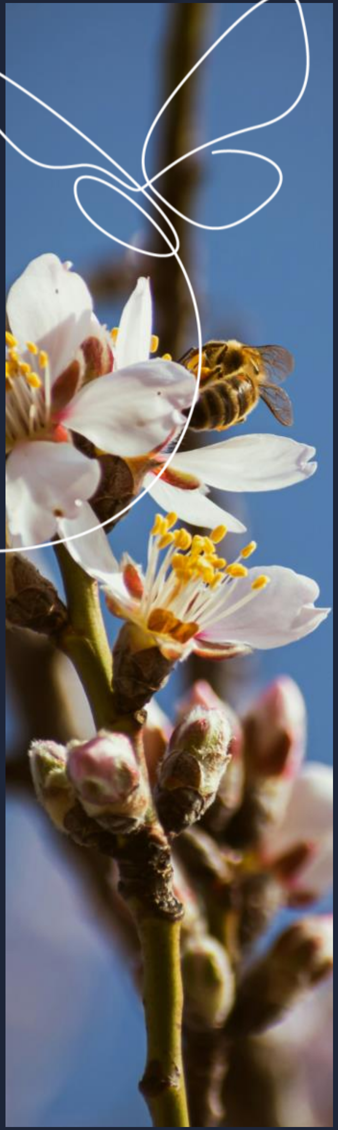
2024

ROOTED TOGETHER

THE ALMOND CONFERENCE



When to Irrigate: Considering Soil and Tree Growth

Moderator

Sebastian Saa, ABC, Ag. Research

Speakers

Astrid Volder, UC Davis

Curt Pierce, UC ANR

Mae Culumber, UC ANR

ALMOND BOARD OF CALIFORNIA

2024

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What to Consider When Managing Roots?

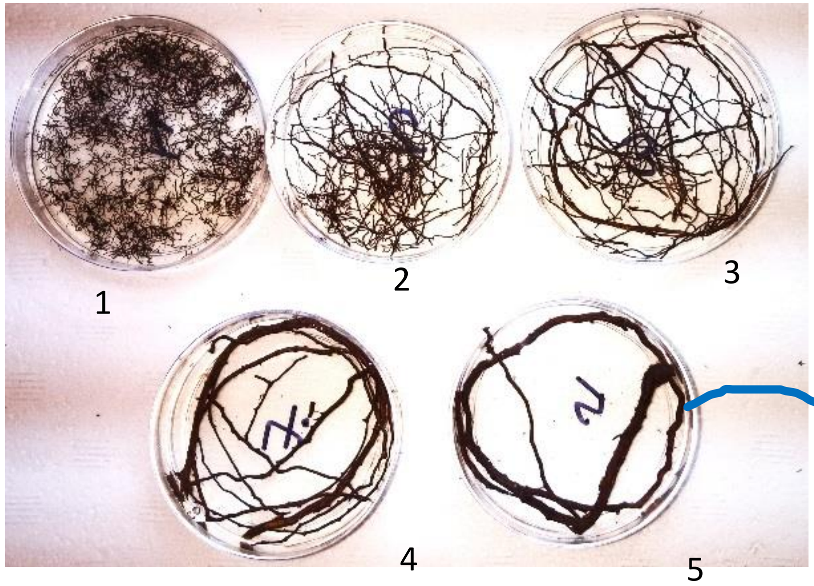
Speakers: Astrid Volder
Department of Plant Sciences, UC Davis

Do roots matter when irrigating?

Yes – they are the entry point for both water and nutrients. If they are not there, extraction of water and nutrients cannot take place.

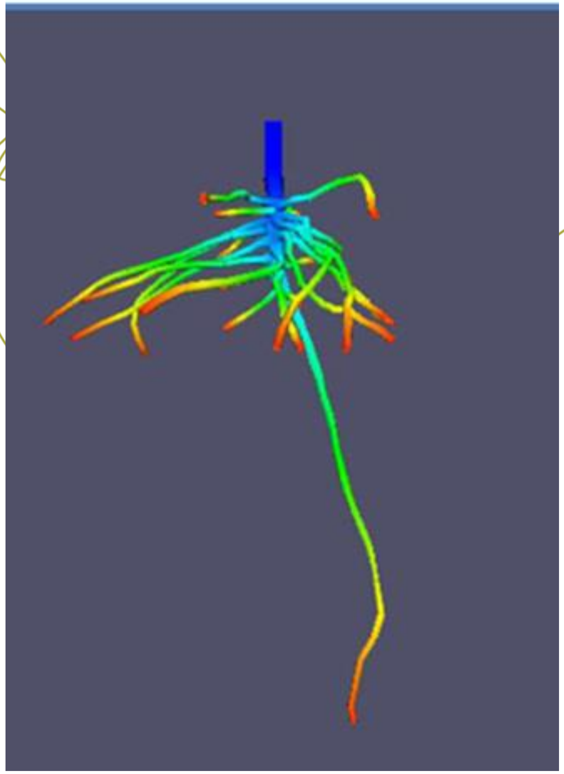
- “Fine roots are akin to belowground leaves. They are short lived but are responsible for extracting most water and nutrients. This presentation will describe the dynamics of fine root growth as affected by orchard management practices such as irrigation and pruning.“

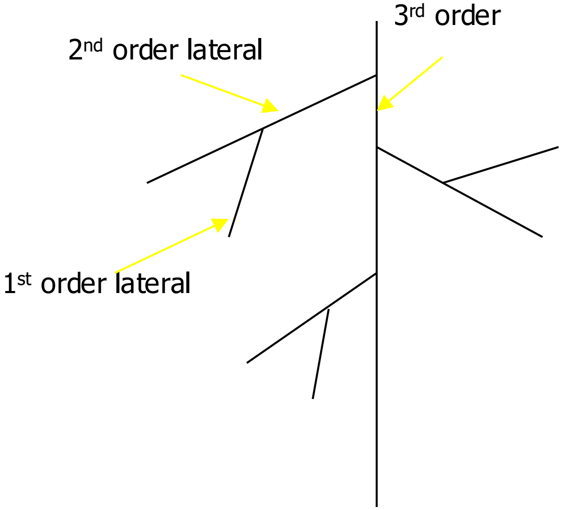
Fine absorptive roots



Functional classification

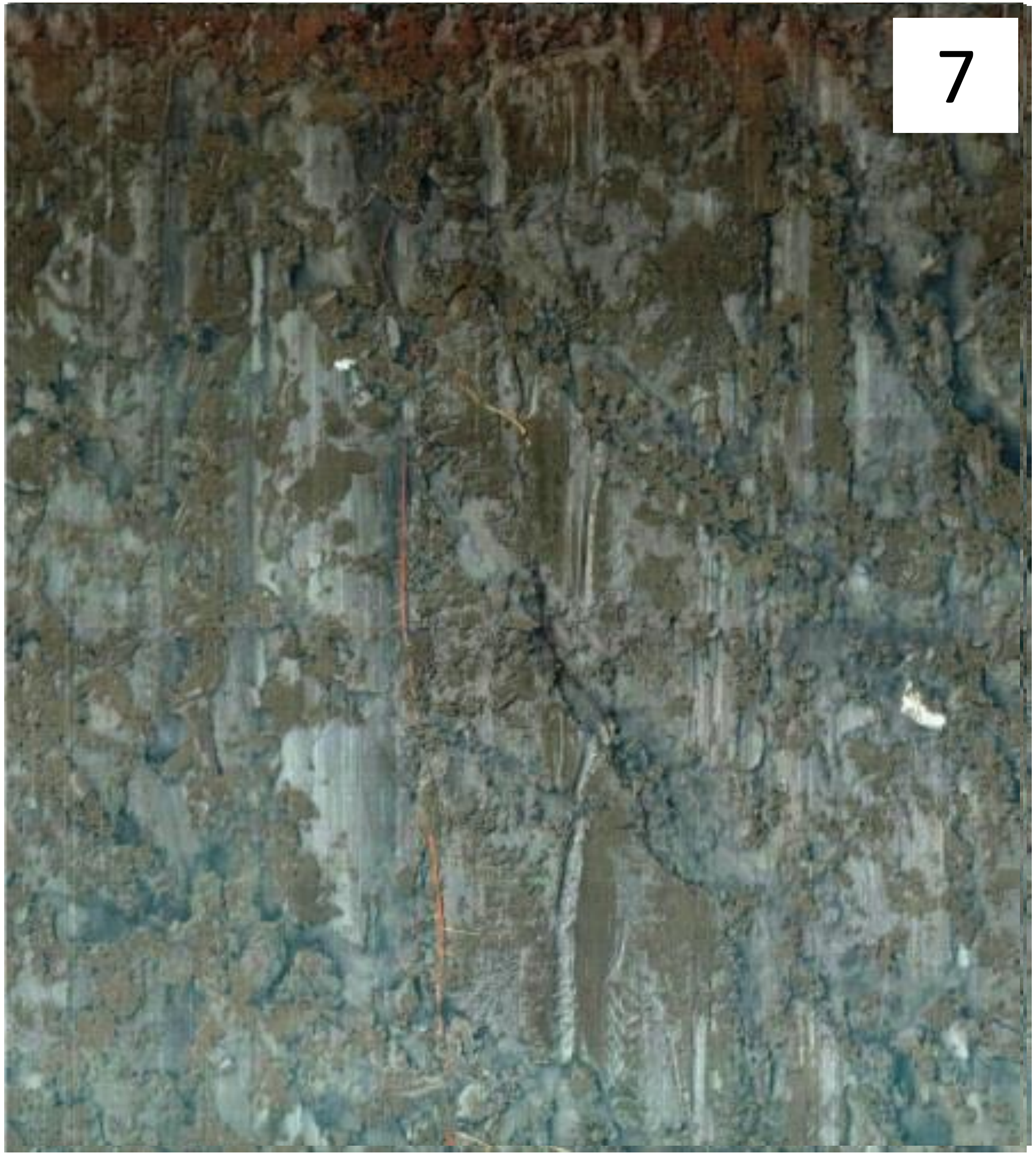
0.5 mm, 0.02 inch diameter





Tip (red) = youngest & most active

Most are not white! Fine roots turn brown within weeks, and live a few months



Roots are born white but turn brown as walls of external cells become suberized (a waxy substance) and much less water permeable.

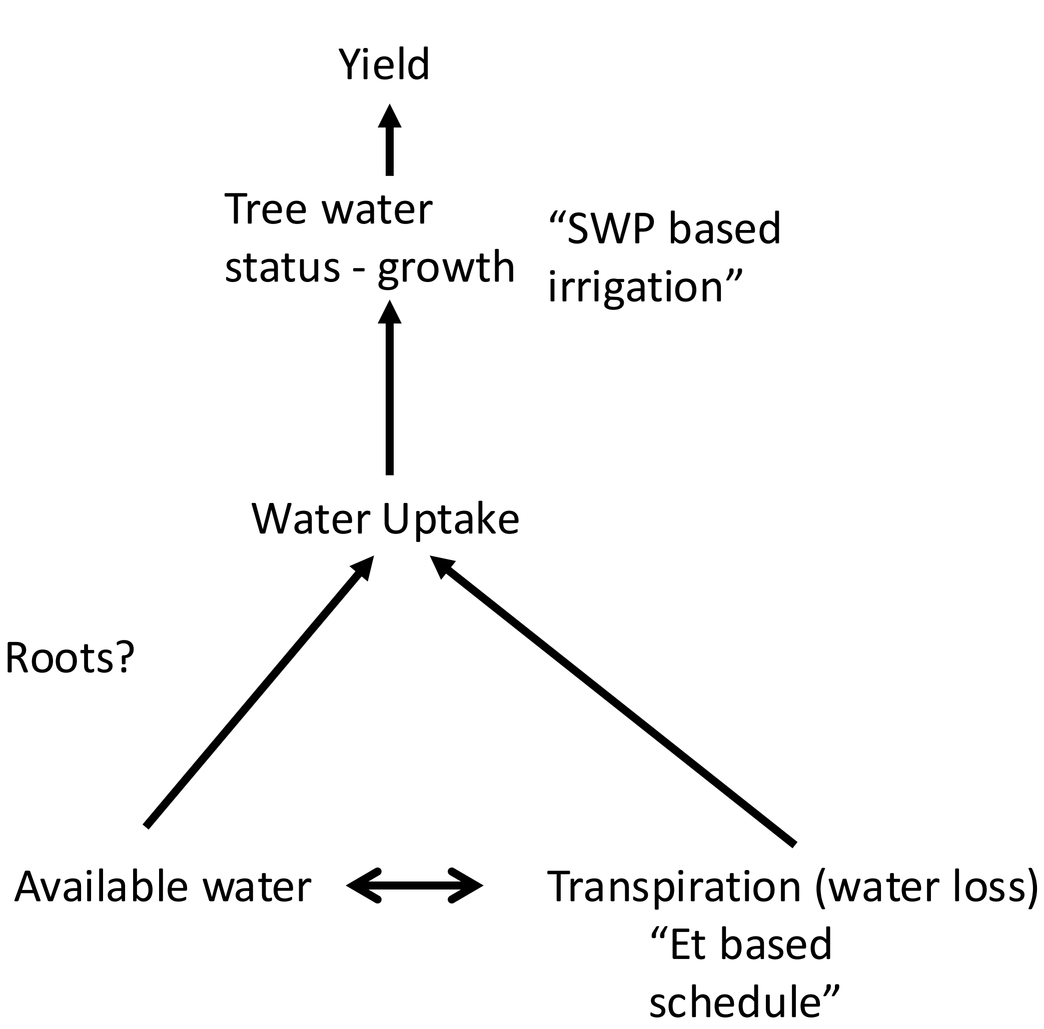
Fine roots have to continually explore new soil volumes to extract nutrients.

Most first order roots have a finite length growth and then die.

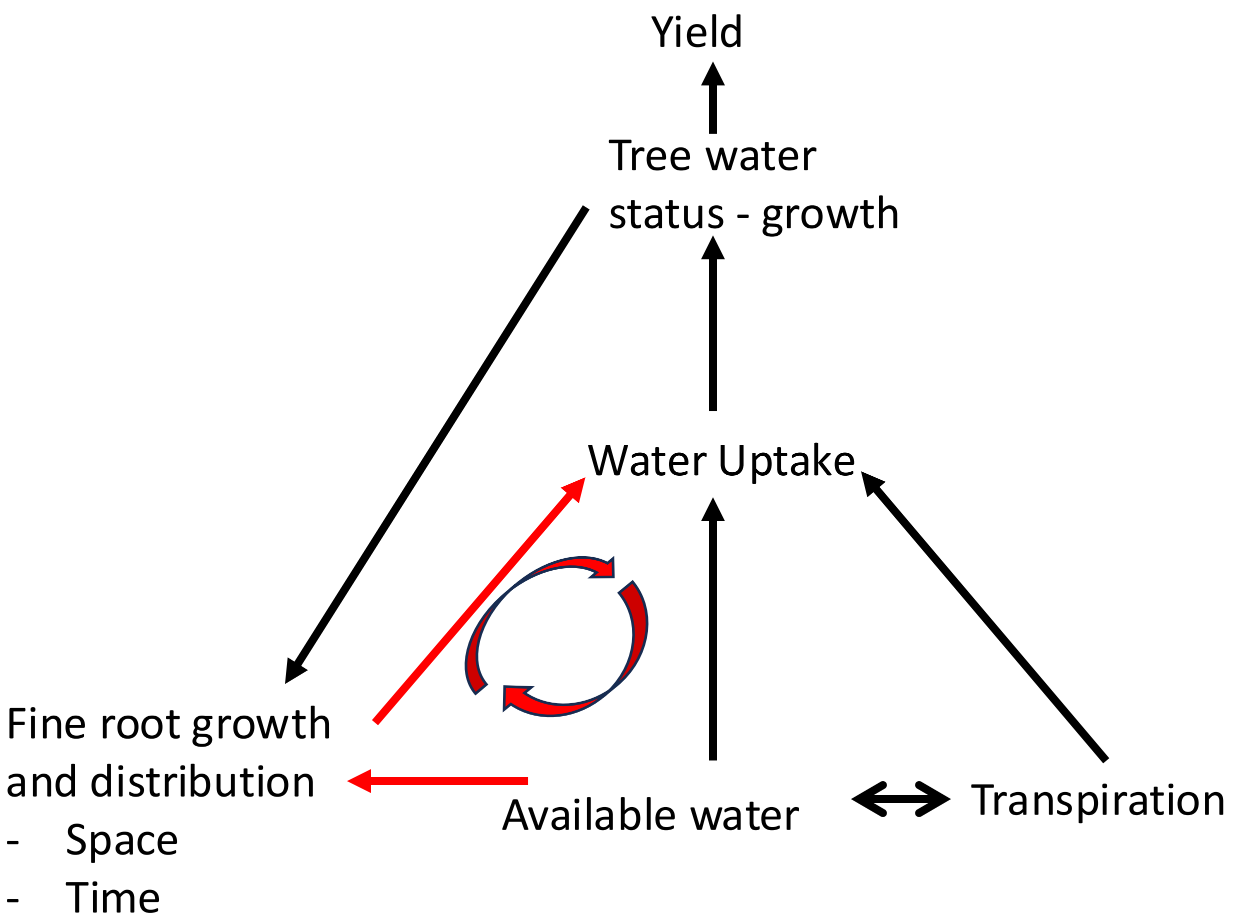
Exploratory (pioneer) roots have indefinite growth and give rise to new lateral roots. They function to explore new soil volumes and are part of the transportation infrastructure to move water and nutrients to the shoot

