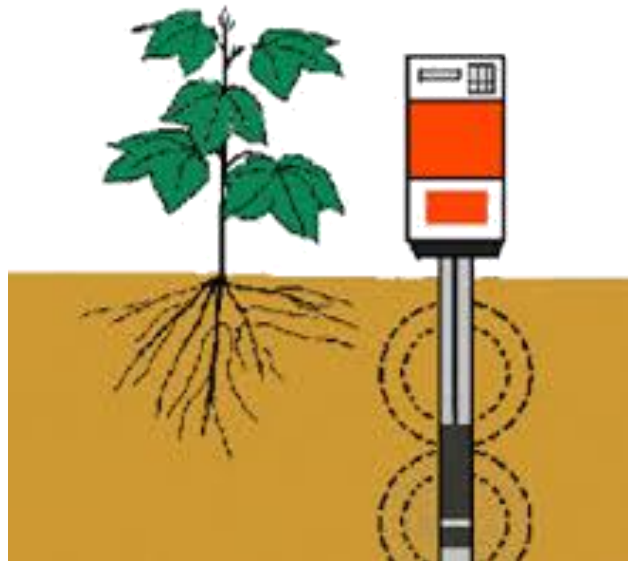
- How much of this rain ran off?
- How much was stored in the soil?
- How deep did it get?
- ...etc.

Checking the soil: Shovel, tensiometer, neutron probe, etc.

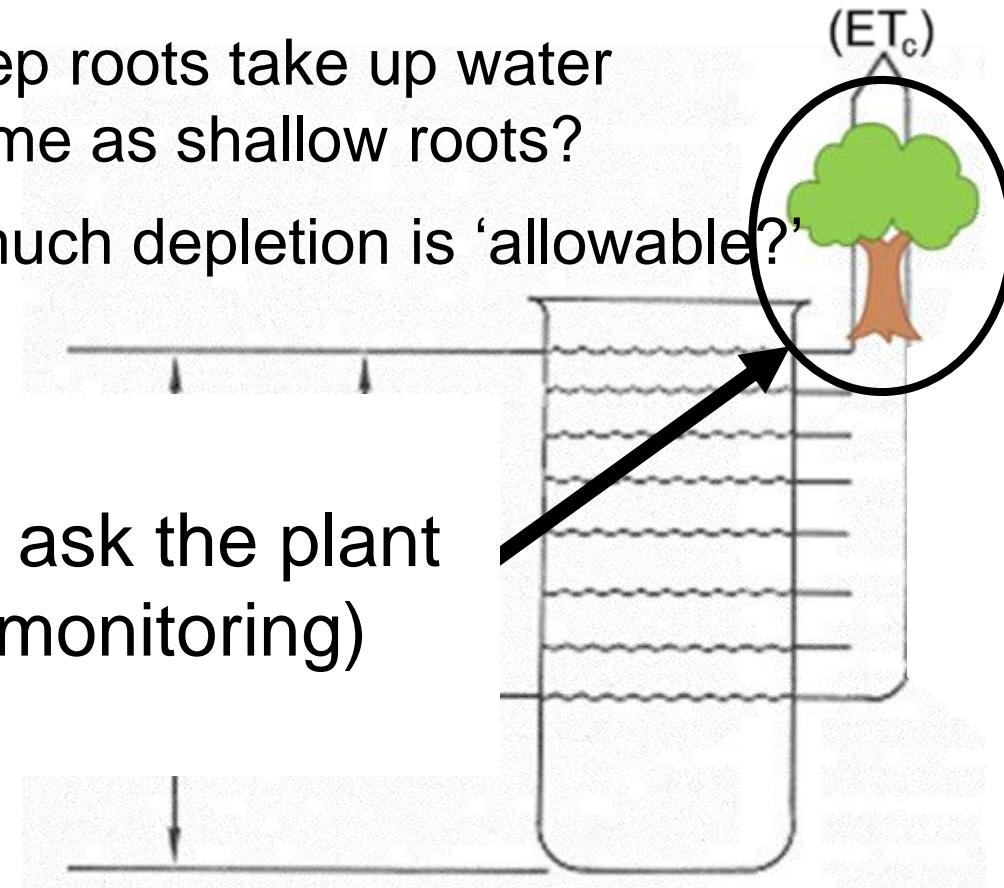


The soil is a reservoir, but this raises further questions:

- Where are the 'active' roots?
- Do deep roots take up water the same as shallow roots?
- How much depletion is 'allowable?'



One solution: ask the plant
(plant-based monitoring)



Everybody's searching for the 'Holy Grail' of plant stress sensors

Diagnosing plant physiological activities and drought stress effects



*In the TV series Star Trek, a tricorder is a handheld scanning and analysis diagnostic device



Image credit: flickr.com/photos/robertodavis

Recent email to me (2/26/25)



Dear Kenneth,

We are excited to personally invite you to our upcoming webinar on March 4th - 16:00 CET: **PLANT DRIVEN VITICULTURE - What are vines teaching us?** Join us for an exclusive one-hour online session where we explore plant electrophysiology and how plant-driven technology helps vineyards optimise water and nutrient use while providing real-time insights into pest and disease pressure. This webinar features leading experts from **JoJo's Vineyard, University of applied Sciences and Arts Western Switzerland, CHANGINS-College for Viticulture and Enology, CREA Italy, and Vivent Biosignals**, who will share insights on the latest advancements in viticulture and plant driven agronomy.

Webinar program:

- **Introduction to plant driven agronomy**
Nigel Wallbridge - **Vivent Biosignals**
- **Challenges and opportunities in viticulture management**
Ian Beecher Jones - **JoJo's Vineyard UK**

[Register for the webinar](#)

MARCH 4TH 2025 - 16:00 CET

Speakers

 Nigel Wallbridge Vivent Biosignals	 Ian Beecher Jones JoJo's Vineyard - UK	 Andrzej Kurenda Vivent Biosignals	 Léo de Riedmatten Vivent Biosignals	 Markus Rienth CHANGINS-College for Viticulture and Enology	 Luca Masiero CREA Italy
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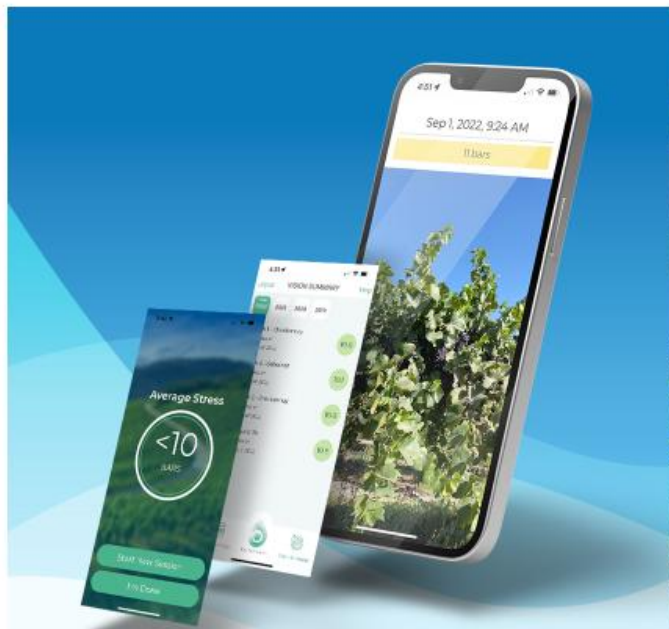
tule + SUZUKI KINGQUAD



TULE VISION

Tule Vision is an iPhone app that allows growers to take and track midday leaf water potential readings anywhere your Suzuki KingQuad will go.





EASY TO USE HOW IT WORKS

Take a look at how you can take leaf water potential readings with an iPhone.

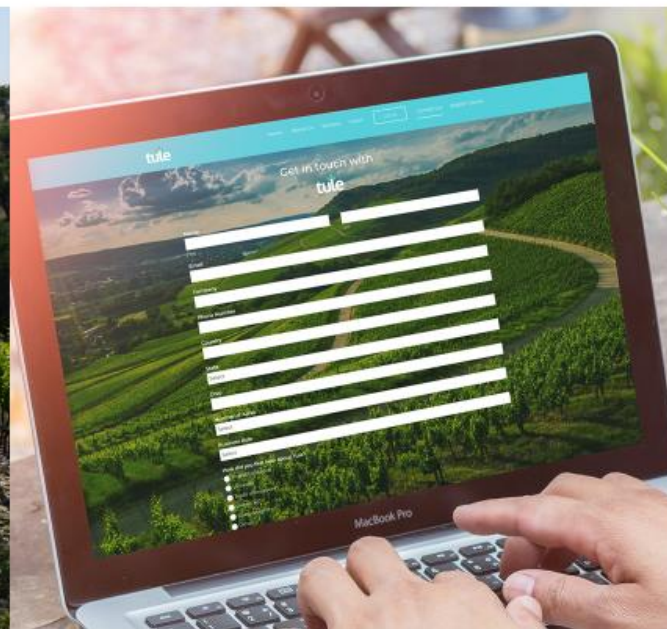
[Watch Now](#) →



HEAR FROM THE GROWERS

Vineyard professionals use Tule Vision to manage water during drought.