One week interval

- fine laterals appear and disappear
- higher order root turns brown

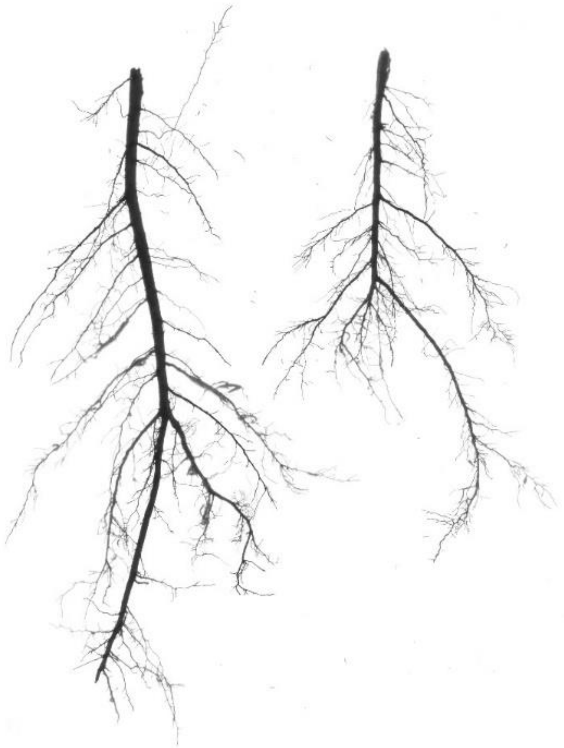


Typical scheme

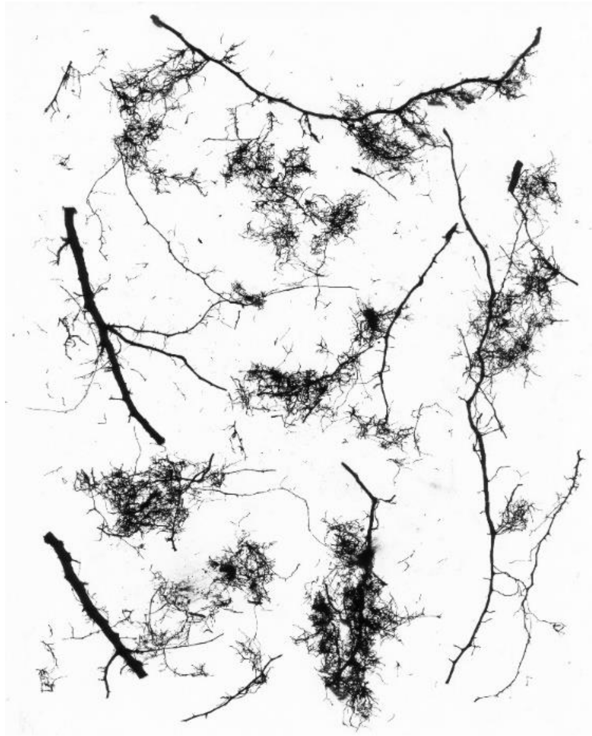


More complicated – **THE CHALLENGE** – water can affect the health and water uptake ability of your roots - how to ensure you have active roots in the right place for water uptake

Most mass in coarse roots, but most length & absorption in finest roots



Krymsk 86

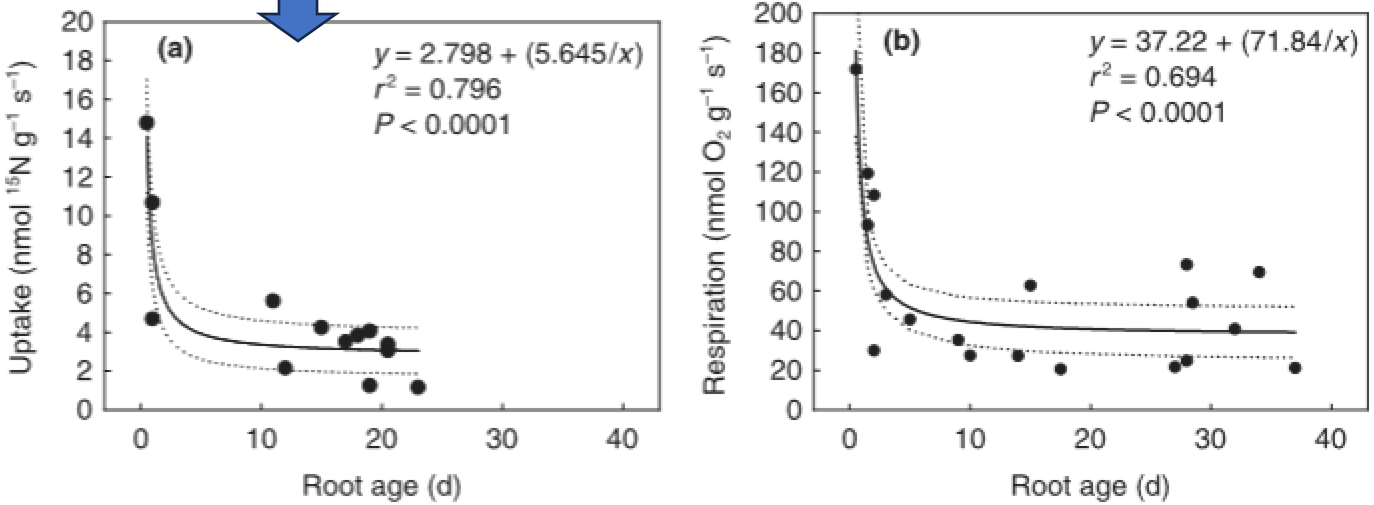


Mariana

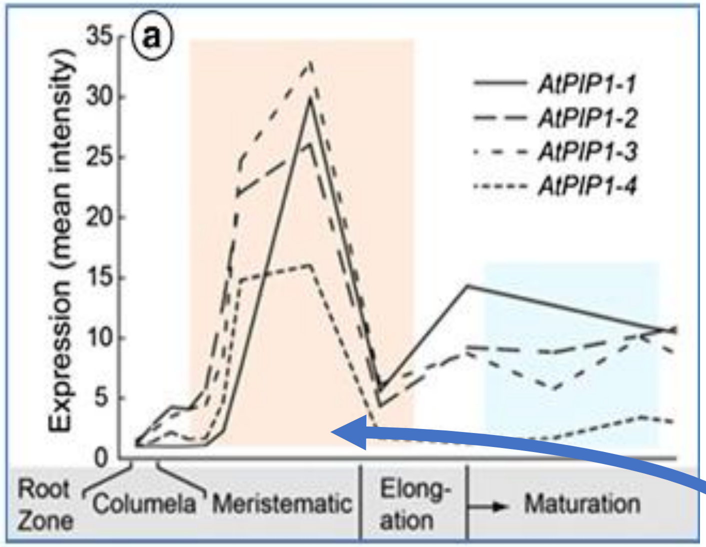
Rootstock differences in fine root architecture – Krymsk 86 has less mass allocated to the fine roots, but 1^{st} order roots make make more length (surface area) per mass (they are finer). This leads to an equal proportion of length in its finest roots

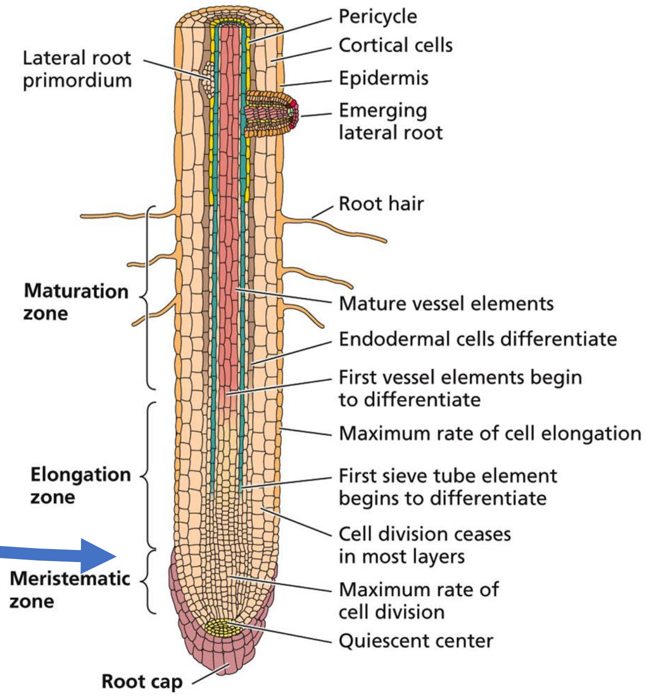
Mariana 2624 fine roots are very closely clustered – while Krymsk 86 explores more soil volume. This affects water and nutrient uptake

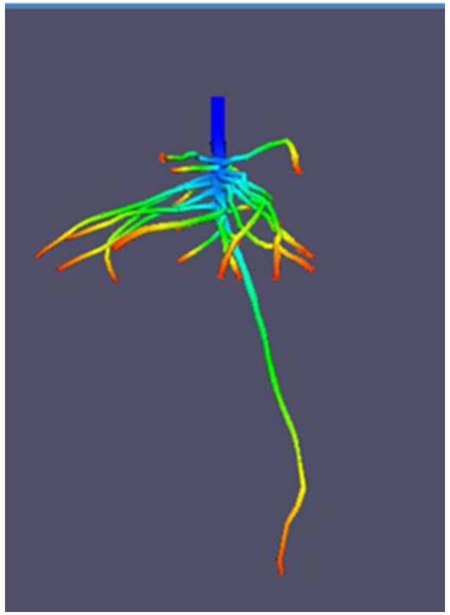
Nitrogen uptake capacity decreases rapidly as a root tip ages in place (turns brown)



Water and nutrient uptake is proportional to the number and age of root tips



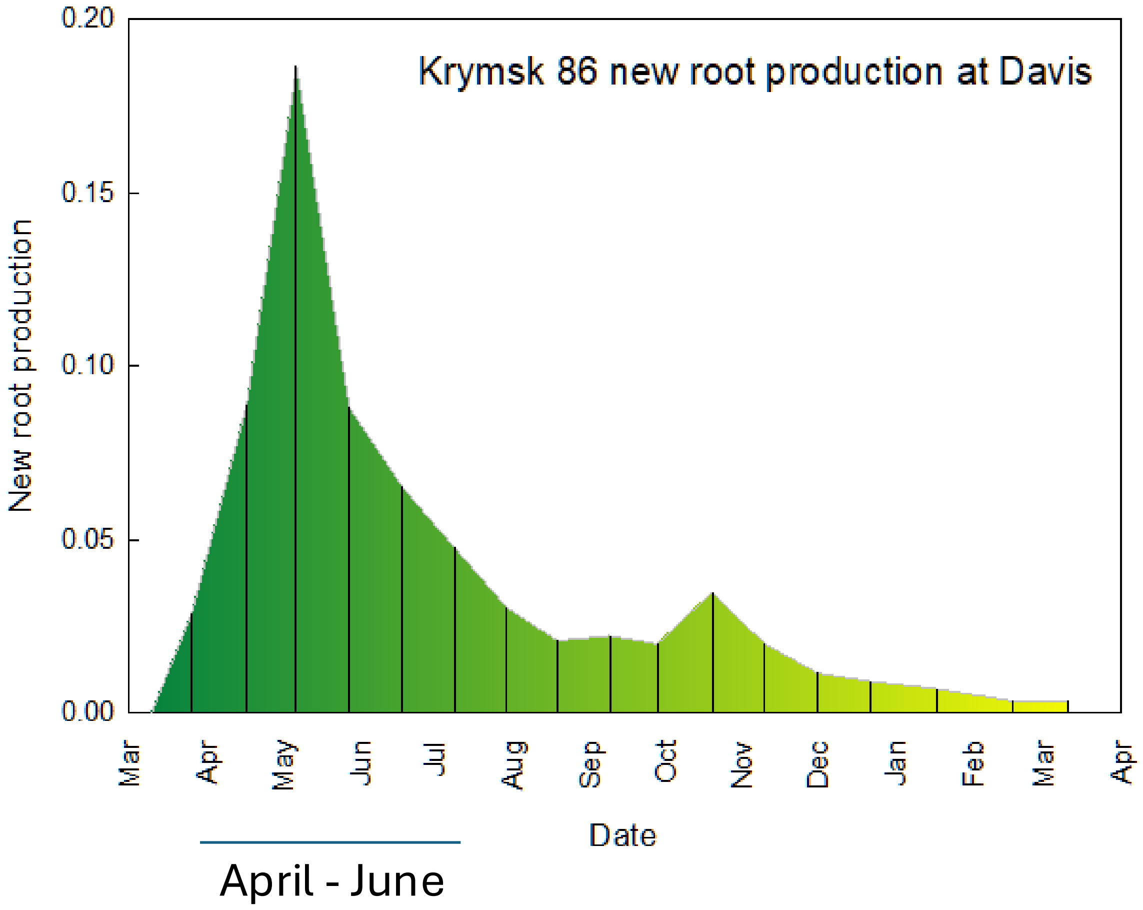




Aquaporins (PIP) allow water to move freely across cell membranes. They are highly expressed in root tips

When are new roots produced?

All year around with a peak in April - June



April –June is when the amount and *depth* of root production can be most affected by irrigation and other management practices

How does water availability affect root depth distribution?

- Accidental discoveries of >70 m (> 200 ft) deep roots in wells and >20 m (>60 ft) roots in caves show enormous plasticity in root response to environment
- Along a topographic gradient, root–water relation shifts systematically based upon *temporal* and *spatial* water availability
- Timing & distribution of water matter for root depth

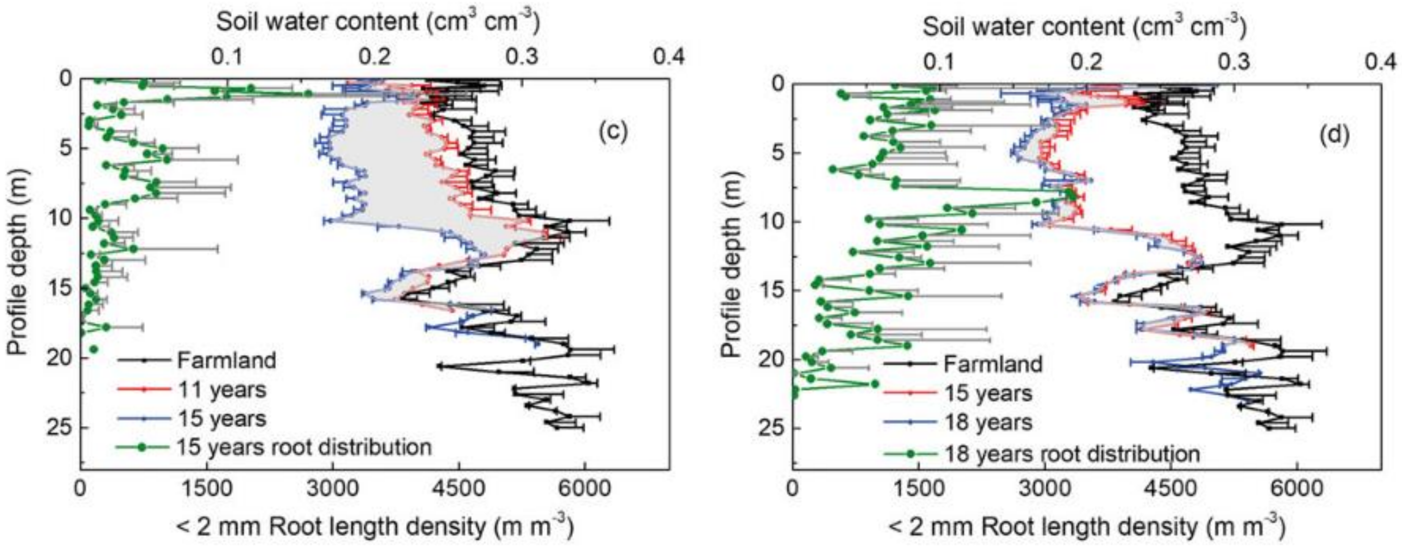
Hydrologic regulation of plant rooting depth

Ying Fan[a,1], Gonzalo Miguez-Macho[b], Esteban G. Jobbágy[c], Robert B. Jackson[d,e,f], and Carlos Otero-Casal[b]

[a]Department of Earth and Planetary Sciences, Rutgers University, New Brunswick, NJ 08854; [b]Non-Linear Physics Group, Faculty of Physics, Universidade de Santiago de Compostela, E-15782 Santiago de Compostela, Galicia, Spain; [c]Grupo de Estudios Ambientales–Instituto de Matemática Aplicada San Luis, Consejo Nacional de Investigaciones Científicas y Técnicas, Universidad Nacional de San Luis, D5700HHW San Luis, Argentina; [d]Department of Earth System Science, Stanford University, Stanford, CA 94305; [e]Woods Institute for the Environment, Stanford University, Stanford, CA 94305; and [f]Precourt Institute for Energy, Stanford University, Stanford, CA 94305

Edited by Thomas Dunne, University of California, Santa Barbara, CA, and approved August 23, 2017 (received for review July 11, 2017)

Roots “chase” deep water



Apple trees ”mined” top soil water and roots went progressively deeper through time

(Loess = excessively drained)

SCIENTIFIC BRIEFING

WILI

Water mining from the deep critical zone by apple trees growing on loess

Huijie Li[1] | Bingcheng Si[1,2] | Pute Wu[1] | Jeffrey J. McDonnell[3,4]

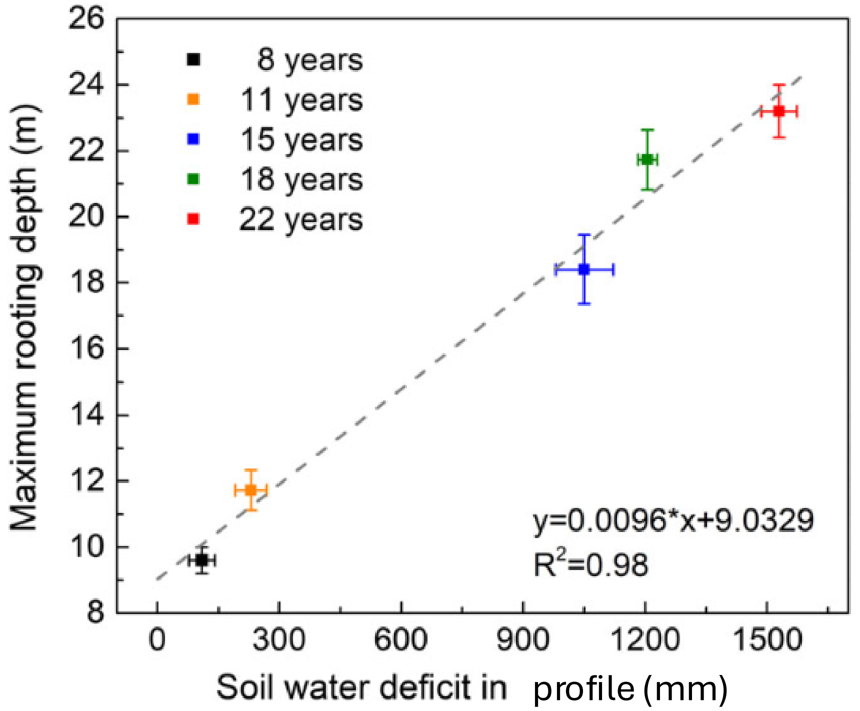
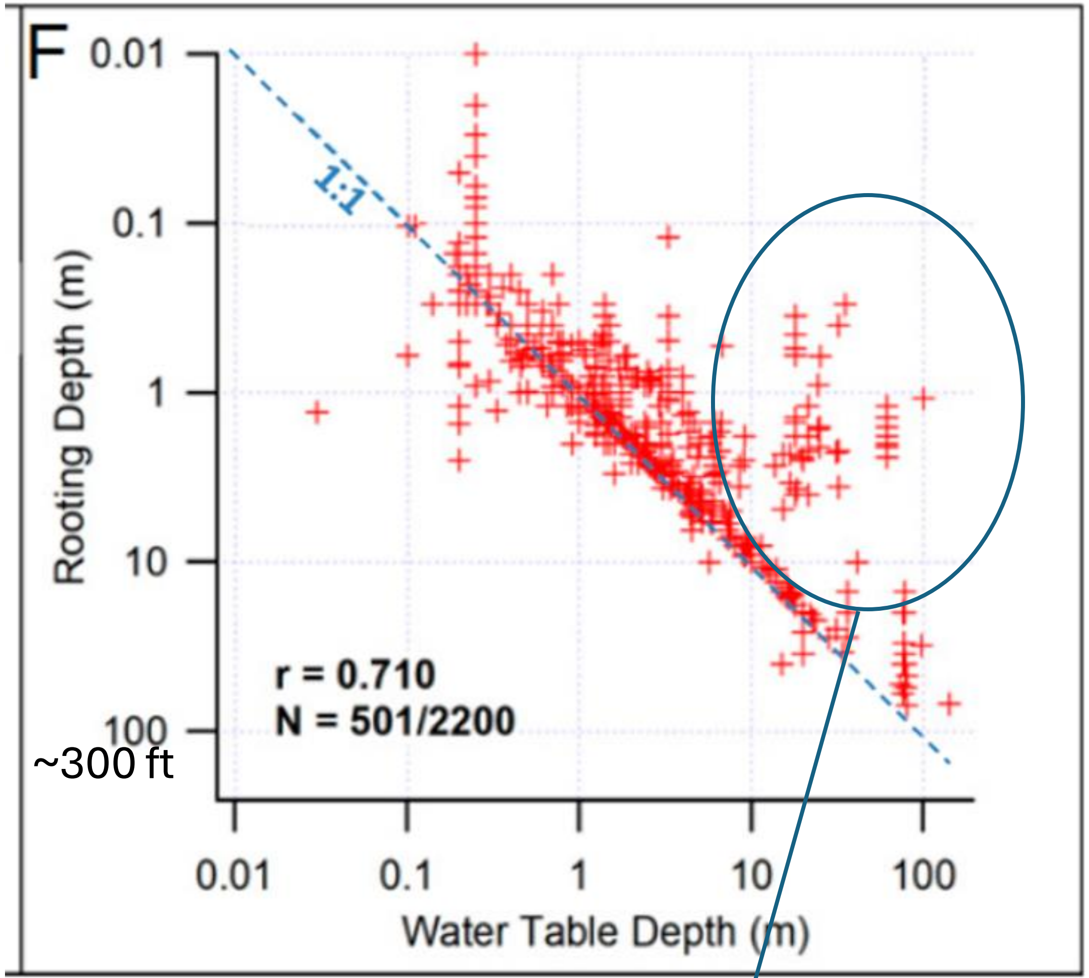
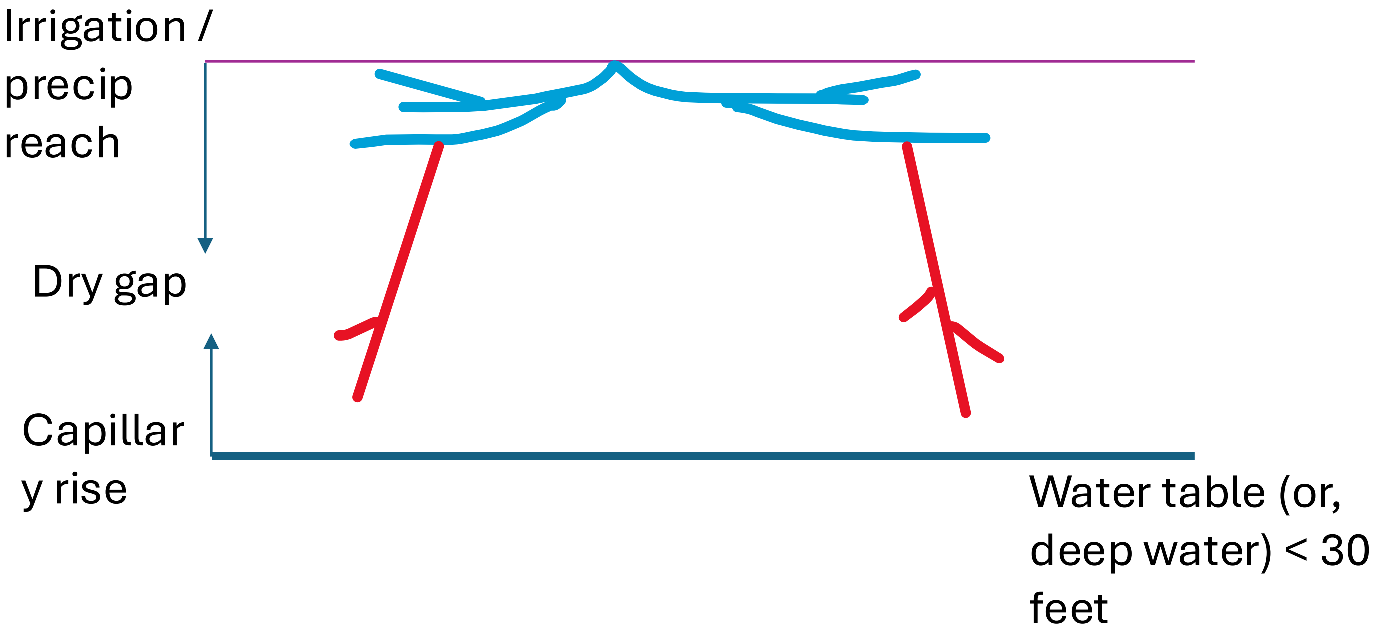


FIGURE 5 The relationship between soil water deficit in deep soil (below 1 m) and maximum rooting depth of fine roots (diameter <2 mm)

As the soil profile is drying out as trees age, roots grow deeper





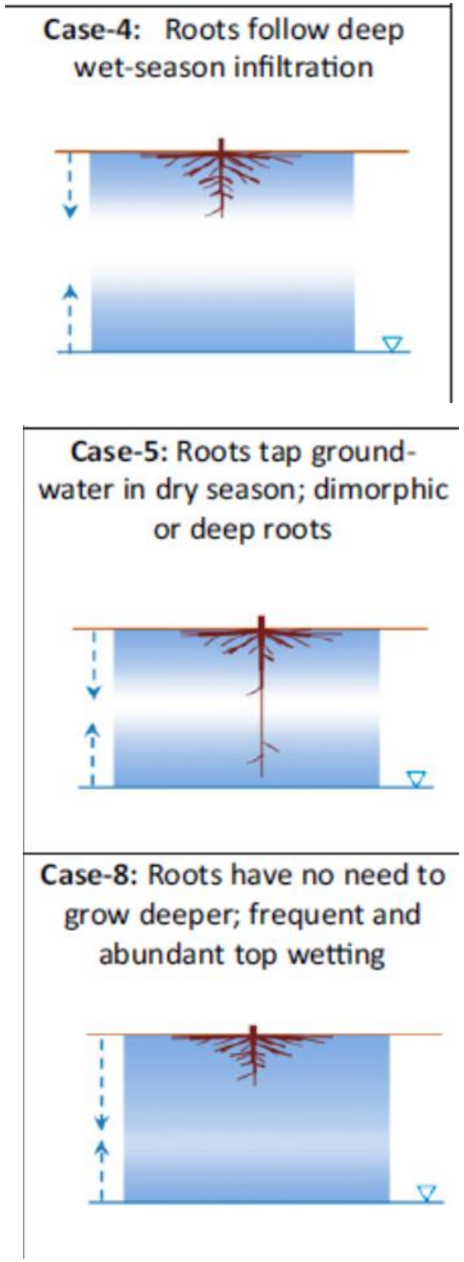
Roots do not reach groundwater because either:

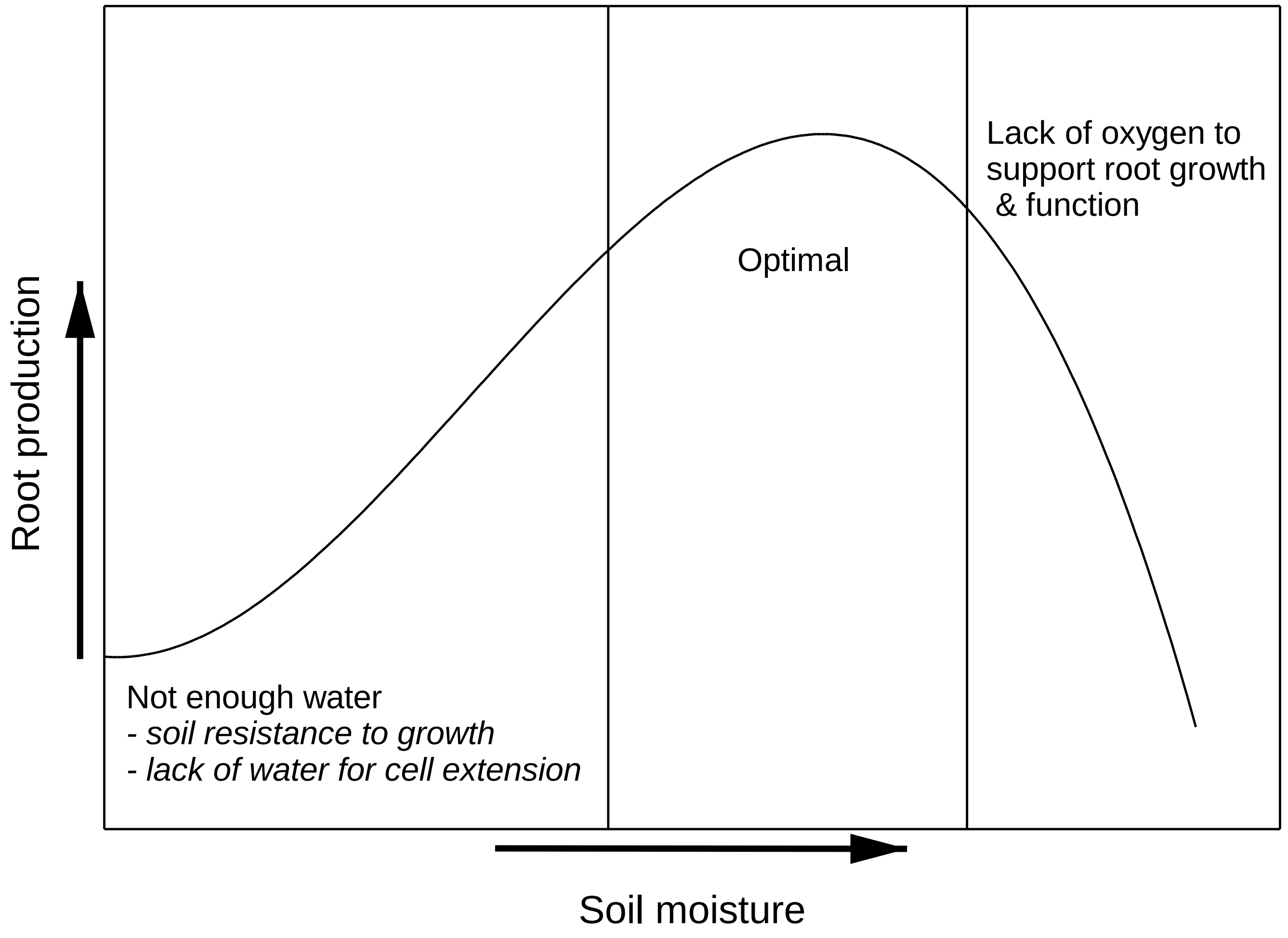
- Dry gap is too large / hard pan
- Topsoil remains too wet all year (frequent irrigation)

Generalizations from the literature

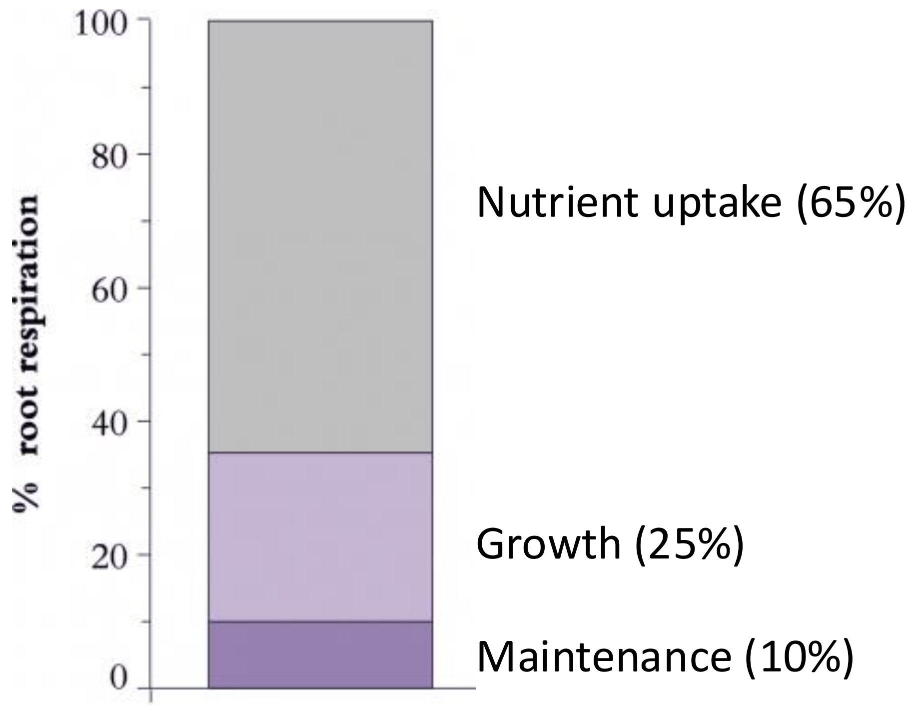
- In deficit irrigation studies: more water applied annually –> deeper and more extensive root system
- In flooding studies - keeping the top-soil close to field capacity –> smaller and more shallow root system