[Watch Now](#) →



GET STARTED WITH TULE VISION

Contact us to receive more information on the app.

[Go Now](#) →

GO ANYWHERE
DO ANYTHING



Toro Ag Launches Transpira™ to Deliver New Insights to Growers

Toro Transpira leverages direct plant sensing technology to measure plant water consumption.

Feb 22, 2023 | [Agriculture](#)

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EL CAJON, Calif. (Feb. 20, 2023) – Toro Ag is excited to introduce Toro® Transpira™ – a new platform for measuring plant water consumption via direct plant sensing. Through a collaboration with technology partner Treetoscope Ltd, Toro brings state of the art technology to growers across the United States, Canada, and Mexico. Toro Transpira adds to the company’s growing range of crop monitoring, decision support and automation solutions, meeting an increasing need for reliable and actionable information on crop water usage and plant health.

“With Toro Transpira, we are measuring what matters,” says Adam Setzler, product manager for Toro’s Ag Business. “What makes the application of this technology unique is that we are measuring water usage directly from the plant using a device that is simple to install and manage. This provides growers with a view of the evapotranspiration process in their field that is not available from other monitoring tools on the market.”

Advantages of Toro Transpira include:

- Actionable information on irrigation demand via direct sensing of plant water uptake.
- Easy-to-read output in inches of water, delivered through a simple, concise dashboard.
- Hassle-free installation completed in minutes with basic tools.
- No need for sensor calibration or maintenance.
- Affordable technology with minimal hardware.
- Trusted results validated by leading agricultural research institutions.

The Toro Transpira platform consists of a compact sensor that is installed into a tree or vine by drilling a small pilot hole into the trunk and inserting the sensor probe. The device periodically transmits data to a cloud-based platform where it is converted into measurements of plant water consumption. Farmers then access this information through a simple dashboard via a mobile device or web browser.



Treetoscope (Israeli)



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April 22, 2016

Every drop counts

Inspired by the actions of one man in India, we explain how Yara is doing our part to optimize global water usage

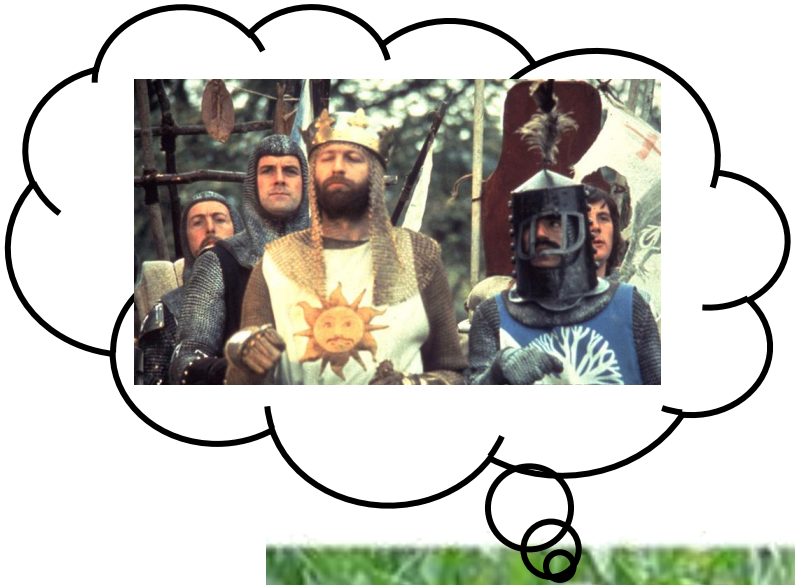


Inspired by the actions of one man in India, we explain how Yara is doing our part to optimize global water usage



The Yara ZIM-system consists of two little magnets clamped against each other onto the leaf.

Pressure chamber/bomb



Walnuts: poster child for a tree that ‘needs a lot of water’
(i.e., is very sensitive to dry soil conditions).

Walnut orchard near Red Bluff,
CA. (Tehama Co., deep, well-
drained sandy-loam soil near the
Sacramento river).

Key grower concern at this
location: trees looked stressed
when irrigation was discontinued
for harvest.

Q: Should we irrigate more in-
season, so the trees have a bigger
‘bank account’ of soil water to
carry them through harvest?



Concerns about starting too early in walnuts:

- Darker kernels (in Howard)
- Leaf symptoms



Late Maturity and Excess Irrigation Trigger Kernel Darkening in 'Howard' English Walnut (*Juglans regia* L.) at Harvest, but not in 'Chandler'