- It all depends on:
  - Soil characteristics (drainage rate)
  - Timing of water applications





- A gradual negative effect on root production when soil moisture is below optimal, but a sharp decline in root production when the soil gets too wet
- The “optimum” depends on soil characteristics and tolerance of your rootstock
- Balance between enough water to reduce soil friction, support evapotranspiration, and still having enough oxygen to support root respiration for nutrient uptake and root growth



This is why anoxic conditions cause nutrient deficiency symptoms – but fertilizer is not the answer – getting oxygen to the roots (reduce water) is

Can you be too wet? – June 2017

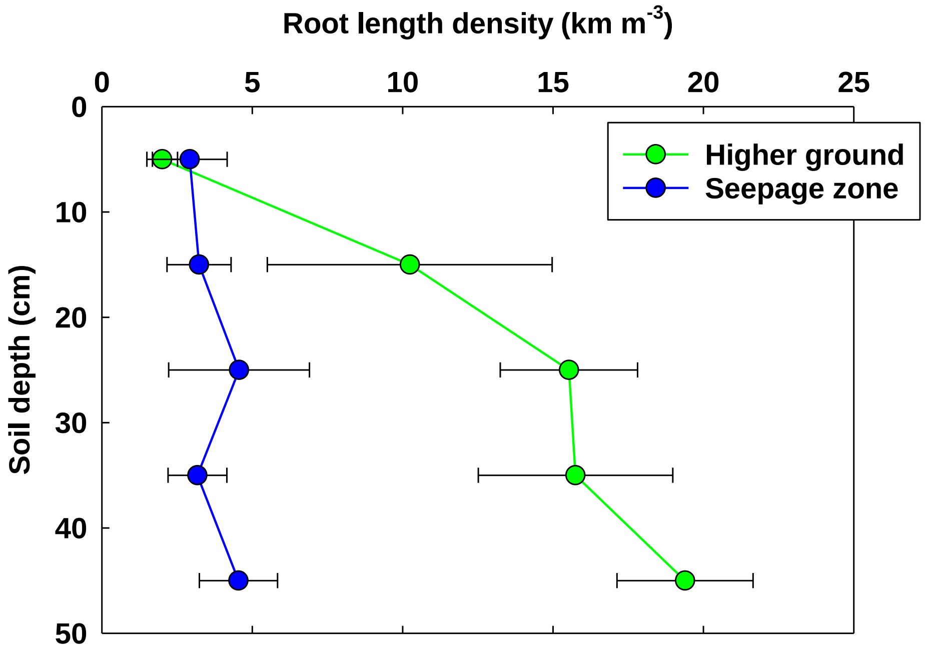
Standing water was only 20" below the soil surface

Walnut

Trees located on higher ground (control)

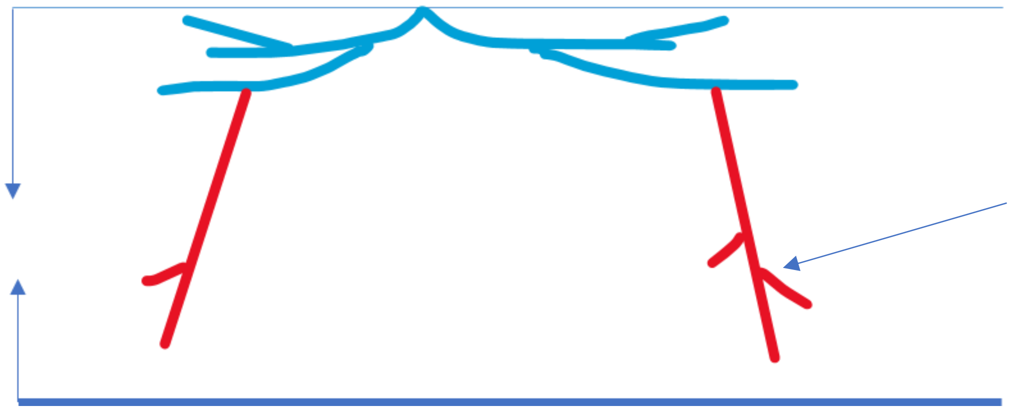
Trees failing to push in the seepage zone

Chandler on RX1 (4th leaf) – soil cores collected on June 29, 2017. Standing water at 50 cm (20”) soil depth.

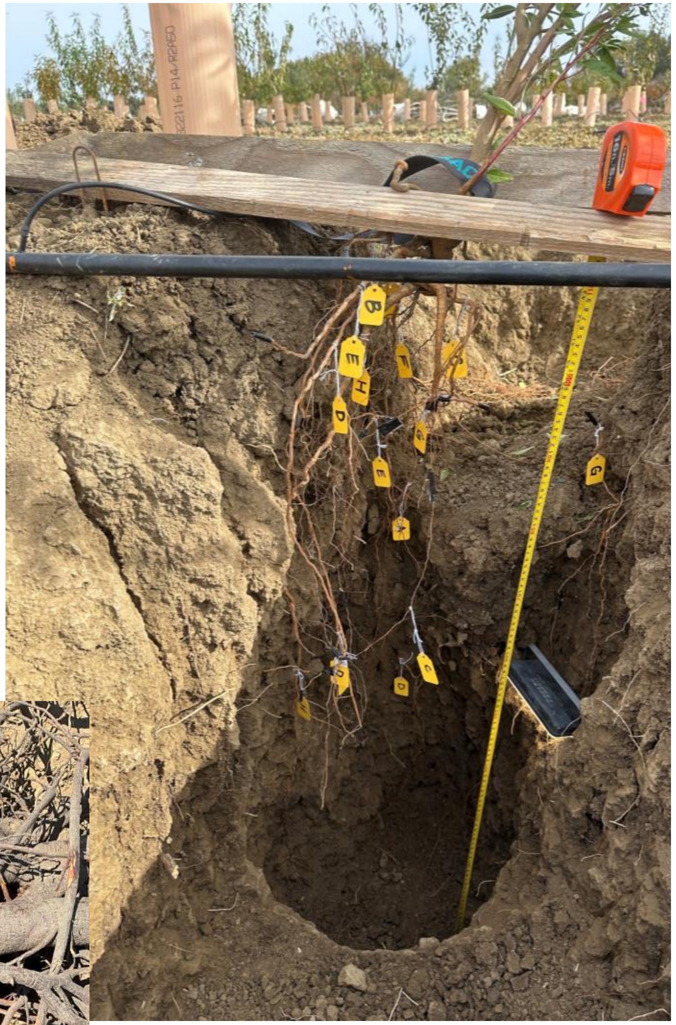


Standing water at ~50 cm – water moves up via capillary movement and lack of oxygen significantly reduces new root production in the top soil (except nearest the surface)

Management of young trees is key



Cannot have fine root production in zones where coarse roots have not developed – so, young trees must be encouraged to develop deep roots early

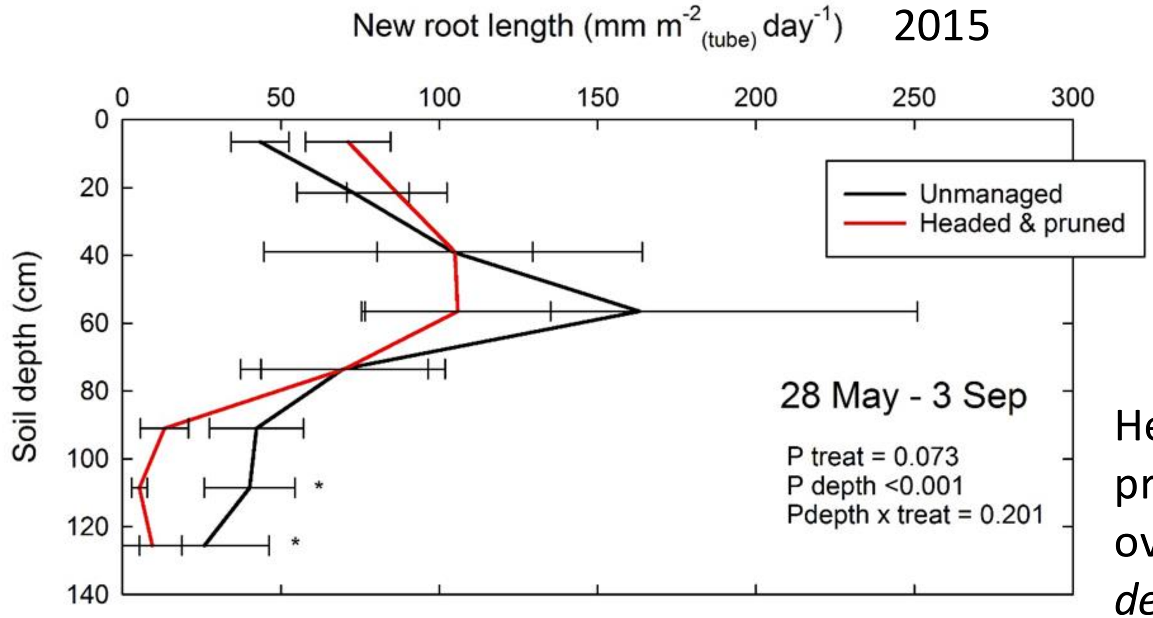


As with canopy structure, characteristics of the structural coarse root system are set early in tree development

Bare root trees

2015

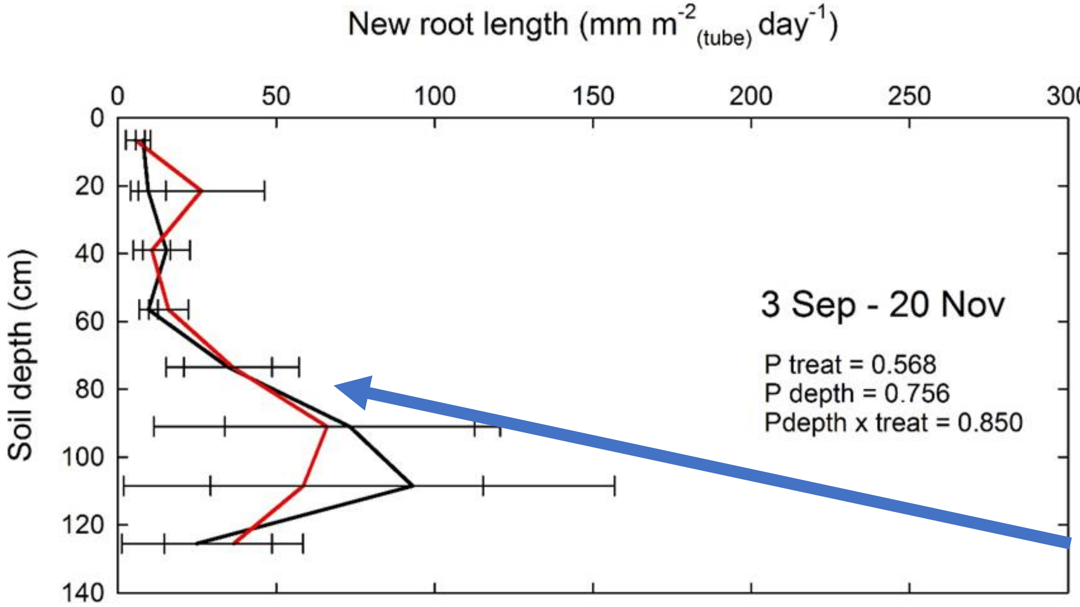
Summer



Red lines are headed and pruned at planting (Feb 2015)

Headed and pruned trees produced less roots overall, *mostly in the deeper soil layers*

Fall



“Bump” in Fall root production mostly deeper than 60 cm, not very relevant for nutrition

Summary

- Fine roots (< 0.5 mm (<0.02 inch)) are most active in water and nutrient uptake
- They are produced throughout the year, with a large peak April – June
- During this period of high activity, fine roots are very sensitive to overwatering (low oxygen)
- Deep water uptake can substantially contribute to tree water uptake
- BUT
  - Roots have to be there in the first place
  - Practices that discourage deep root growth include
    - frequent shallow water applications
    - creating anoxic soil conditions in spring when most root growth occurs
    - heavy pruning of young trees

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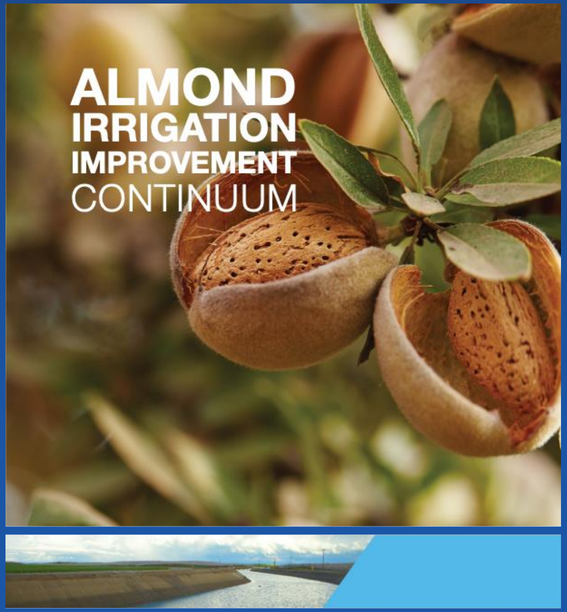
When to Irrigate: Considering Soil & Tree Growth

Speakers: Curt Pierce (UC ANR)

Advancing the Continuum

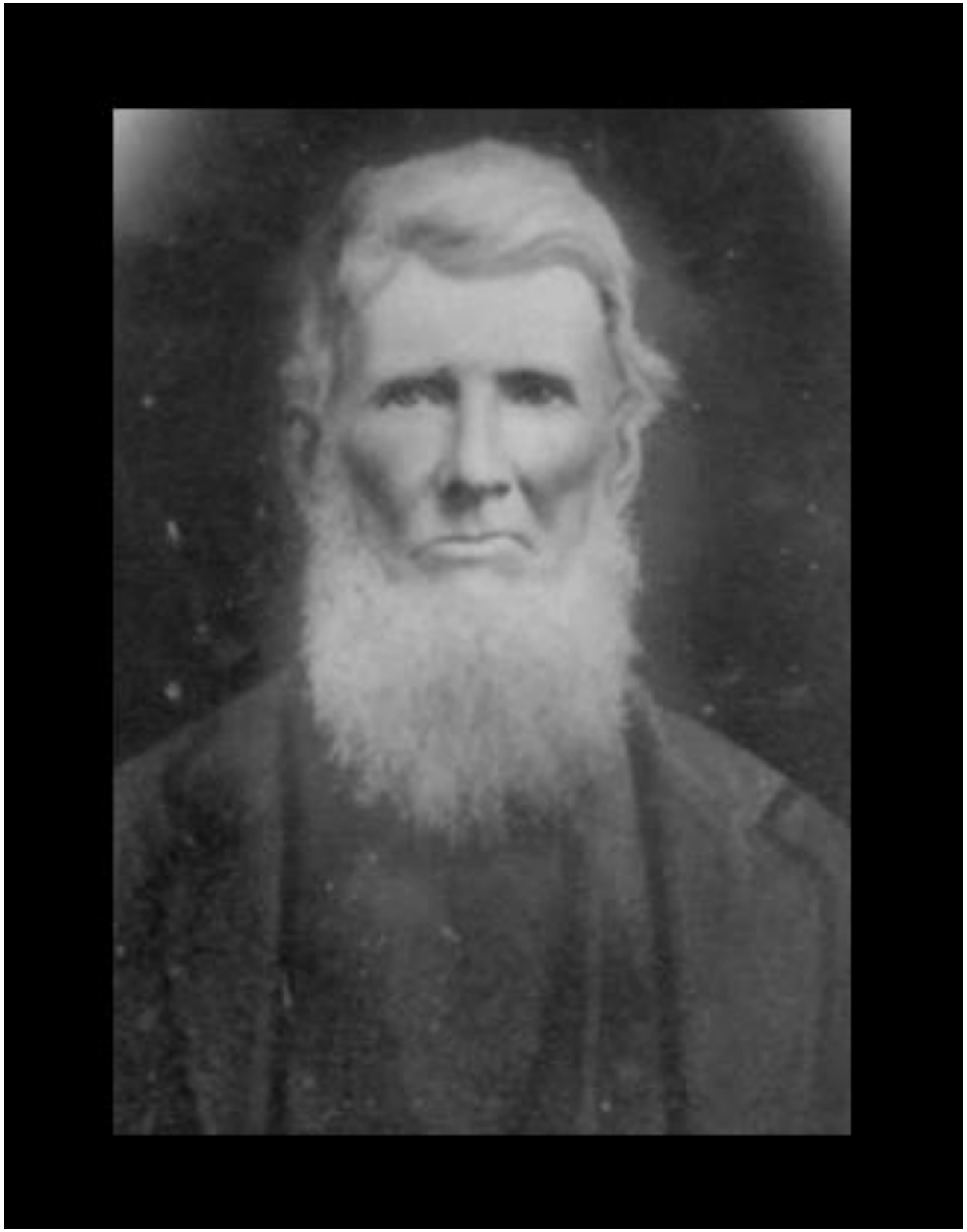
Tools for Irrigating Almond Trees in 2025



Curt Pierce, Irrigation and Water Resources Advisor
Glenn, Tehama, Colusa, and Shasta Counties

December 11, 2024

UNIVERSITY OF CALIFORNIA
Agriculture and Natural Resources



“Orchard management is as much about timing and moderation as it is about supply.”