RIKA P. FIELDS¹, IRWIN RONALDO DONIS-GONZALEZ², BRUCE LAMPINEN¹, AND CARLOS H. CRISOSTO¹

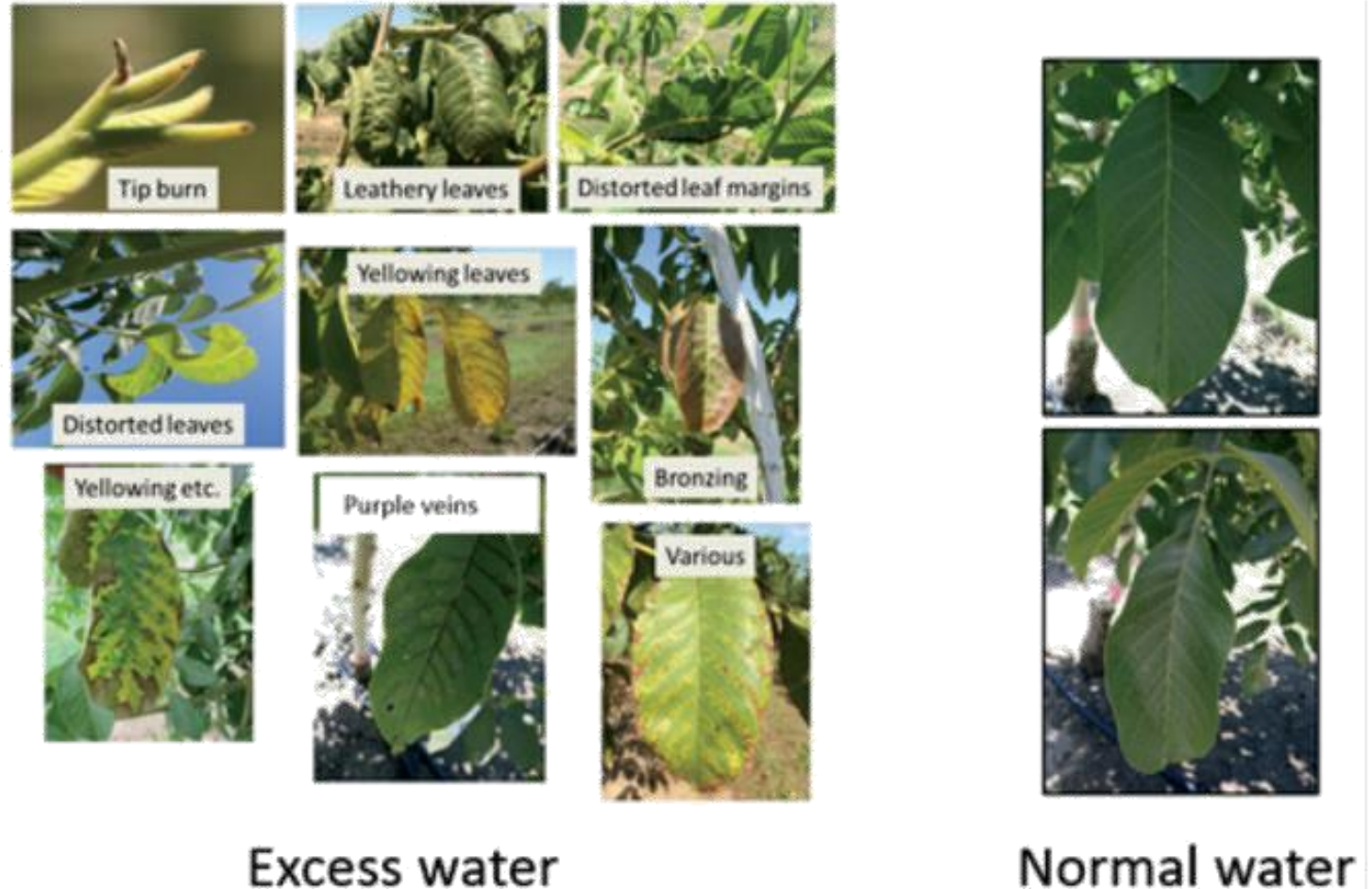
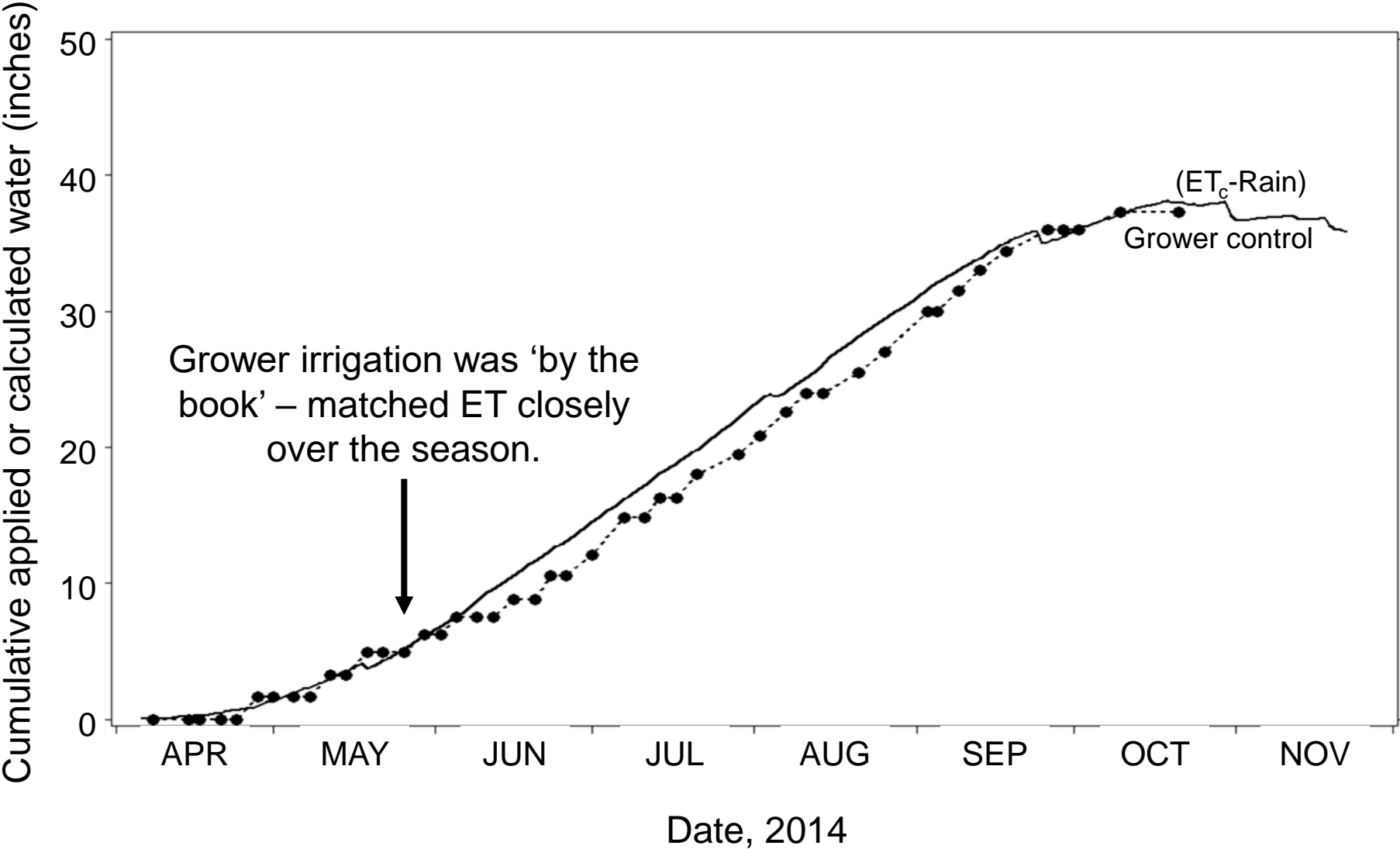


Fig. 6. Trees irrigated to near or wetter than the baseline through the early part of summer developed leaf damage symptoms including yellow leaves, leaf tip burn, and marginal browning of leaves.

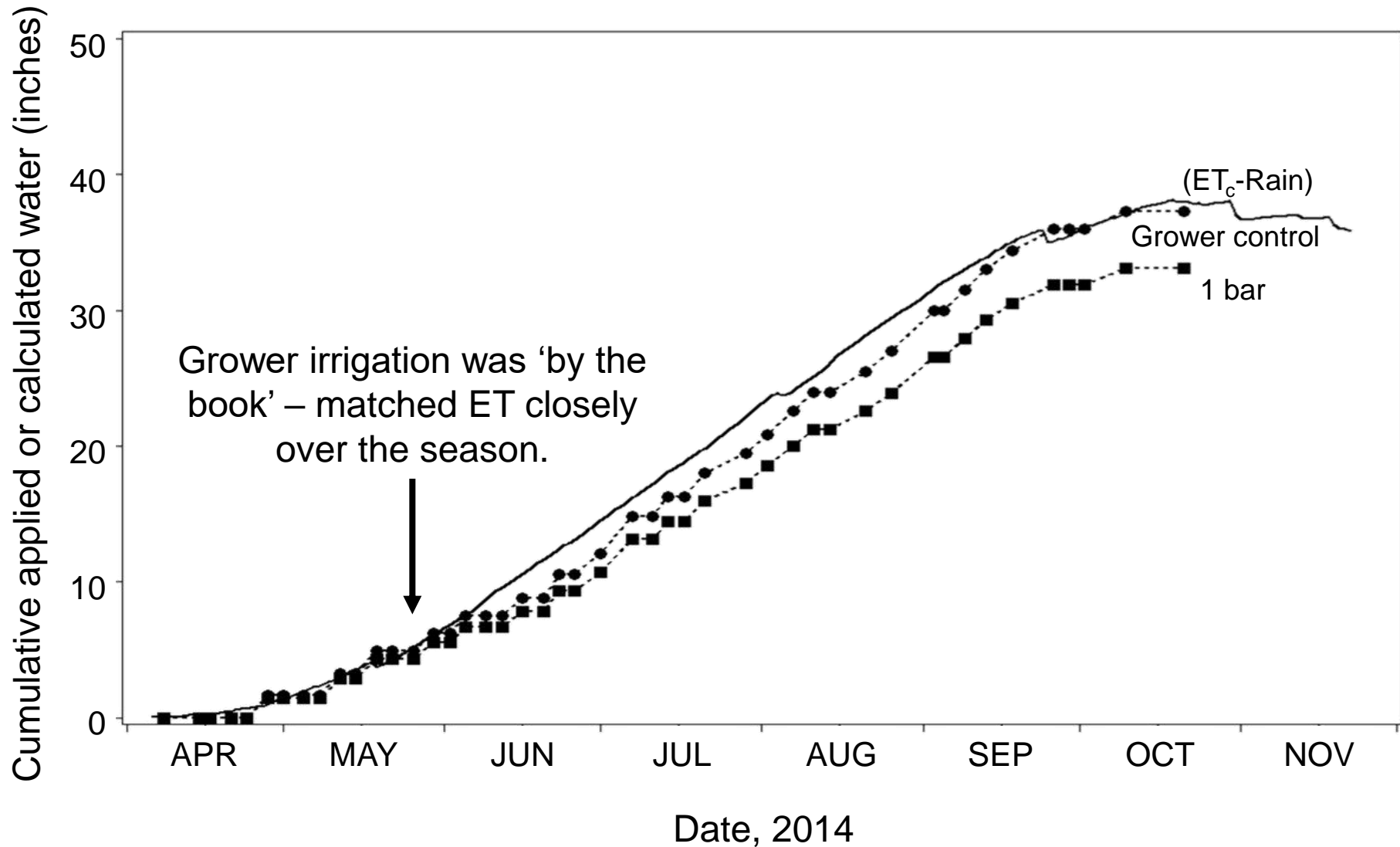
The Beginning: Tehama, 2014

Applied irrigation compared to irrigation demand (ET_c -Rain)



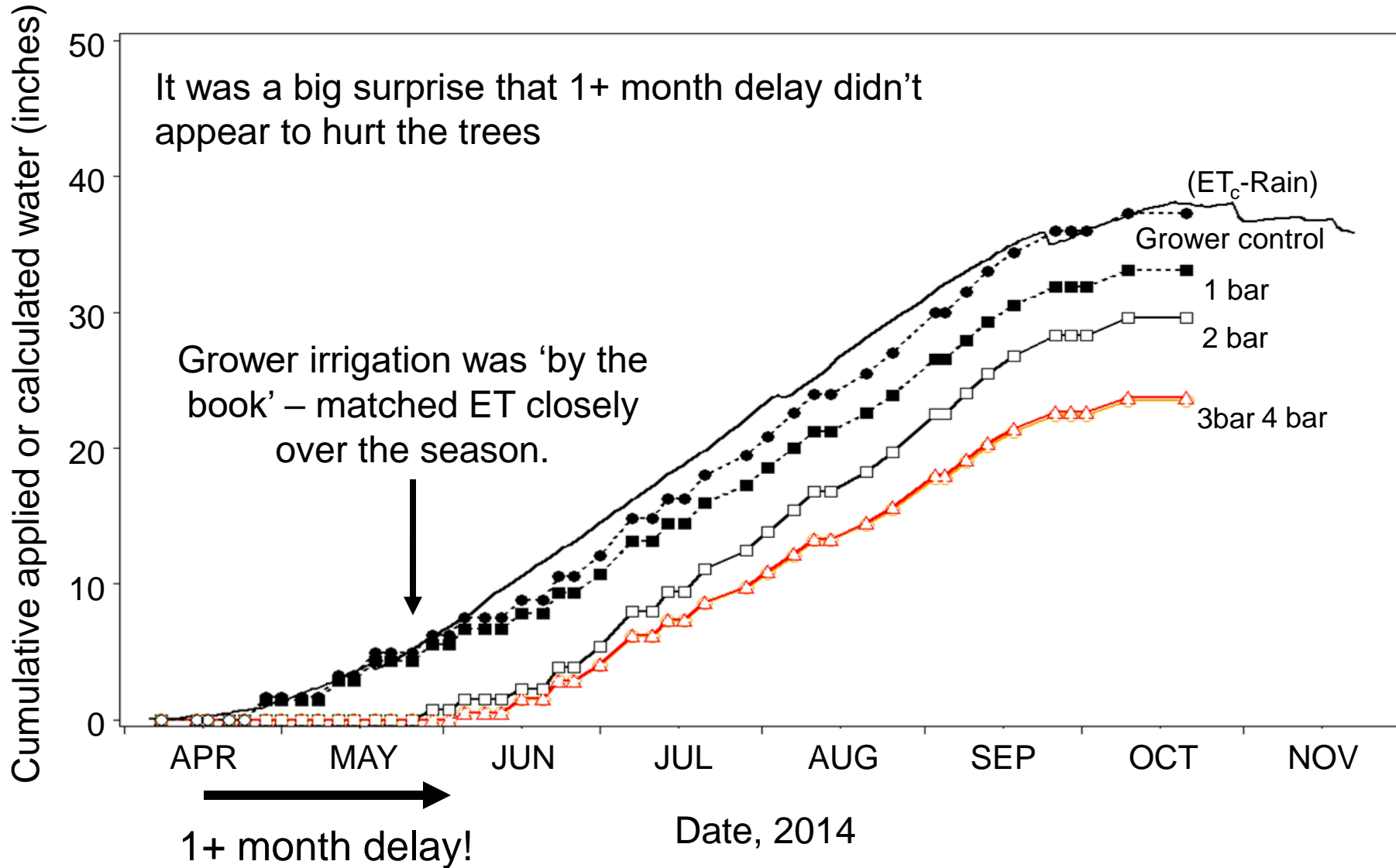
The Beginning: Tehama, 2014

Applied irrigation compared to irrigation demand (ET_c -Rain)



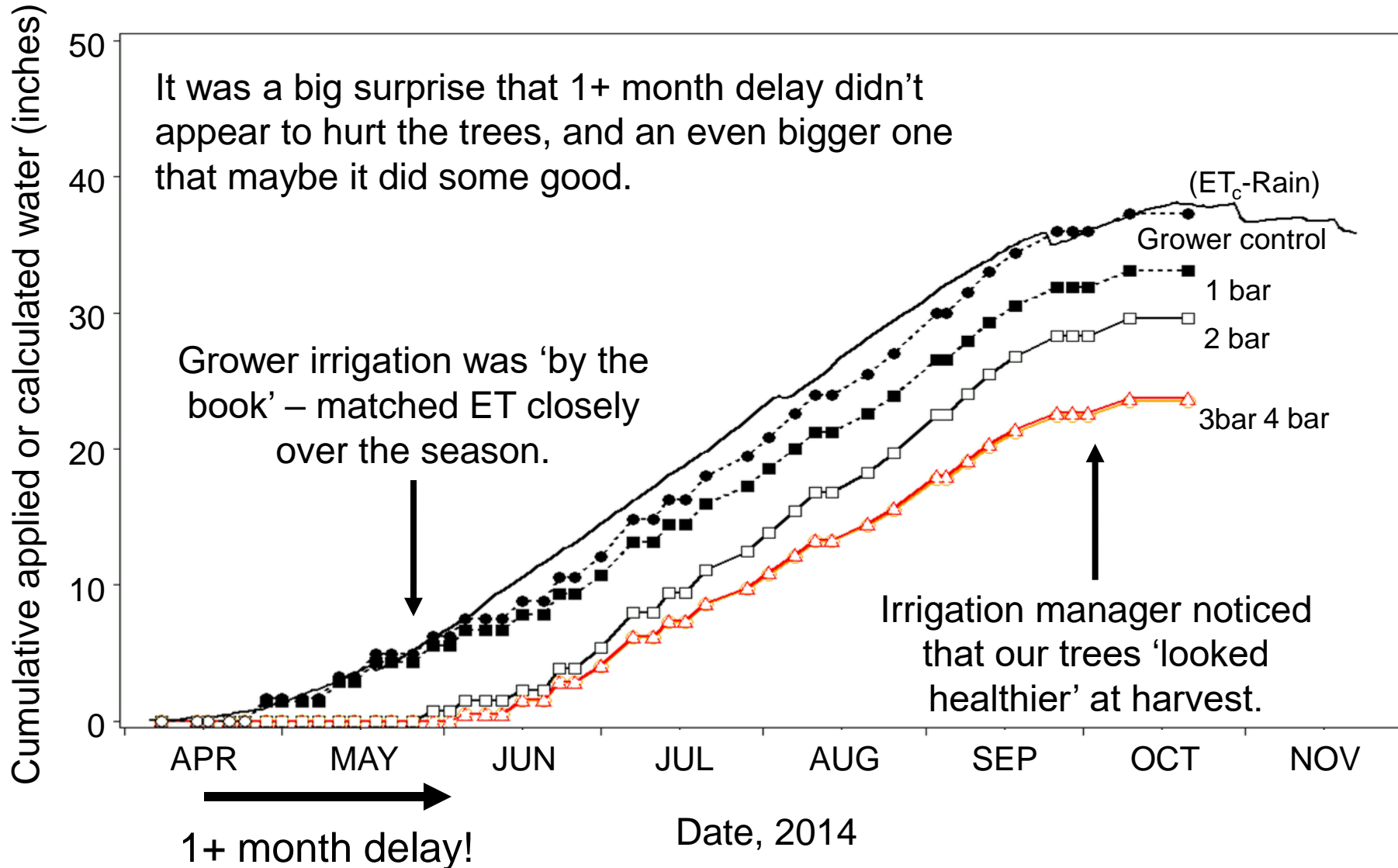
The Beginning: Tehama, 2014

Applied irrigation compared to irrigation demand (ET_c -Rain)