Evapotranspiration (ET) Replacement using ET reports

- Uses reference ET and crop coefficients to estimate water need
  - Pros:
    - Low-cost, straightforward
  - Cons:
    - Not specific to individual tree status, data sources?
- Good for baseline scheduling
- No additional equipment needed

WEEKLY ET REPORT
(Estimated Crop Evapotranspiration or ETc)
10/18/24 through 10/24/24

Crops (Leafout Date)	Tehama County - Gerber South			Butte County - Biggs			Butte County - Durham			Colusa County - Williams		
	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	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
Pasture [ETo]	0.96	50.09	0.68	0.93	46.39	0.63	0.78	40.61	0.58	1.11	47.39	0.74
Olives Table *	0.74	37.92	0.52	0.71	35.10	0.47	0.60	30.74	0.44	0.84	35.84	0.54
Olives High Density *	0.57	30.02	0.40	0.56	27.91	0.37	0.46	24.31	0.37	0.67	28.40	0.44
Citrus *	0.63	32.63	0.46	0.60	30.22	0.43	0.52	26.41	0.37	0.73	30.89	0.48
Almonds (3/01) *	0.84	49.60	0.59	0.82	45.87	0.53	0.70	39.88	0.48	0.98	46.52	0.61
Cling Peaches (3/25) *	0.84	42.82	0.59	0.82	39.51	0.53	0.70	34.25	0.48	0.98	39.70	0.61
Pistachios (4/7) *	0.84	45.91	0.59	0.82	42.10	0.53	0.70	36.53	0.48	0.98	42.20	0.61
Prunes (3/25) *	0.57	43.14	0.38	0.56	39.82	0.36	0.48	34.50	0.31	0.67	40.30	0.41
Walnuts (4/7) *	0.57	42.47	0.40	0.56	38.88	0.37	0.46	33.81	0.37	0.67	39.30	0.44
Urban Turf Grass	0.66	41.73	0.47	0.65	38.61	0.43	0.54	33.92	0.40	0.77	39.39	0.51
Past 7 days precipitation (inches)		(0.00)			(0.00)			(0.00)			(0.00)	
Accumulated precipitation (inches)		(4.83)			(4.02)			(4.52)			(2.48)	

*Accumulations started on March 1st 2024 for pasture, table and high density olives, citrus, almond, turf grass, and rainfall. Accumulations for prune, walnuts, and vineyards will begin as soon as leafout occurs for the 2024 season and the leafout date will be noted in parentheses next to the crop.
* Estimates are for orchard floor conditions where vegetation is managed by some combination of strip applications of herbicides, frequent mowing or tillage, and by mid and late season shading and water stress. Weekly estimates of soil moisture loss can be as much as 25 percent higher in orchards where cover crops are planted and managed more intensively for maximum growth.

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

Crops	Tehama County - Gerber South			Butte County - Biggs			Butte County - Durham			Colusa County - Williams		
System Efficiency >>	70%	80%	90%	70%	80%	90%	70%	80%	90%	70%	80%	90%
Olives Table	1.1	0.9	0.8	1.0	0.9	0.8	0.9	0.8	0.7	1.2	1.1	0.9
Olives High Density	0.8	0.7	0.6	0.8	0.7	0.6	0.7	0.6	0.5	1.0	0.8	0.7
Citrus	0.9	0.8	0.7	0.9	0.8	0.7	0.7	0.7	0.6	1.0	0.9	0.8
Almonds (3/01)	1.2	1.1	0.9	1.2	1.0	0.9	1.0	0.9	0.8	1.4	1.2	1.1
Cling Peaches (3/25)	1.2	1.1	0.9	1.2	1.0	0.9	1.0	0.9	0.8	1.4	1.2	1.1
Pistachios (4/7)	1.2	1.1	0.9	1.2	1.0	0.9	1.0	0.9	0.8	1.4	1.2	1.1
Prunes (3/25)	0.8	0.7	0.6	0.8	0.7	0.6	0.7	0.6	0.5	1.0	0.8	0.7
Walnuts (4/7)	0.8	0.7	0.6	0.8	0.7	0.6	0.7	0.6	0.5	1.0	0.8	0.7

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%; and Border-furrow, 50%-75%.
For further information concerning all counties receiving this report, contact the Glenn Co. Farm Advisor's office at (530) 865-1153 or email calpierce@ucanr.edu
This same information and source is now available in the ET Reports section of the sacvalleyorchards.com website. Same information, just in a different format.

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Olives High Density	0.8	0.7	0.6	0.8	0.7	0.6	0.7	0.6	0.5	1.0	0.8	0.7
Citrus	0.9	0.8	0.7	0.9	0.8	0.7	0.7	0.7	0.6	1.0	0.9	0.8
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Pistachios (4/7)	1.2	1.1	0.9	1.2	1.0	0.9	1.0	0.9	0.8	1.4	1.2	1.1
Prunes (3/25)	0.8	0.7	0.6	0.8	0.7	0.6	0.7	0.6	0.5	1.0	0.8	0.7
Walnuts (4/7)	0.8	0.7	0.6	0.8	0.7	0.6	0.7	0.6	0.5	1.0	0.8	0.7

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%; and Border-furrow, 50%-75%.
For further information concerning all counties receiving this report, contact the Glenn Co. Farm Advisor's office at (530) 865-1153 or email calpierce@ucanr.edu
This same information and source is now available in the ET Reports section of the sacvalleyorchards.com website. Same information, just in a different format.

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Application Rate (AR)

- Inlet T pressures (5 total)
  - Low, 9 psi
  - High, 10.5 psi
  - Variation, 15%
- Hose line pressure variation
  - Minimum, .5 psi
  - Maximum, 1.5 psi
- Overall pressure variation
  - Lowest recorded in field, 9 psi
  - Highest recorded in field, 10.5 psi
  - Range 15%
- Pressure details
  - Manufacturer specifications for Netafim Supernet Jr.
    - Pressure range 15 to 35 psi
    - Flow rate, gray nozzle 12 – 16.9 gph
  - Field evaluation data
    - Pressure range 9 to 10 psi
    - Average flow rate 9.36 gph

This irrigation system's performance:

Distribution Uniformity 92.7%

Application Rate... .026 in/hr

Rated AR for this system design is 3.64 to 4.4 in/hr

- No degree of irrigation management can be done without knowing application rate
- That application rate is unlikely to be what is documented on design reports
- Annual assessment of system performance – especially application rate is vital

Credit: Tehama County Mobile Irrigation Lab

EXAMPLE: 90 trees per acre, solid set mini-sprinklers, one sprinkler every other tree, offset every other row so 45 sprinkler per acre. Nozzle flow rate 1.2 gpm at 30 psi.

90 trees ÷ 2 (one sprinkler every other tree) x 1.2 gallons per sprinkler per minute x 60 minutes per hour = 3,240 gallons applied per hour per acre

3,240 gallons ÷ 27,154 gallons = **<u>0.12</u>** inch per hour

NOTE: *27,154 gallons of water = 1.0 acre-inch of water (enough to fill a one-acre pool to a depth of 1")*

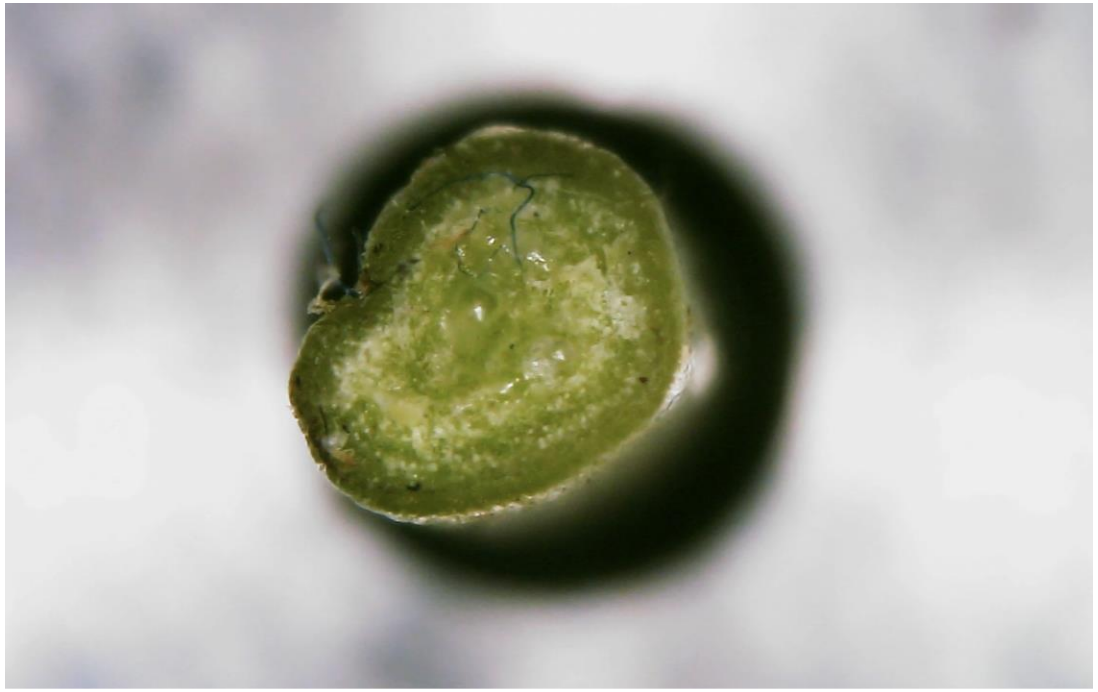
Estimating Soil Moisture (SM) with Sensors

Credit: Wildeye®

- Tensiometer or dielectric sensors report soil moisture % at depth
  - Pros:
    - Can be relatively inexpensive and easy to install, continuous data reports
  - Cons:
    - Issues can arise from improper installs and calibration. Location matters.
- Beneficial for “truthing” ET replacement, determining timing

Determine Stem Water Potential (SWP)

- Use of portable pressure chamber devices to determine tree water stress via SWP
  - Pros:
    - Highly accurate, direct measurements – “gold standard”
  - Cons:
    - Cost of labor and/or equipment, ease of use, time constraints, use of gas needed for operation
- Helps estimate effectiveness of irrigation management programs



Air Temp (F)	Air Relative Humidity															
	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85
60	-6.0	-5.9	-5.8	-5.7	-5.6	-5.5	-5.4	-5.3	-5.2	-5.1	-4.9	-4.8	-4.7	-4.6	-4.5	-4.4
62	-6.1	-6.0	-5.9	-5.8	-5.7	-5.6	-5.5	-5.4	-5.2	-5.1	-5.0	-4.9	-4.8	-4.7	-4.6	-4.4
64	-6.3	-6.2	-6.1	-5.9	-5.8	-5.7	-5.6	-5.4	-5.3	-5.2	-5.1	-5.0	-4.8	-4.7	-4.6	-4.5
66	-6.5	-6.3	-6.2	-6.1	-5.9	-5.8	-5.7	-5.5	-5.4	-5.3	-5.1	-5.0	-4.9	-4.8	-4.6	-4.5
68	-6.6	-6.5	-6.3	-6.2	-6.1	-5.9	-5.8	-5.6	-5.5	-5.4	-5.2	-5.1	-4.9	-4.8	-4.7	-4.5
70	-6.8	-6.7	-6.5	-6.4	-6.2	-6.1	-5.9	-5.8	-5.6	-5.5	-5.3	-5.2	-5.0	-4.9	-4.7	-4.6
72	-7.0	-6.8	-6.7	-6.5	-6.4	-6.2	-6.0	-5.9	-5.7	-5.5	-5.4	-5.2	-5.1	-4.9	-4.7	-4.6
74	-7.2	-7.0	-6.9	-6.7	-6.5	-6.3	-6.2	-6.0	-5.8	-5.6	-5.5	-5.3	-5.1	-5.0	-4.8	-4.6
76	-7.4	-7.2	-7.0	-6.9	-6.7	-6.5	-6.3	-6.1	-5.9	-5.8	-5.6	-5.4	-5.2	-5.0	-4.8	-4.7
78	-7.6	-7.4	-7.2	-7.0	-6.9	-6.7	-6.5	-6.3	-6.1	-5.9	-5.7	-5.5	-5.3	-5.1	-4.9	-4.7
80	-7.9	-7.7	-7.5	-7.2	-7.0	-6.8	-6.6	-6.4	-6.2	-6.0	-5.8	-5.6	-5.4	-5.1	-4.9	-4.7
82	-8.1	-7.9	-7.7	-7.5	-7.2	-7.0	-6.8	-6.6	-6.3	-6.1	-5.9	-5.7	-5.4	-5.2	-5.0	-4.8
84	-8.4	-8.2	-7.9	-7.7	-7.4	-7.2	-7.0	-6.7	-6.5	-6.2	-6.0	-5.8	-5.5	-5.3	-5.1	-4.8
86	-8.7	-8.4	-8.2	-7.9	-7.7	-7.4	-7.2	-6.9	-6.6	-6.4	-6.1	-5.9	-5.6	-5.4	-5.1	-4.9
88	-9.0	-8.7	-8.4	-8.2	-7.9	-7.6	-7.4	-7.1	-6.8	-6.5	-6.3	-6.0	-5.7	-5.5	-5.2	-4.9
90	-9.3	-9.0	-8.7	-8.4	-8.1	-7.9	-7.6	-7.3	-7.0	-6.7	-6.4	-6.1	-5.8	-5.5	-5.3	-5.0
92	-9.6	-9.3	-9.0	-8.7	-8.4	-8.1	-7.8	-7.5	-7.2	-6.9	-6.6	-6.3	-5.9	-5.6	-5.3	-5.0
94	-10.0	-9.7	-9.3	-9.0	-8.7	-8.4	-8.0	-7.7	-7.4	-7.0	-6.7	-6.4	-6.1	-5.7	-5.4	-5.1
96	-10.4	-10.0	-9.7	-9.3	-9.0	-8.6	-8.3	-7.9	-7.6	-7.2	-6.9	-6.5	-6.2	-5.8	-5.5	-5.1
98	-10.8	-10.4	-10.0	-9.6	-9.3	-8.9	-8.5	-8.2	-7.8	-7.4	-7.1	-6.7	-6.3	-5.9	-5.6	-5.2
100	-11.2	-10.8	-10.4	-10.0	-9.6	-9.2	-8.8	-8.4	-8.0	-7.6	-7.2	-6.8	-6.5	-6.1	-5.7	-5.3
102	-11.6	-11.2	-10.8	-10.4	-9.9	-9.5	-9.1	-8.7	-8.3	-7.9	-7.4	-7.0	-6.6	-6.2	-5.8	-5.4
104	-12.1	-11.6	-11.2	-10.7	-10.3	-9.9	-9.4	-9.0	-8.5	-8.1	-7.6	-7.2	-6.8	-6.3	-5.9	-5.4
106	-12.5	-12.1	-11.6	-11.1	-10.7	-10.2	-9.7	-9.3	-8.8	-8.3	-7.9	-7.4	-6.9	-6.4	-6.0	-5.5
108	-13.1	-12.6	-12.1	-11.6	-11.1	-10.6	-10.1	-9.6	-9.1	-8.6	-8.1	-7.6	-7.1	-6.6	-6.1	-5.6
110	-13.6	-13.1	-12.5	-12.0	-11.5	-11.0	-10.4	-9.9	-9.4	-8.8	-8.3	-7.8	-7.3	-6.7	-6.2	-5.7
112	-14.2	-13.6	-13.0	-12.5	-11.9	-11.4	-10.8	-10.2	-9.7	-9.1	-8.6	-8.0	-7.5	-6.9	-6.3	-5.8
114	-14.7	-14.2	-13.6	-13.0	-12.4	-11.8	-11.2	-10.6	-10.0	-9.4	-8.8	-8.2	-7.6	-7.1	-6.5	-5.9
116	-15.4	-14.7	-14.1	-13.5	-12.9	-12.2	-11.6	-11.0	-10.4	-9.7	-9.1	-8.5	-7.9	-7.2	-6.6	-6.0
118	-16.0	-15.4	-14.7	-14.0	-13.4	-12.7	-12.0	-11.4	-10.7	-10.1	-9.4	-8.7	-8.1	-7.4	-6.7	-6.1
120	-16.7	-16.0	-15.3	-14.6	-13.9	-13.2	-12.5	-11.8	-11.1	-10.4	-9.7	-9.0	-8.3	-7.6	-6.9	-6.2

Pressure chamber reading or SWP measurement (bars)	Extent of crop stress and types of crop responses associated with different SWP levels in almond
0 to –6.0	Not commonly observed in almond.
–6.0 to –10.0	Low stress (when fully irrigated). Stimulates shoot growth, especially in developing orchards. Higher yield potential may be possible if these levels of crop stress are sustained over a season, barring no other limitations related to frost, pollination, diseases, or nutrition. Sustaining these levels may result in higher incidence of disease and reduced life span.
–10.0 to –14.0	Mild stress. Suitable from mid-June until the onset of hull split (July). Still able to produce competitively. Recommended crop stress level after harvest. May reduce energy costs or help cope with drought conditions.
–14.0 to –18.0	Moderate stress. Stops shoot growth in young orchards. Mature almonds can tolerate this level of crop stress during hull split (July/August) and still yield competitively. May help control diseases such as hull rot and alternaria, if present. May expedite hull split and lead to more uniform nut maturity. Also may help reduce energy costs and cope with drought conditions.
–18.0 to –20.0	Moderate to high stress. Should be avoided for extended periods. Likely to reduce yield potential, and may contribute to lower limb dieback.
–20.0 to –30.0	High stress. Wilting observed. Some defoliation. Impacts yield potential.
–30.0 to –60.0	Very high to severe stress. Extensive or complete defoliation is common. Trees may survive despite severe defoliation and may be rejuvenated.
less than –60.0	Trees are likely to die.