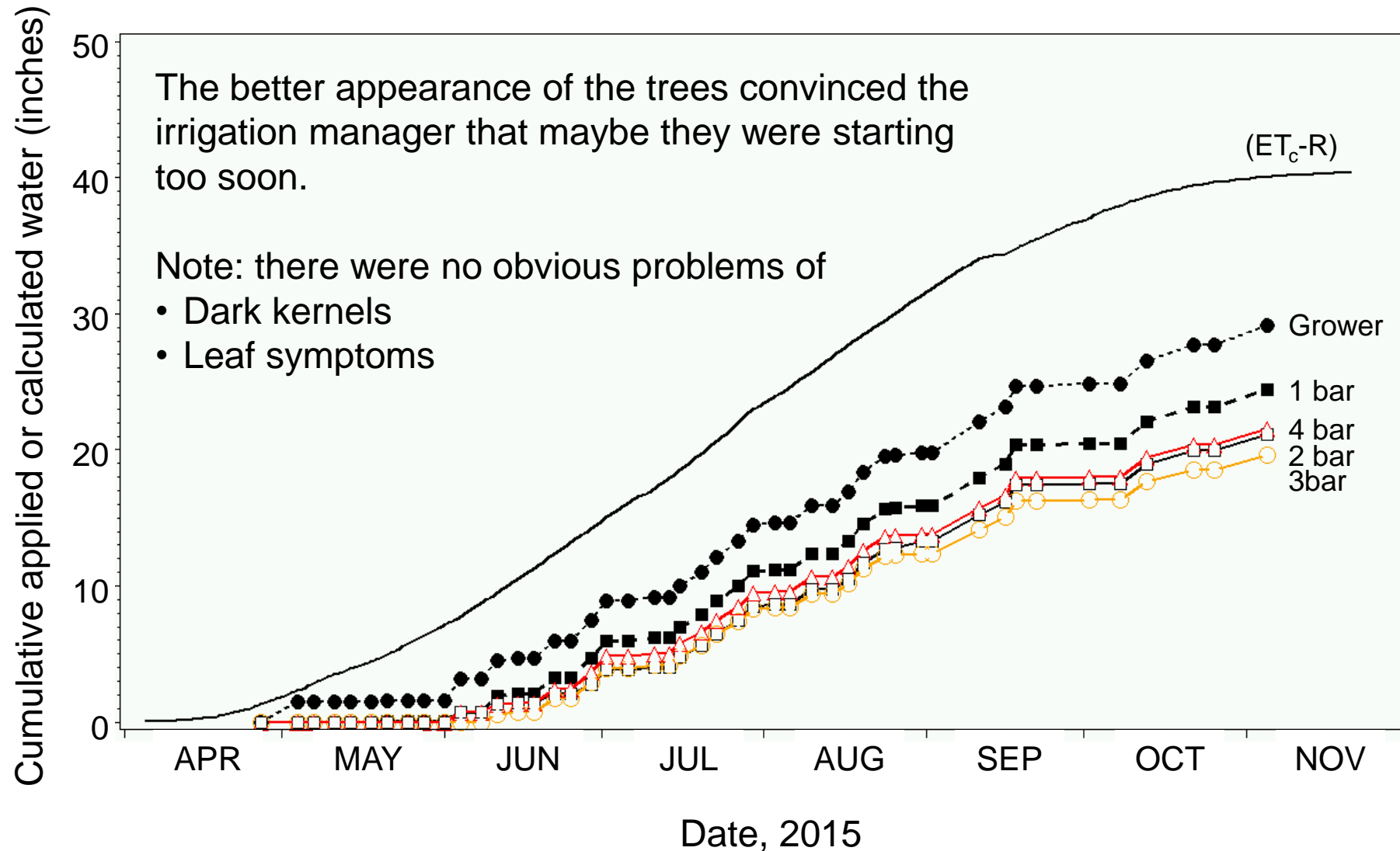
The Beginning: Tehama, 2014

Applied irrigation compared to irrigation demand (ET_c -Rain)



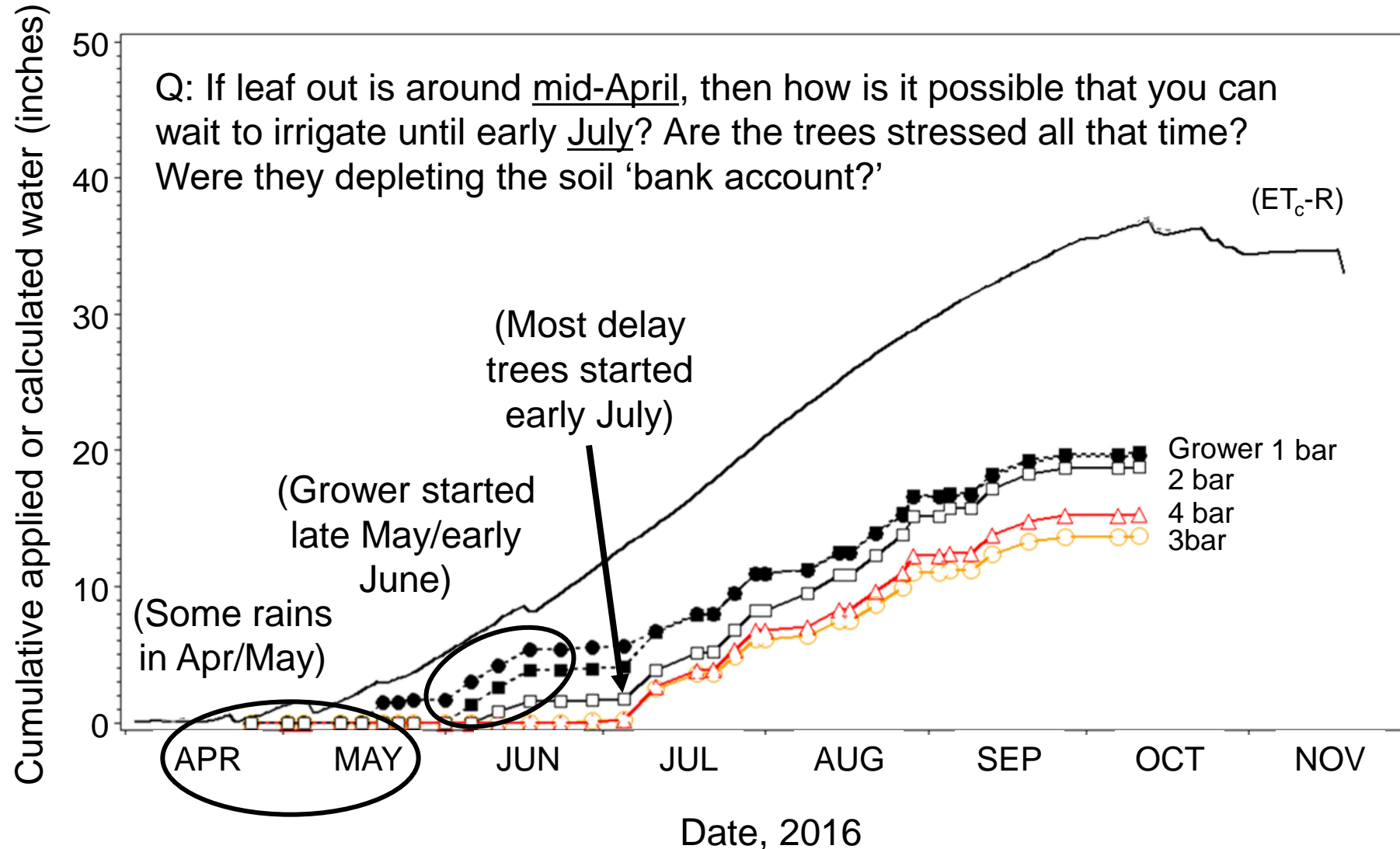
2015

Applied irrigation compared to irrigation demand (ET_c -Rain)

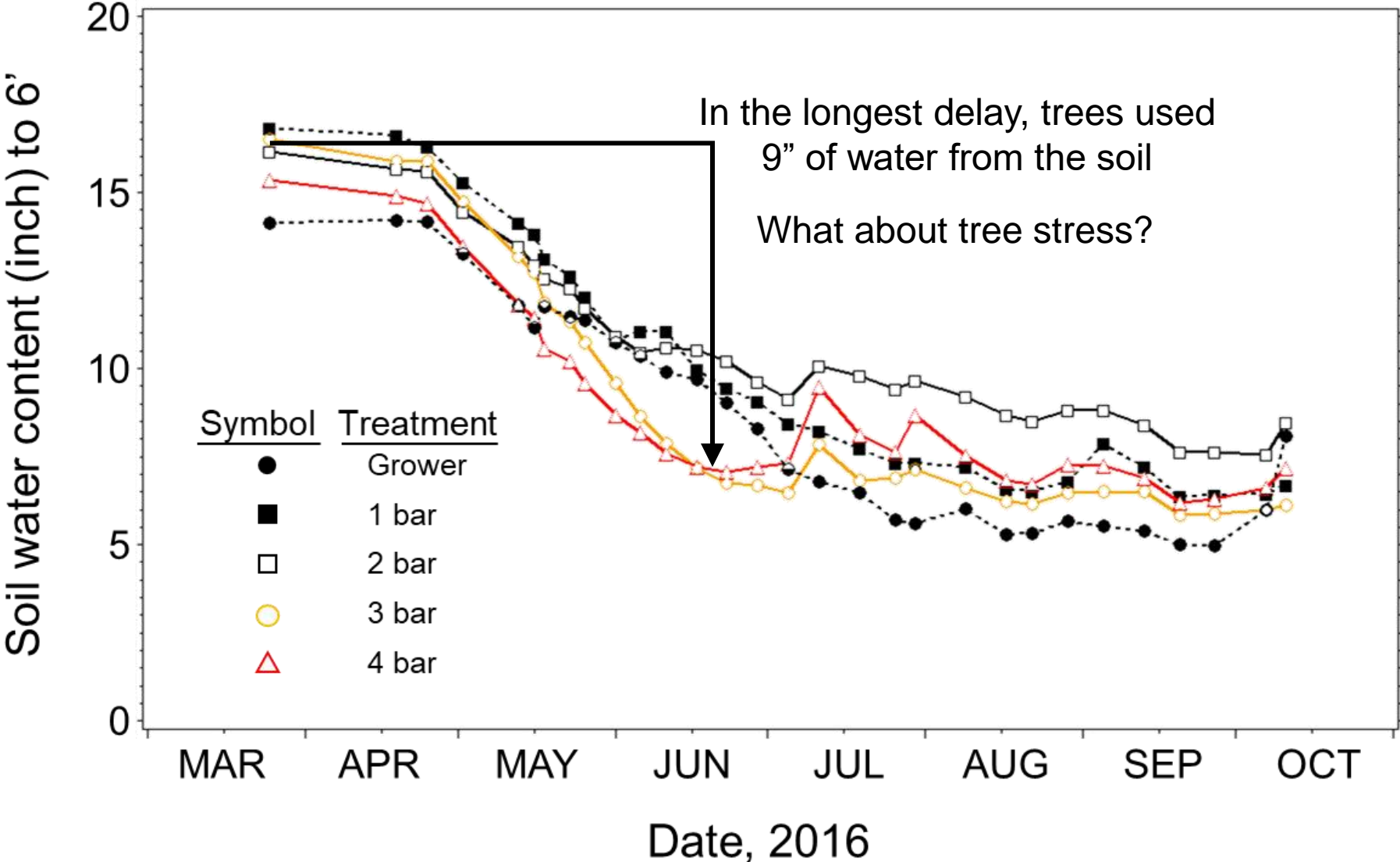


2016

Applied irrigation compared to irrigation demand (ET_c-Rain)

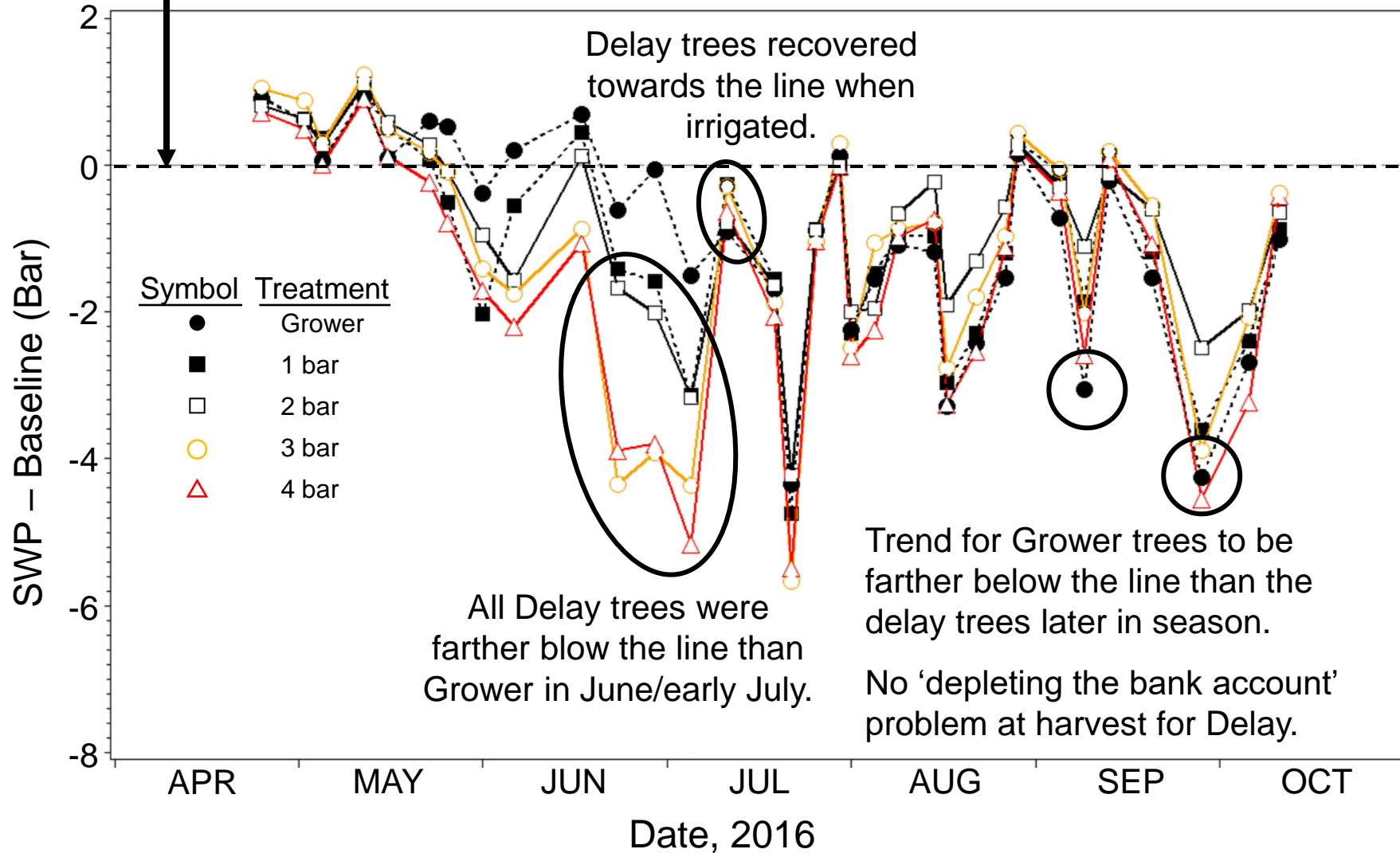


The 'bank account': Measuring soil moisture to 6' with a neutron probe

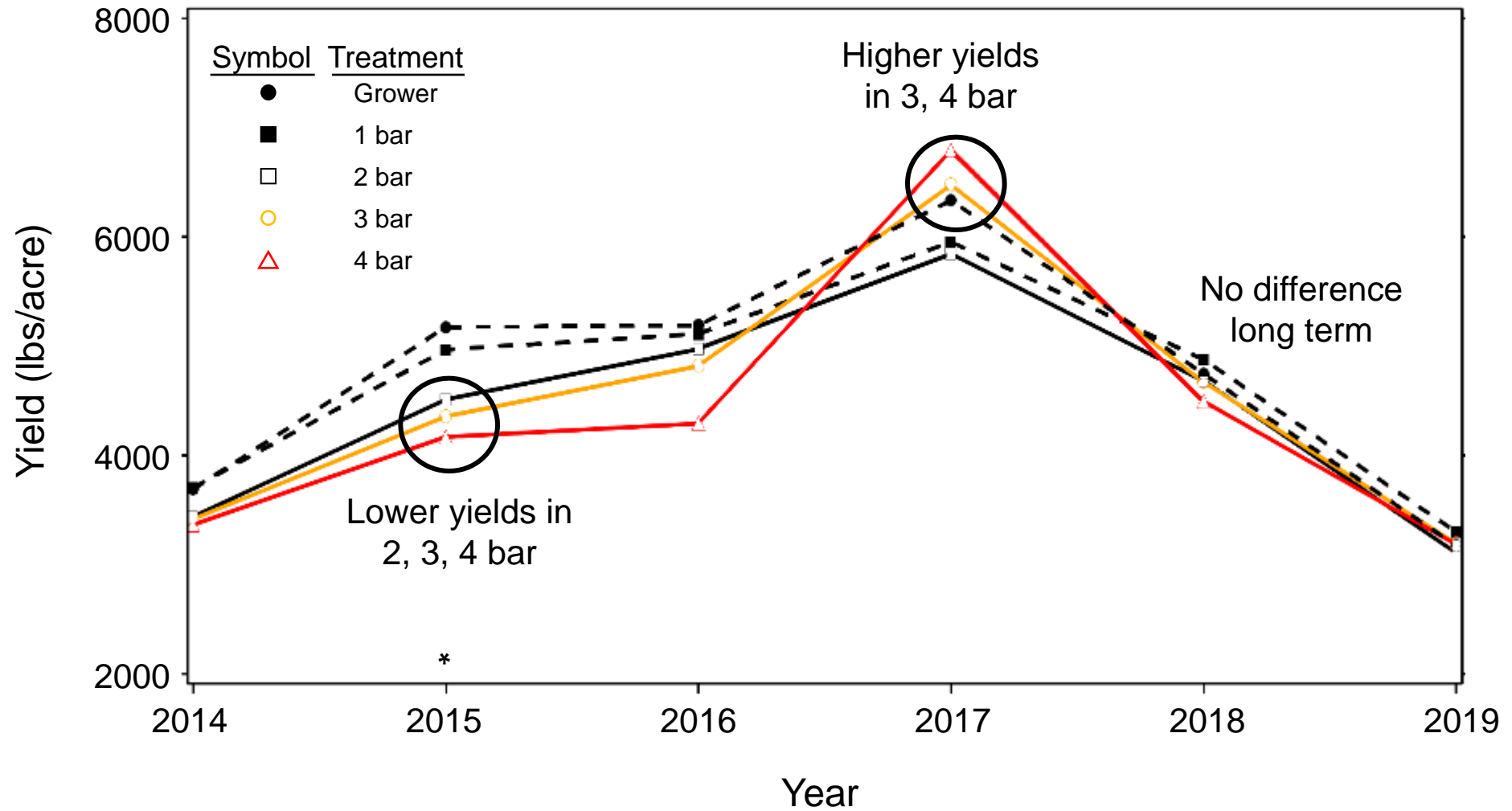


Midday SWP (difference from baseline)

(Dash line at 0 is 'fully irrigated' SWP. Above zero = wetter, below 0 = drier)



Yields over 6 years: Negative effect initially, no effect later.