PressureBomb EXPRESS

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Monitoring Tree Water Status

- Use of in-situ microtensiometer devices to determine tree water stress
  - Pros:
    - Accurate, direct measurements, little to no labor, continuous data reporting
  - Cons:
    - Cost, maintenance, durability
- Helps estimate effectiveness and inform irrigation management programs

Credit: FloraPulse

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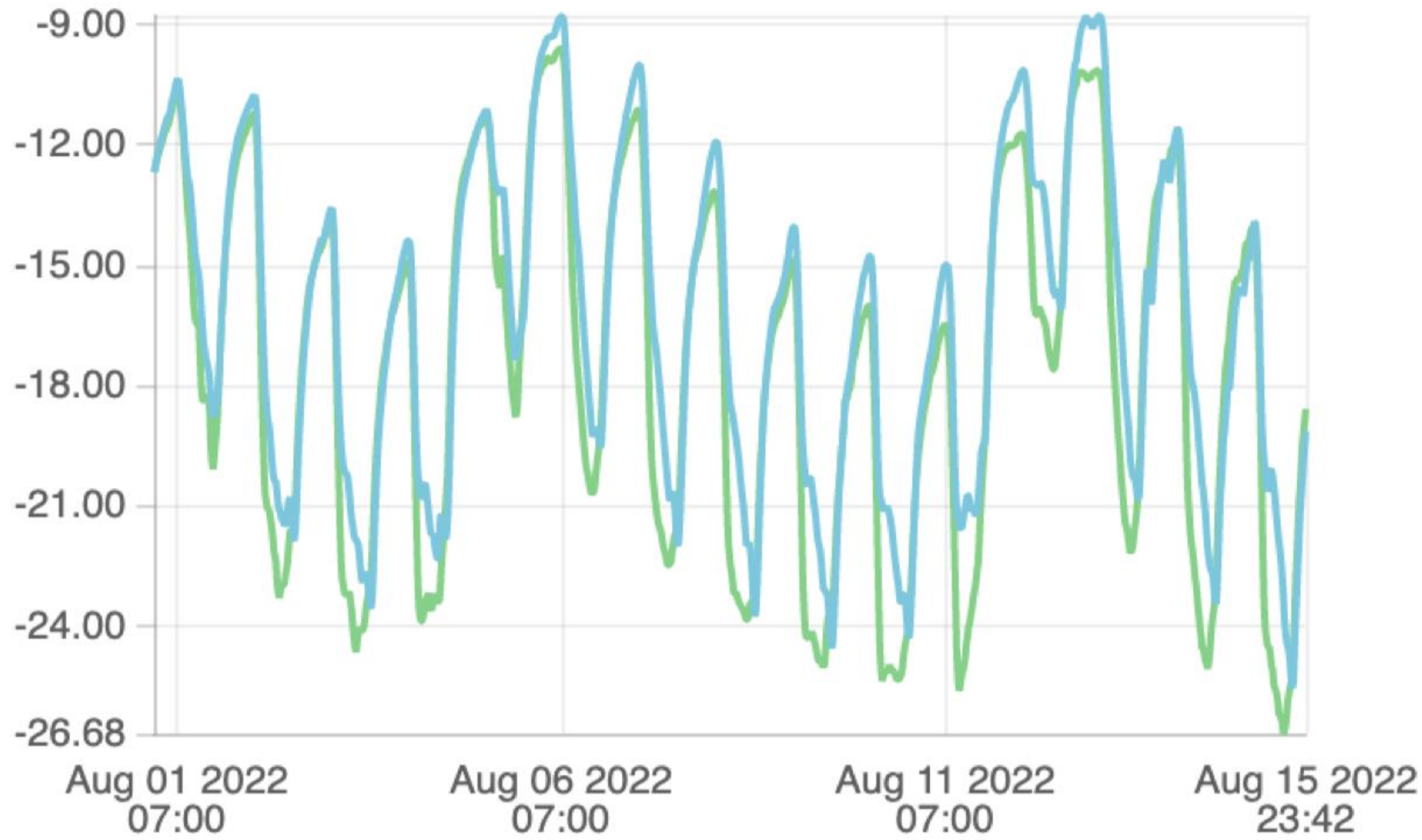
FloraPulse

24/7 - Almond



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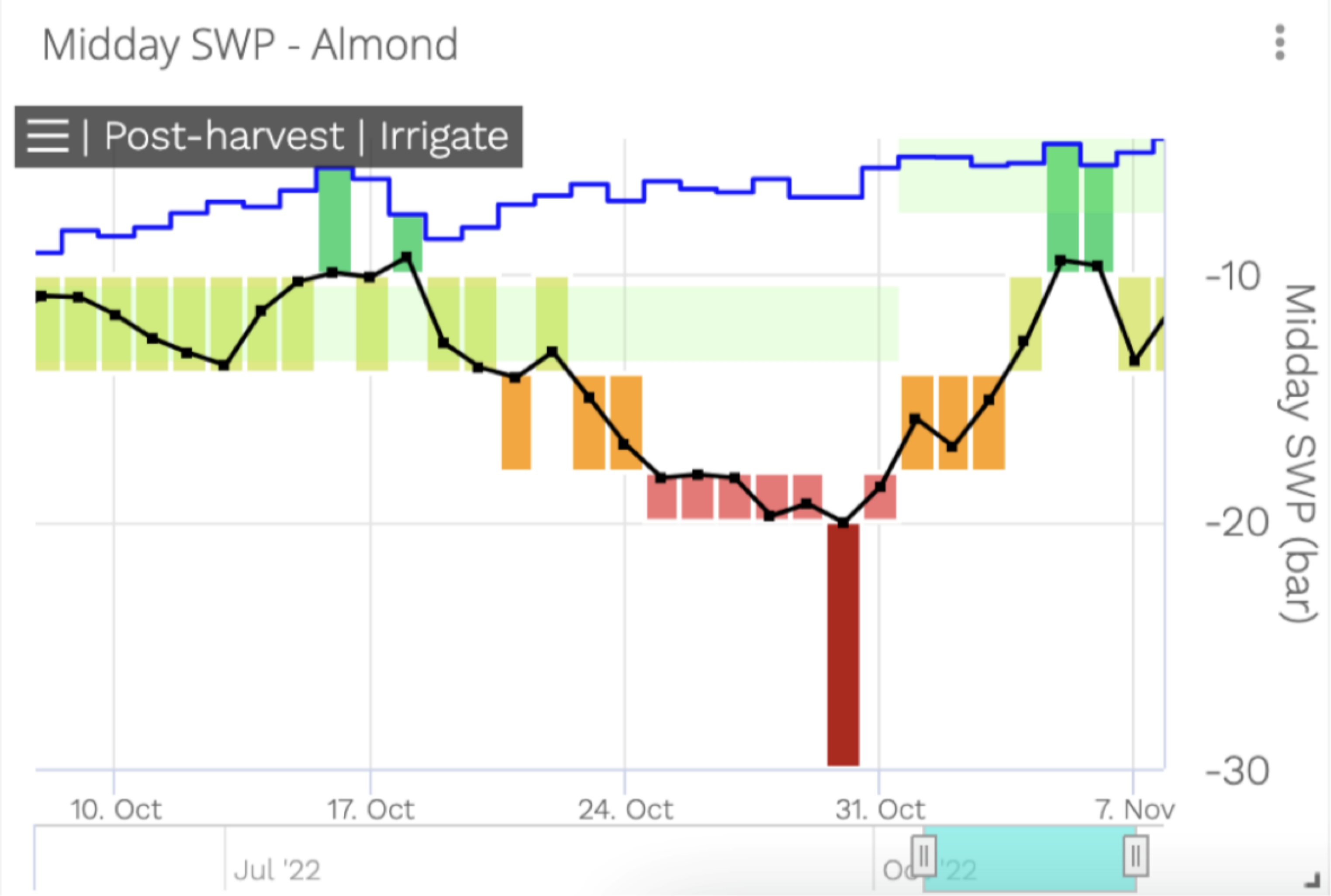
FloraPulse



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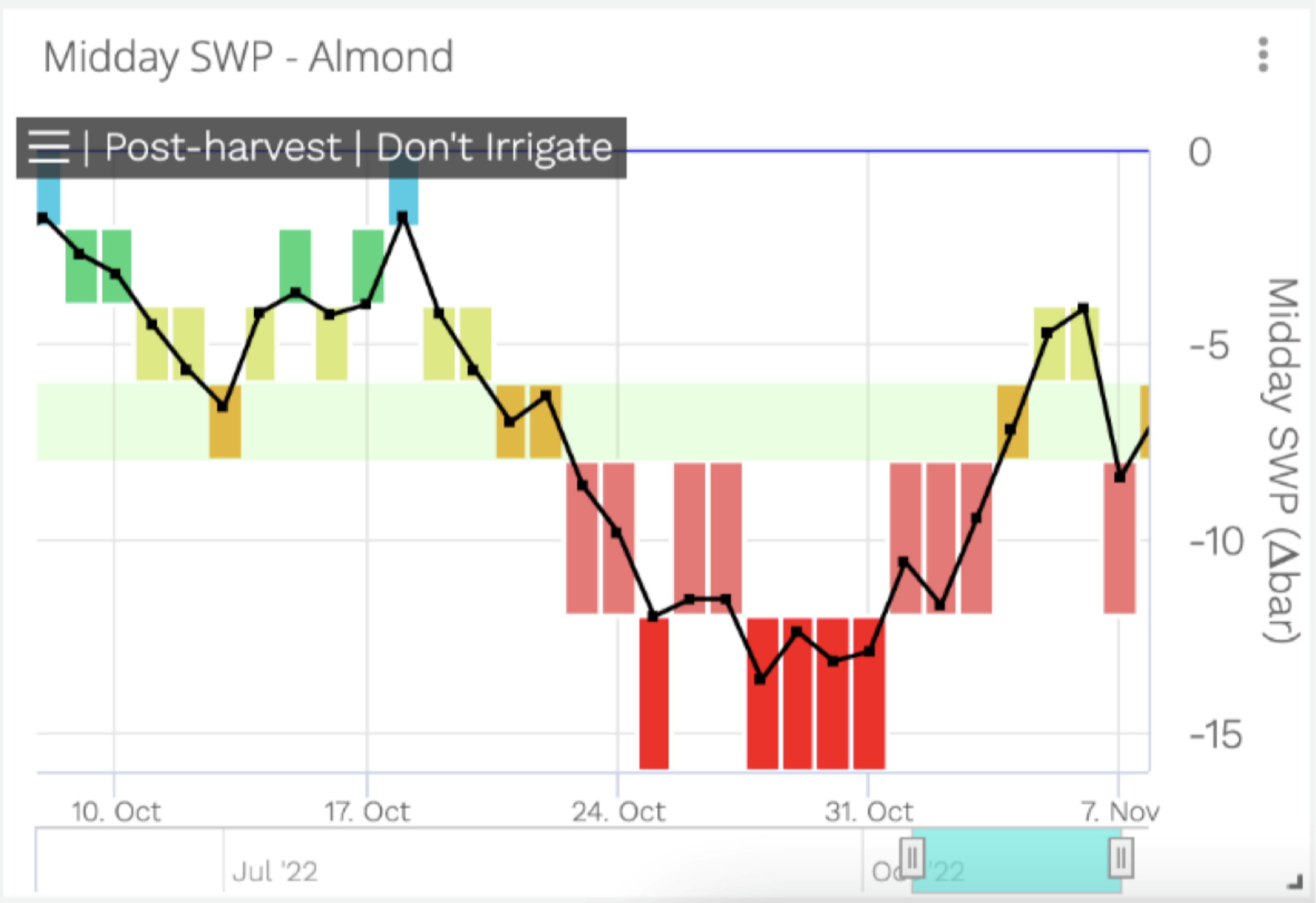

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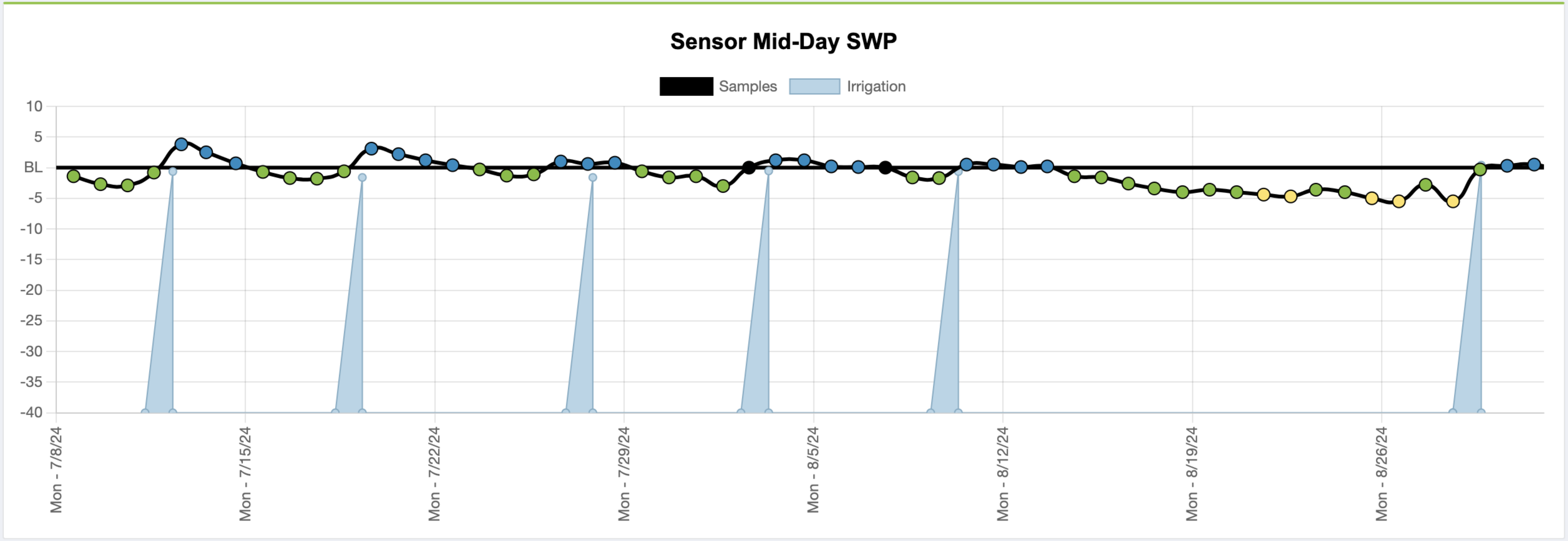
PressureBomb EXPRESS



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Timing and Moderation

WEEKLY ET REPORT
(Estimated Crop Evapotranspiration or ETc)
10/18/24 through 10/24/24

Crops (Leafout Date)	Tehama County - Gerber South			Butte County - Biggs			Butte County - Durham			Colusa County - Williams		
	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	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
Pasture [ETo]	0.96	50.09	0.68	0.93	46.39	0.63	0.78	40.61	0.58	1.11	47.39	0.74
Olives Table *	0.74	37.92	0.52	0.71	35.10	0.47	0.60	30.74	0.44	0.84	35.84	0.54
Olives High Density *	0.57	30.02	0.40	0.56	27.91	0.37	0.46	24.31	0.37	0.67	28.40	0.44
Citrus *	0.63	32.63	0.46	0.60	30.22	0.43	0.52	26.41	0.37	0.73	30.89	0.48
Almonds (3/01) *	0.84	49.60	0.59	0.82	45.87	0.53	0.70	39.88	0.48	0.98	46.52	0.61
Cling Peaches (3/25) *	0.84	42.82	0.59	0.82	39.51	0.53	0.70	34.25	0.48	0.98	39.70	0.61
Pistachios (4/7) *	0.84	45.91	0.59	0.82	42.10	0.53	0.70	36.53	0.48	0.98	42.20	0.61
Prunes (3/25) *	0.57	43.14	0.38	0.56	39.82	0.36	0.48	34.50	0.31	0.67	40.30	0.41
Walnuts (4/7) *	0.57	42.47	0.40	0.56	38.88	0.37	0.46	33.81	0.37	0.67	39.30	0.44
Urban Turf Grass	0.66	41.73	0.47	0.65	38.61	0.43	0.54	33.92	0.40	0.77	39.39	0.51
Past 7 days precipitation (inches)		(0.00)			(0.00)			(0.00)			(0.00)	
Accumulated precipitation (inches)		(4.83)			(4.02)			(4.52)			(2.48)	

*Accumulations started on March 1st 2024 for pasture, table and high density olives, citrus, almond, turf grass, and rainfall. Accumulations for prune, walnuts, and vineyards will begin as soon as leafout occurs for the 2024 season and the leafout date will be noted in parentheses next to the crop.
* Estimates are for orchard floor conditions where vegetation is managed by some combination of strip applications of herbicides, frequent mowing or tillage, and by mid and late season shading and water stress. Weekly estimates of soil moisture loss can be as much as 25 percent higher in orchards where cover crops are planted and managed more intensively for maximum growth.

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

Crops	Tehama County - Gerber South			Butte County - Biggs			Butte County - Durham			Colusa County - Williams		
System Efficiency >>	70%	80%	90%	70%	80%	90%	70%	80%	90%	70%	80%	90%
Olives Table	1.1	0.9	0.8	1.0	0.9	0.8	0.9	0.8	0.7	1.2	1.1	0.9
Olives High Density	0.8	0.7	0.6	0.8	0.7	0.6	0.7	0.6	0.5	1.0	0.8	0.7
Citrus	0.9	0.8	0.7	0.9	0.8	0.7	0.7	0.7	0.6	1.0	0.9	0.8
Almonds (3/01)	1.2	1.1	0.9	1.2	1.0	0.9	1.0	0.9	0.8	1.4	1.2	1.1
Cling Peaches (3/25)	1.2	1.1	0.9	1.2	1.0	0.9	1.0	0.9	0.8	1.4	1.2	1.1
Pistachios (4/7)	1.2	1.1	0.9	1.2	1.0	0.9	1.0	0.9	0.8	1.4	1.2	1.1
Prunes (3/25)	0.8	0.7	0.6	0.8	0.7	0.6	0.7	0.6	0.5	1.0	0.8	0.7
Walnuts (4/7)	0.8	0.7	0.6	0.8	0.7	0.6	0.7	0.6	0.5	1.0	0.8	0.7

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%; and Border-furrow, 50%-75%.
For further information concerning all counties receiving this report, contact the Glenn Co. Farm Advisor's office at (530) 865-1153 or email calpierce@ucanr.edu
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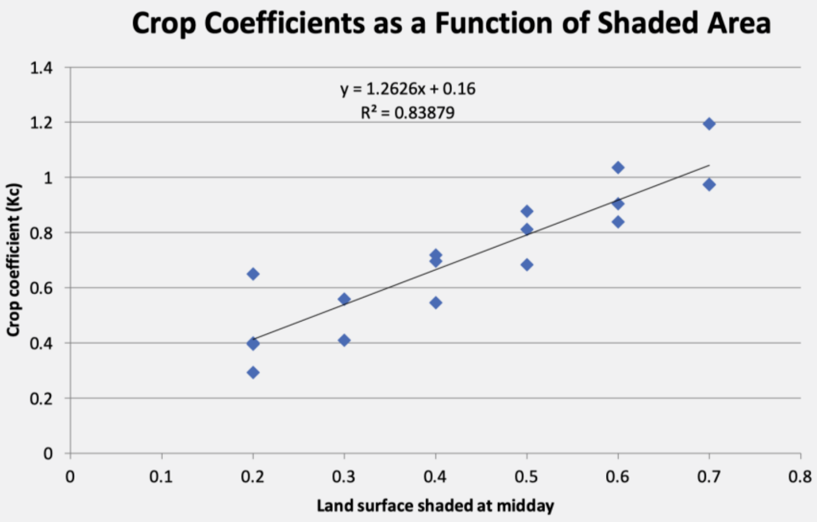

Figure 7. Relationship between the percentage of ground shading and crop coefficient (Kc).

% Shaded area	Crop Coefficient
20	41
30	54
40	67
55	79
60	92
70	100

Table 2. Growers can use this table to determine from the percent of midday ground shading in their orchard to estimate the crop coefficient of less than full canopy orchards.

Approximate canopy shading = 41 %

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Example calculation of reduced ET_c for young Almond orchard

WEEKLY ET REPORT
(Estimated Crop Evapotranspiration or ETc)
04/07/23 through 04/13/23

Crops (Leafout Date)	Tehama County - Gerber South			Butte County - Biggs			Butte County - Durham			Colusa County - Williams		
	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	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
Pasture [ETo]	1.15	4.90	1.32	1.15	4.93	1.16	1.14	4.68	1.22	1.25	5.35	1.28
Olives Table *	0.87	3.73	0.99	0.87	3.74	0.88	0.86	3.57	0.91	0.94	4.08	0.97
Olives High Density *	0.69	2.93	0.79	0.69	2.98	0.69	0.67	2.80	0.73	0.75	3.23	0.77
Citrus *	0.75	3.22	0.85	0.75	3.20	0.75	0.74	3.08	0.79	0.81	3.48	0.83
Almonds (3/01) *	0.89	3.06	1.07	0.89	3.09	0.93	0.87	2.93	0.97	0.96	3.34	1.02
Cling Peaches (3/25) *	0.46	1.28	0.53	0.45	1.27	0.49	0.46	1.20	0.51	0.49	1.34	0.53
Pistachios (4/7) *	0.49	0.49	0.57	0.50	0.50	0.49	0.48	0.48	0.51	0.53	0.53	0.54
Prunes (3/25) *	0.94	2.00	1.13	0.94	2.08	0.99	0.92	1.96	1.05	1.01	2.17	1.09
Walnuts (4/7) *	0.69	0.69	0.84	0.69	0.69	0.75	0.67	0.67	0.77	0.74	0.74	0.81
Urban Turf Grass	0.92	3.81	1.05	0.92	3.83	0.95	0.93	3.68	0.98	1.00	4.16	1.04
Past 7 days precipitation (inches)		(0.16)			(0.22)			(0.24)			(0.13)	
Accumulated precipitation (inches)		(8.98)			(6.29)			(6.86)			(6.18)	

*Accumulations started on March 1, 2023 for pasture, table and high density olives, citrus, almond, turf grass, and rainfall. Accumulations for prune, walnuts, and vineyards will begin as soon as leafout occurs for the 2023 season and the leafout date will be noted in parentheses next to the crop.
* Estimates are for orchard floor conditions where vegetation is managed by some combination of strip applications of herbicides, frequent mowing or tillage, and by mid and late season shading and water stress. Weekly estimates of soil moisture loss can be as much as 25 percent higher in orchards where cover crops are planted and managed more intensively for maximum growth.

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

Crops	Tehama County - Gerber South			Butte County - Biggs			Butte County - Durham			Colusa County - Williams		
System Efficiency >>	70%	80%	90%	70%	80%	90%	70%	80%	90%	70%	80%	90%
Olives Table	1.2	1.1	1.0	1.2	1.1	1.0	1.2	1.1	1.0	1.3	1.2	1.0
Olives High Density	1.0	0.9	0.8	1.0	0.9	0.8	1.0	0.8	0.7	1.1	0.9	0.8
Citrus	1.1	0.9	0.8	1.1	0.9	0.8	1.1	0.9	0.8	1.2	1.0	0.9
Almonds (3/01)	1.3	1.1	1.0	1.3	1.1	1.0	1.2	1.1	1.0	1.4	1.2	1.1
Cling Peaches (3/25)	0.7	0.6	0.5	0.6	0.6	0.5	0.7	0.6	0.5	0.7	0.6	0.5
Pistachios (4/7)	0.7	0.6	0.5	0.7	0.6	0.6	0.7	0.6	0.5	0.8	0.7	0.6
Prunes (3/25)	1.3	1.2	1.0	1.3	1.2	1.0	1.3	1.2	1.0	1.4	1.3	1.1
Walnuts (4/7)	1.0	0.9	0.8	1.0	0.9	0.8	1.0	0.8	0.7	1.1	0.9	0.8

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%; and Border-furrow, 50%-75%.
For further information concerning all counties receiving this report, contact the Tehama Co. Farm Advisor's office at (530) 527-3101 or the Glenn Co. Farm Advisor's office at (530) 865-1153.
This same information and source is now available in the ET Reports section of the sacvalleyorchards.com website. Same information, just in a different format.

0.96” x 0.67 = 0.64”
No consideration of irrigation efficiency

1.2” x 0.67 = 0.8”
Allowing for 80 % irrigation efficiency

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Weekly tracking of irrigation water

Sign out | Weekly Irrigation Scheduling Trac

Not secure | sacvalleyorchards.com/et-reports/et-calculators/irrigation-scheduling-tracker-per-acre/

Weekly Irrigation Scheduling Tracker (per acre)

Home > Et Reports > Et Calculators

Posted on September 11 2019 by Dani Lightle

This tracker compares maximum hours of irrigation that may be needed during a week to actual hours applied. This tracker is limited to weekly use. It is not capable of tracking total irrigation for the season.

Enter your orchard specific information into the yellow boxes and the results will display under the 'Calculation Results' heading below.

Information Needed:	
Weekly crop ET estimate (inch per acre per week)	2.2
Average hourly water application rate (inch per hour)	0.12
Actual hours of irrigation applied for the week	12
Answer:	
Maxiumum weekly hours of irrigation needed	18
Actual inches of water applied for the week	1.4
Percent of estimated weekly crop ET	64

Thank you

Curt Pierce, Irrigation and Water Resources Advisor

Glenn, Tehama, Colusa, and Shasta Counties

calpierce@ucanr.edu

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2024

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Soil Structure Considerations for Irrigation Efficiency

Speakers: Mae Culumber (UCCE Fresno)

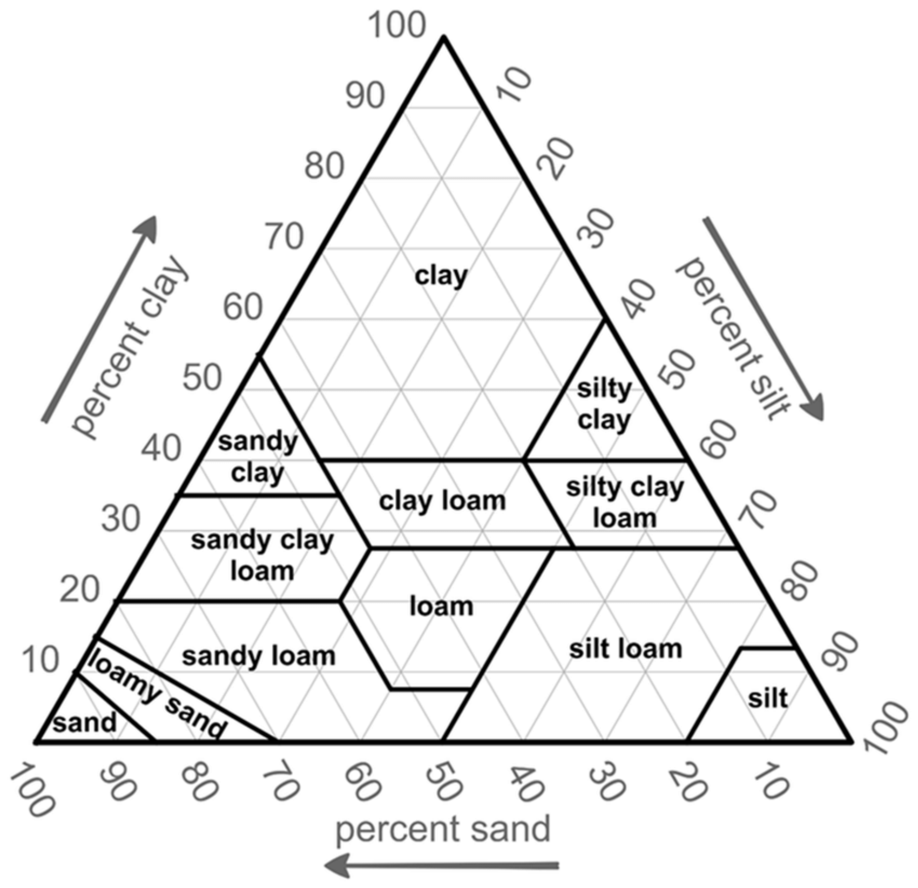
Irrigation systems are most efficient when the application rate matches infiltration and permeability of the soil

Factors influencing permeability

- Soil pore size and volume
- Soil structure aggregates
- Plant roots
- Soil cultivation practices
- Soil and water sodicity

Soil texture vs. structure

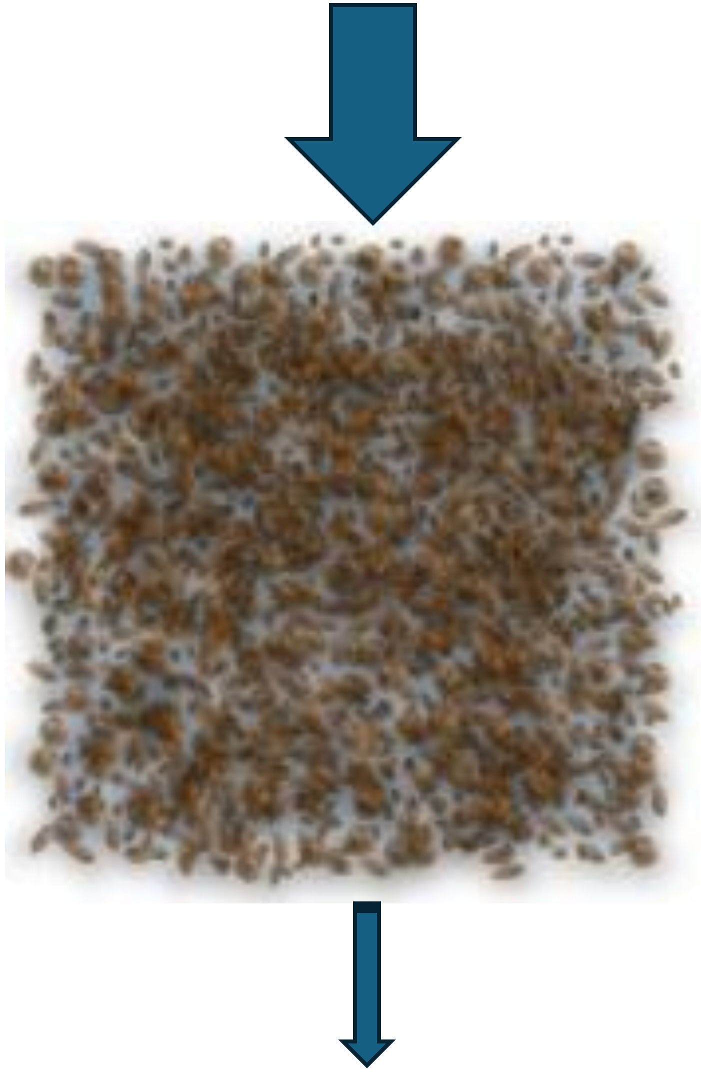
- Texture is proportion of different sized clay, silt, and sand particles
- cannot be changed, but different textured soils can be managed to improve soil structure