Yield and nut quality effects, last 2 years (2018/19)

Grower advantage

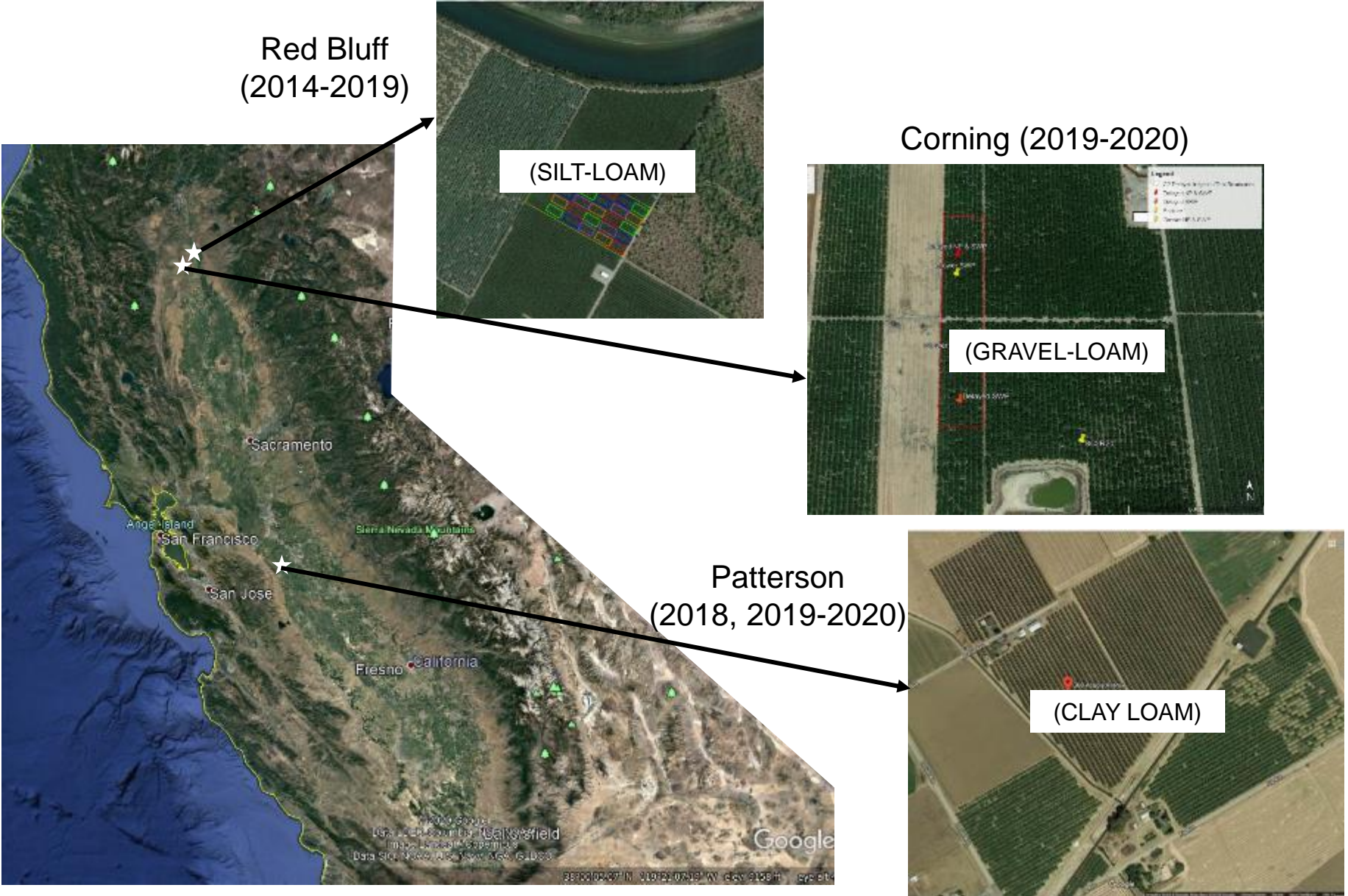
Nut Weight (g)		Yield (lbs./ac)		% Shriveled		% Off Grade	
Treatment	Average	Treatment	Average	Treatment	Average	Treatment	Average
1 bar	10.8	1 bar	4090	4 bar	3.7	3 bar	2.1
Grower	10.8	Grower	3960	2 bar	2.9	2 bar	2
2 bar	10.3	3 bar	3930	1 bar	2.6	4 bar	2
3 bar	10.3	2 bar	3890	3 bar	2.5	1 bar	1.7
4 bar	10.2	4 bar	3840	Grower	1.9	Grower	1.4

Delay advantage

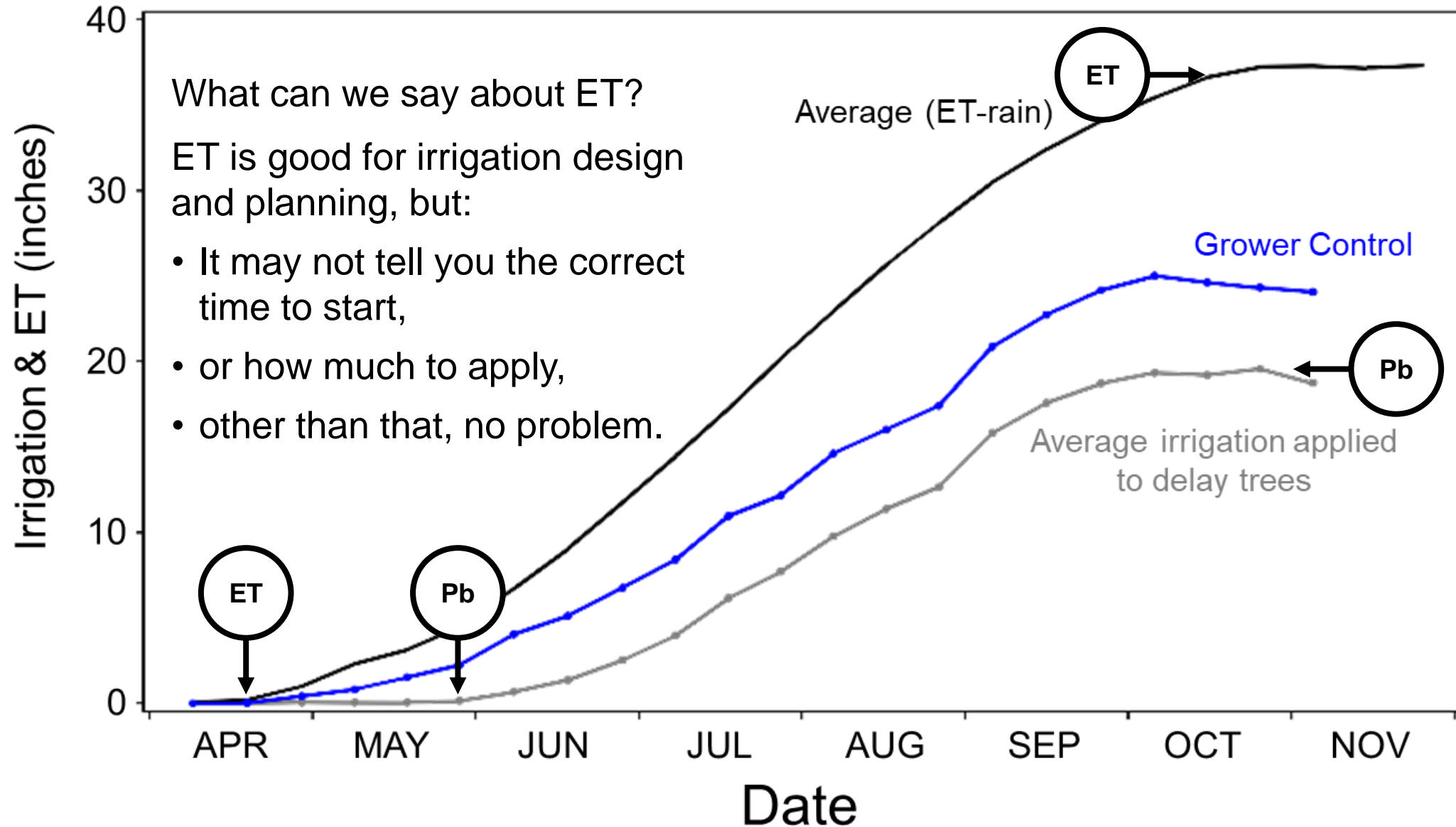
% Edible Yield		% Extra Light		Relative Value	
Treatment	Average	Treatment	Average	Treatment	Average
3 bar	44.8	1 bar	55.5	3 bar	0.89
4 bar	44.7	4 bar	55.3	4 bar	0.89
1 bar	44.2	3 bar	53.8	1 bar	0.88
2 bar	43.8	2 bar	53.7	2 bar	0.87
Grower	43.5	Grower	48.5	Grower	0.86
p 0.06				p 0.01	

(None of these differences were statistically significant)

Multiple sites, multiple years



Averaged over all sites and years thus far, the delay period has been almost 2 months, compared to the start of ET, and about 1 month compared to grower practice.



This years (2024) project

Commercial orchard (Winters, CA)

- Main objective: test two automated SWP sensors.



This years (2024) project

- Main objective: test two automated SWP sensors.
- Secondary question: were trees in low vigor areas water stressed? Was water stress associated with a reduction in % light kernels?

Background: a nearby orchard (same grower) was uniform, high vigor, and typically 90-95 % light. This orchard was typically 50-60% light.

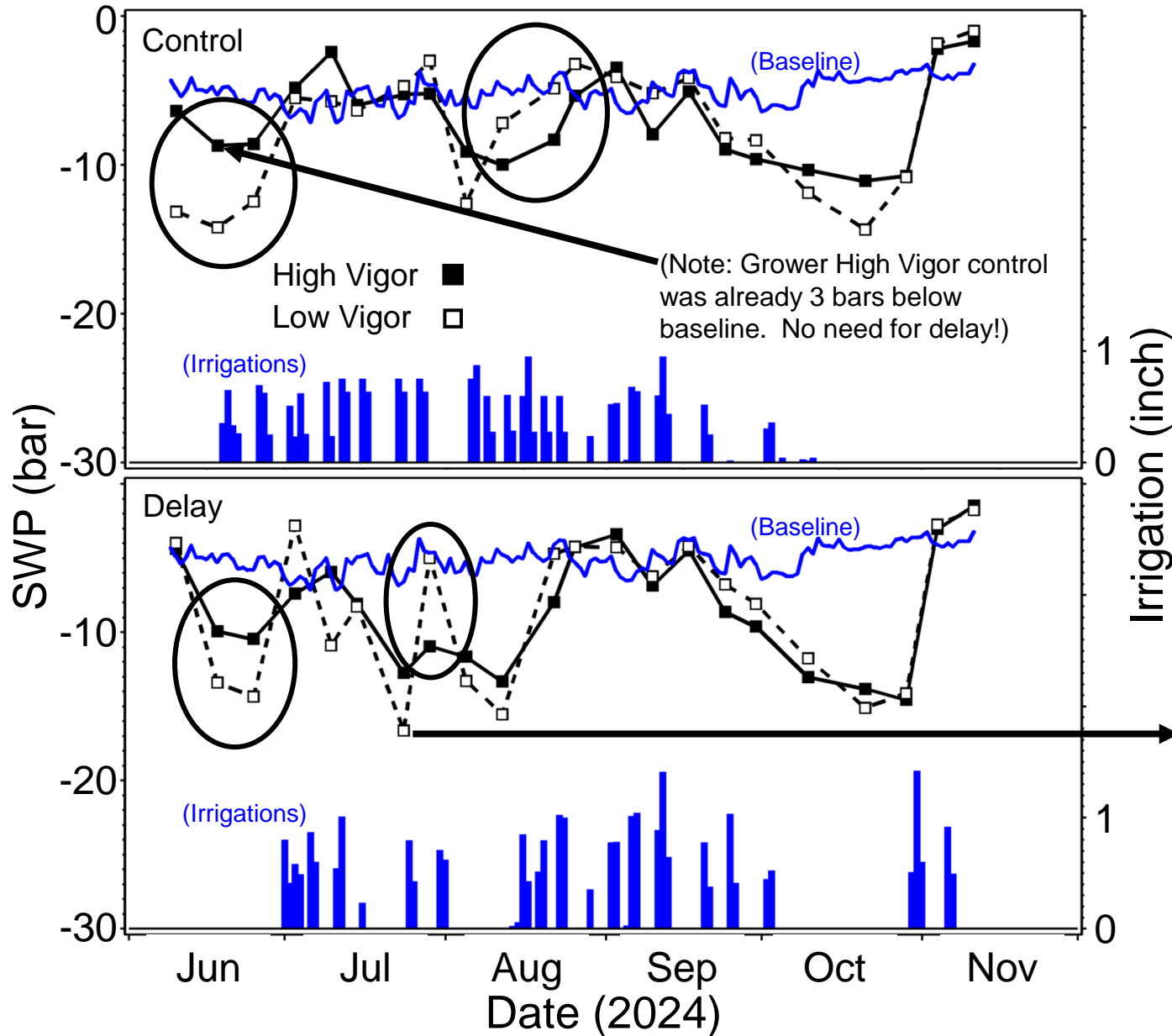
Commercial orchard (Winters, CA)

■ High Vigor Area

■ Low Vigor Area



SWP results (weekly pressure bomb)



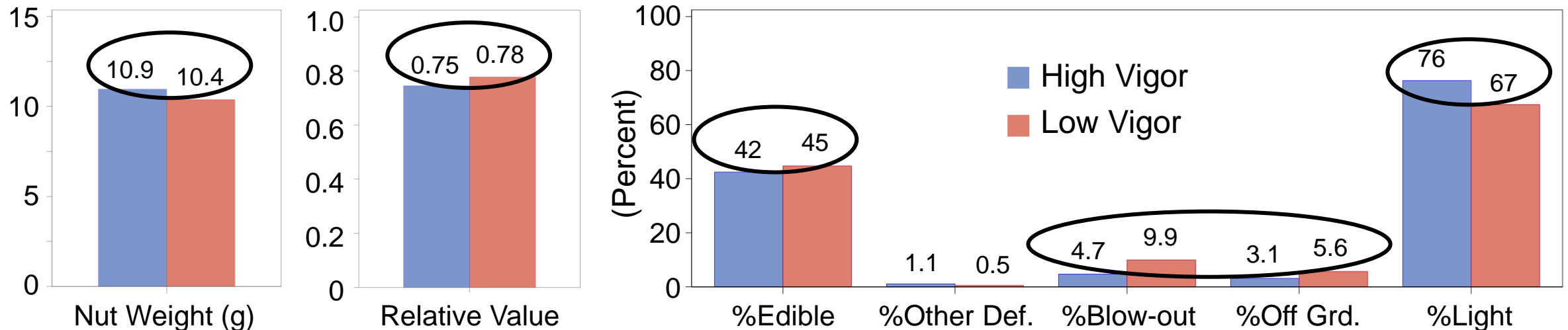
Delay Low Vigor tree



Severe stress (nut quality effects?).

Nut Quality:

- 1) Statistically lower nut weight in Low Vigor (-)
- 2) Trend of higher % Edible and higher Relative Value in Low Vigor (+)
- 3) Trend of more off grade in Low Vigor (-)
- 4) % Light was lower in low vigor, but given the very high stress and temporarily shriveled hulls in July, it appears that water stress in may not be as detrimental as you might imagine.
- 5) Some evidence suggests that water stress earlier in the season (June) may be associated with daker kernels – a question for next year.



Summary:

- ET and soil information is useful for designing and planning, but for walnuts, may or may not give you the right answer for how to manage irrigation.
- In most walnut orchards studied to date (especially NSJV) irrigation can be substantially delayed (May/June) compared to ET (April). This may have long term beneficial effects on tree health.
- Some orchards (e.g., Winters) may need to start earlier – thus far the only way to know is to check SWP.
- Automated methods for SWP monitoring in walnuts are improving, but not yet ‘plug-and-play’ for most growers. Some (FloraPulse, Cavicam) may be reasonable for tech-savvy growers to try at this point.
- FYI, we have just started a statewide 5-year (\$1.4M) USDA/NRCS funded study on the use of manual and automated plant-based irrigation in walnuts to delay the first irrigation. Stay tuned for results (unless I hear differently from Elon Musk)!

Plant-based Irrigation Management in Walnuts

Thanks for your attention,
Questions??

CWB/CWC supported project

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