Soil texture influences pore size and volume

Sand 0.05 – 2 mm **Silt 0.002 – 0.05 mm** **Clay < 0.002 mm**

Low water holding potential

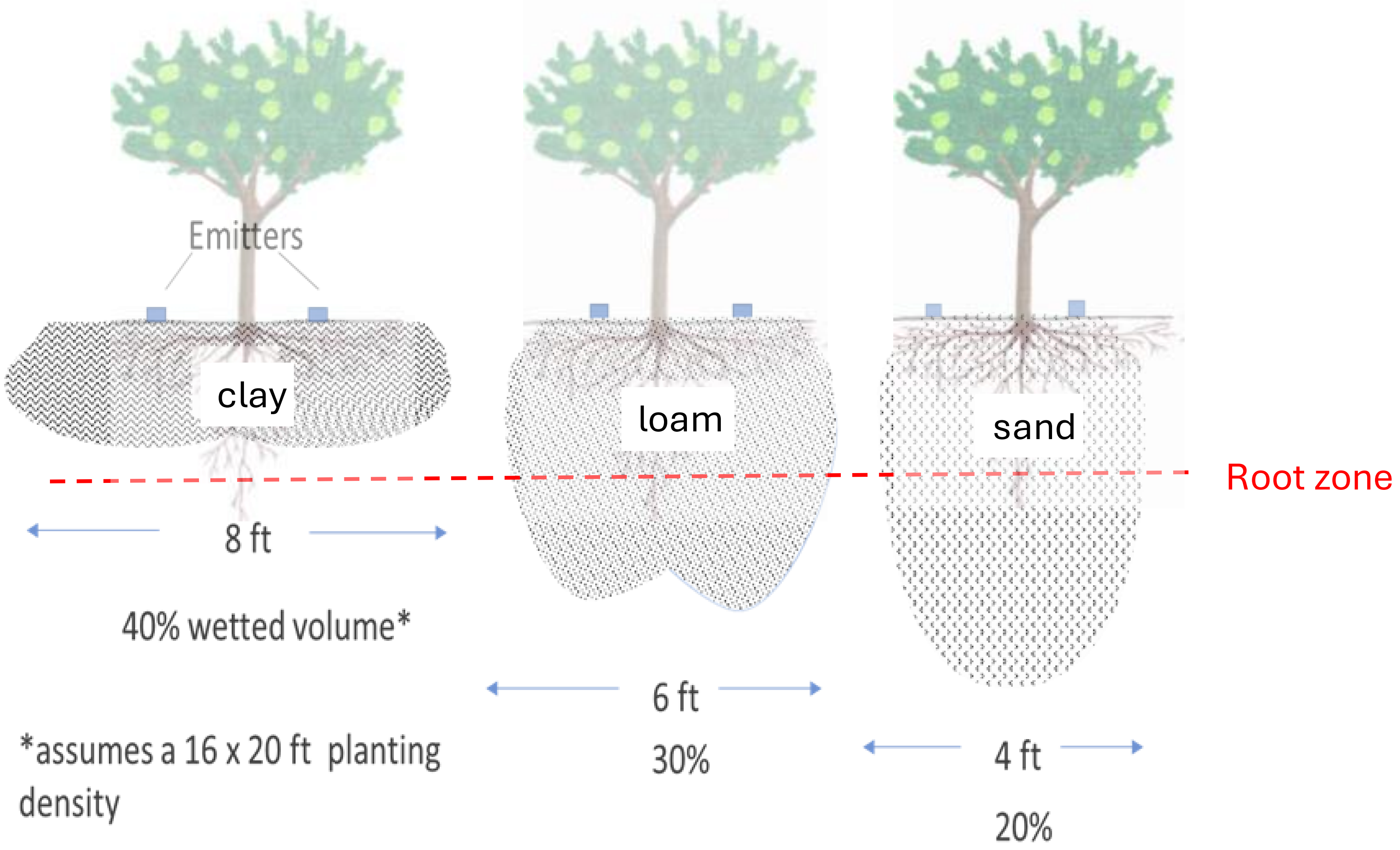


High water holding potential

Soil texture influences permeability

Permeability Class	Inches / hour	Soil texture
Very slow	0.1	clay
slow	0.1- 0.2	sandy clay, silty clay
Moderately slow	0.2 - 0.8	clay loam, sandy clay loam, silty clay loam
Moderate	0.8 - 2.5	very fine sandy loam, loam, silt loam, silty clay loam, silt
Moderately rapid	2.5 – 5	sandy loam, fine sandy loam
Rapid	5 - 10	sand, loamy sand
Very Rapid	> 10	coarse sand

Irrigation System % wetted area



- Easy to over-irrigate (exceed infiltration rate or lose water to deep percolation)
- Need to consider the % of wetted area influence by the system and soil type

Range of water holding capacity by texture

Soil Texture	Available Water Capacity (AWC) in/ft
Coarse Sand	0.2–0.8
Fine Sand	0.7–1.0
Loamy Sand	0.8–1.3
Sandy Loam	1.1–1.6
Fine Sandy Loam	1.2–2.0
Silt Loam	1.8–2.5
Silty Clay Loam	1.6–1.9
Silty Clay	1.5–2.0
Clay	1.3–1.8
Peat Mucks	1.9–2.9

Water applied = $[(MAD \div 100) \times \mathbf{W_a} \times Z_E] \div Eff_A$

Assessing soil texture by lab analyses

Saturation percentage %: the portion of soil pore space filled with water

Sandy soils < 20 %

Sandy loam to loam 20-35%

Clay soil 35 - > 50%

Group Number: **54541** Date Received: 8/20/2019 Report Date: 8/22/2019

Sample ID:	Field Name:	Depth:	Crop:
54541 - 2	Side NW	1-3	Pistachio

	Result			
Salinity				
pH (Sat Paste)	8.07	6.5-7.5		
EC (dS/m)	2.53	< 2		
Ca(meq/L)	6.75			
Mg (meq/L)	2.98			
Na (meq/L)	16.60			
Cl (meq/L)	5.64			
SO4 (meq/L)	11.40			
SAR	7.53	< 5		
B (mg/L)	1.60	< 1		
Sat %	50.34			
Exchangeable Cations (ppm)				
Calcium (ppm)	5380			
Magnesium (ppm)	659			
Potassium (ppm)	125			
Sodium (ppm)	649			
Base Saturation (%)				
TEC (meq/100g)	36.76			
Calcium (%)	73.04	65-75%		
Magnesium (%)	14.74	10-15%		
Potassium (%)	0.87	2-5%		
Sodium (%)	7.68	0-2%		
Hydrogen (%):	0.00			
Other Bases (%):	3.33			
Nutrients			Lb/Ac-Ft	
Sulfate-S (ppm):	92.0		368	
Nitrate-N (ppm)	32.1		128	
Phosphate-P (ppm)	3.3		13	(30.1 Lb/Ac P2O5)
Zinc (ppm)	0.4		2	
Iron (ppm)	5.6		22	
Copper (ppm)	1.0		4	
Manganese (ppm)	1.0		4	
Organic Matter (%)				
Limestone:				

Assessing soil texture by lab analyses

Cation exchange capacity

Soil texture	CEC meq/100 g
Loamy fine sand	< 10
Sandy loam	10 –12
loam	12–15
Silt loam	15 – 20
Clay loam	20 – 30+
Organic	50 –100

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Organic Matter (%)			
Limestone:			

Soil Structure types

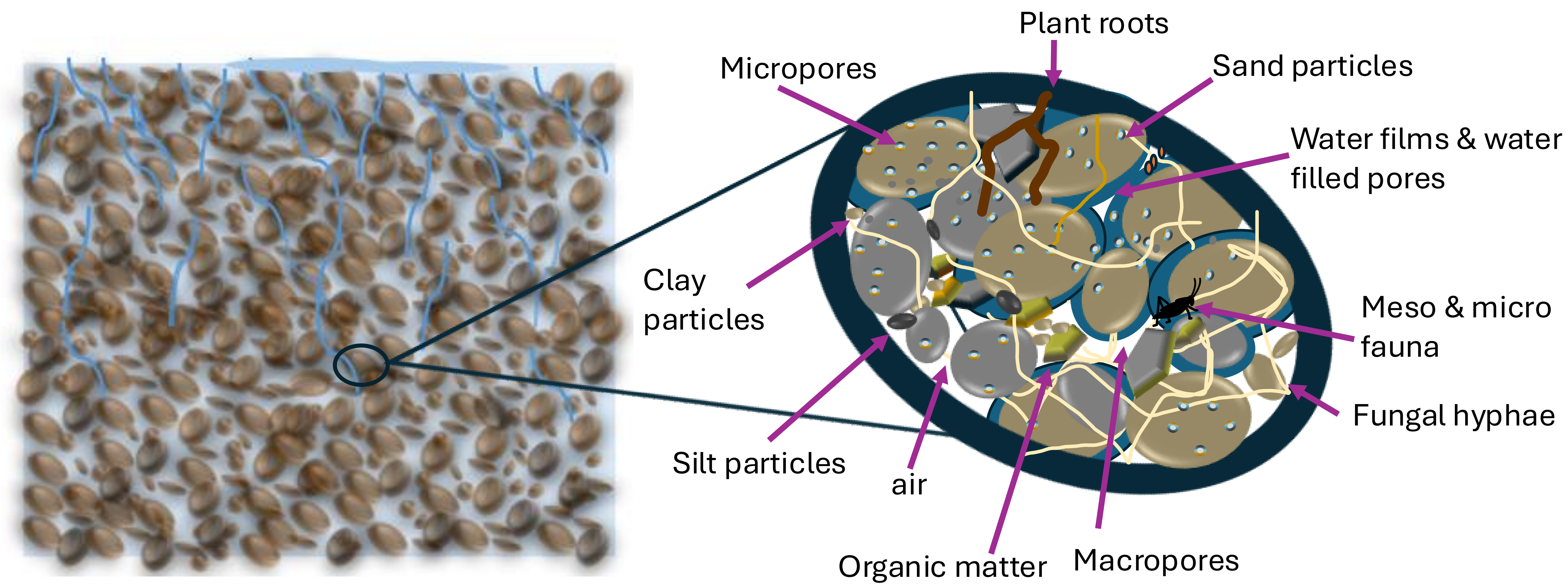
- Single grain
- Granular
- Blocky
- Columnar
- Platy
- Prismatic


Good permeability


Moderate permeability


Low permeability

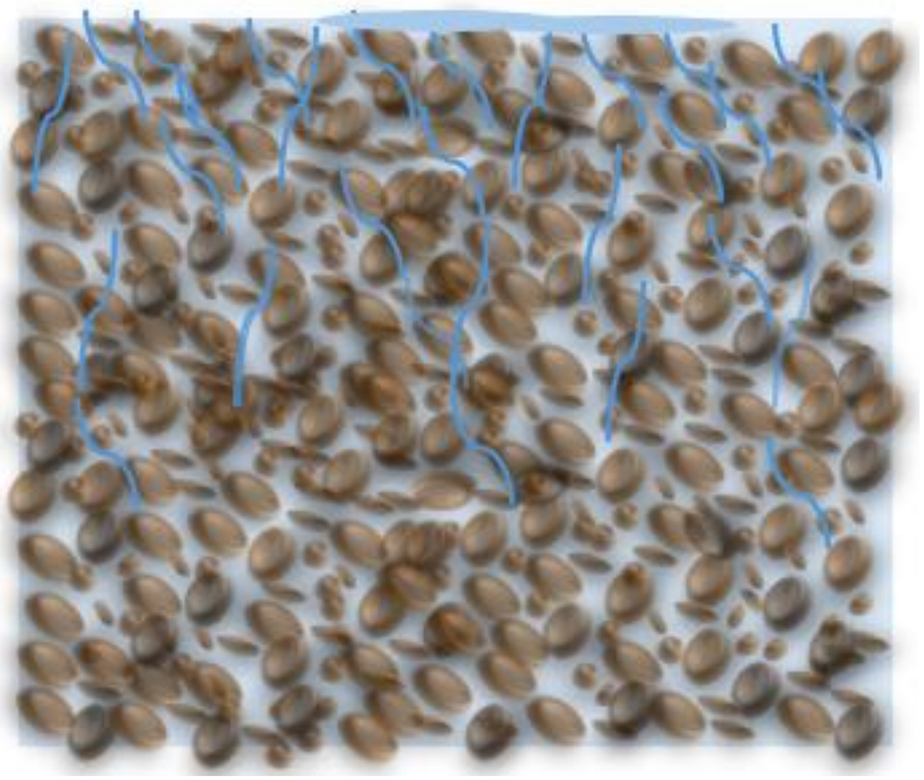
Components of an aggregated structured soil



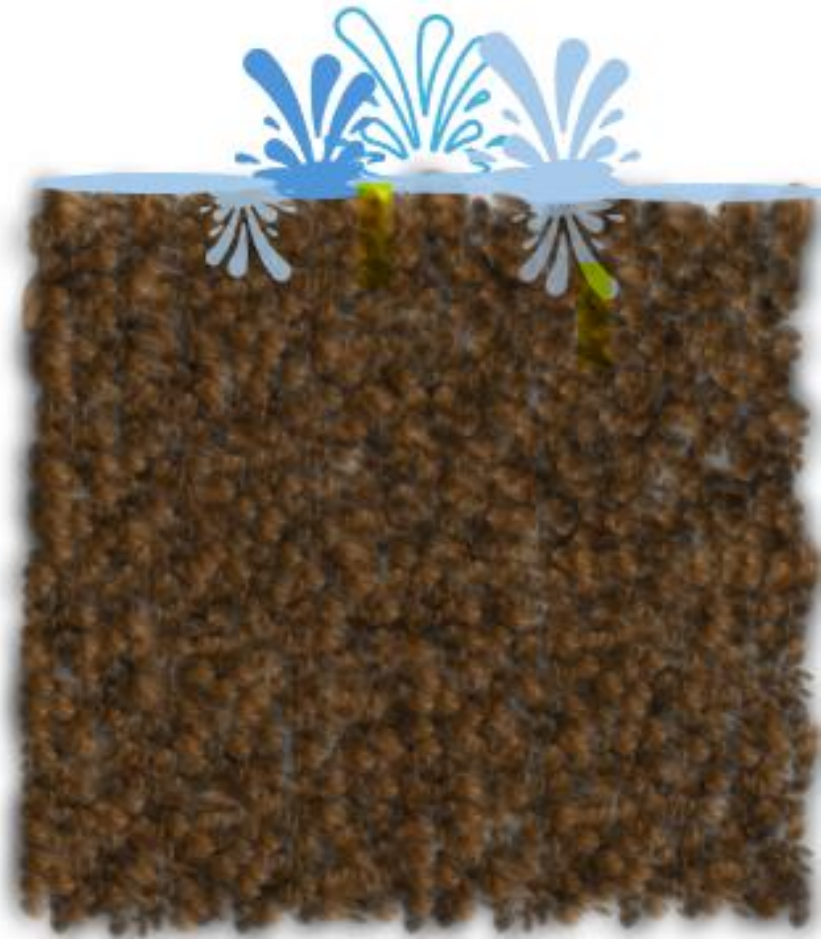
Frequent soil cultivation and wheel traffic creates soil crusts, surface compaction, and plow pans that will restrict root growth and slow water movement through the profile

Structure influences permeability

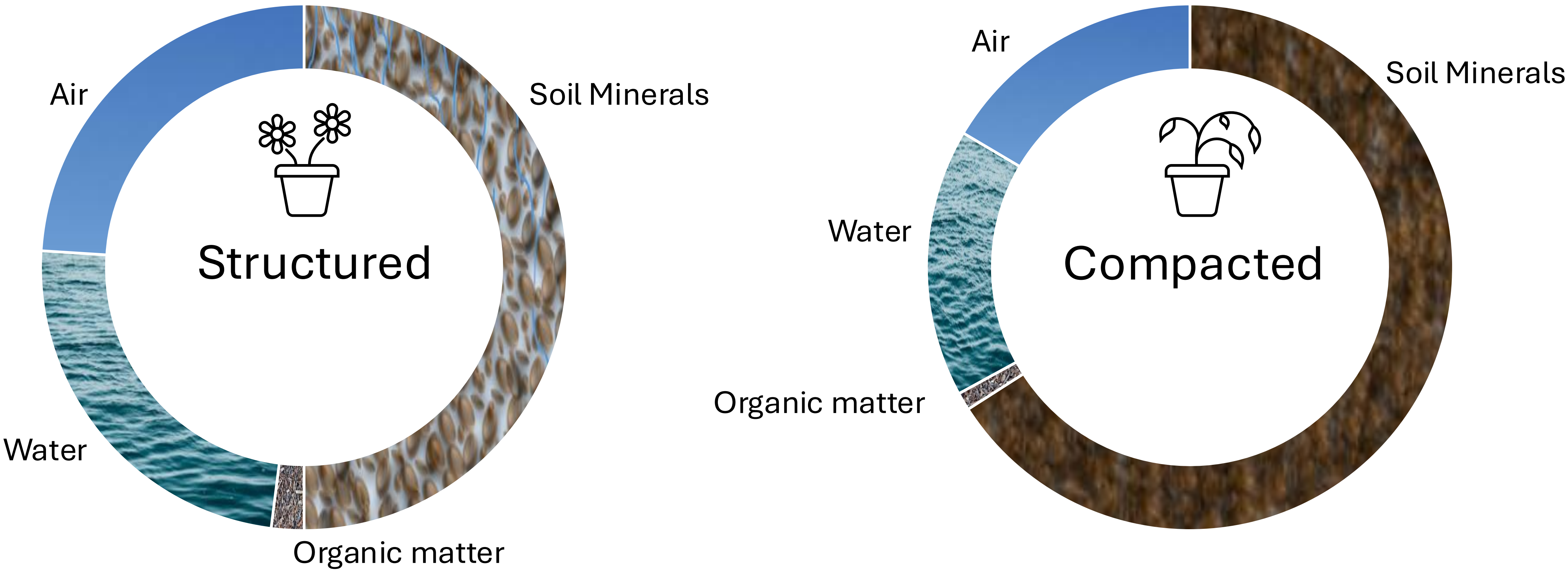
Structured



Compacted

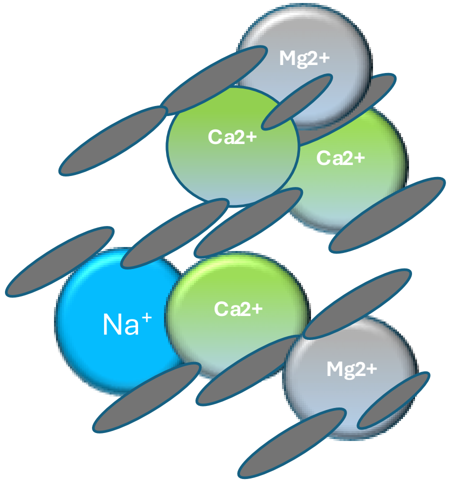


Compaction increases the proportion of solid material to water and air-filled pore space

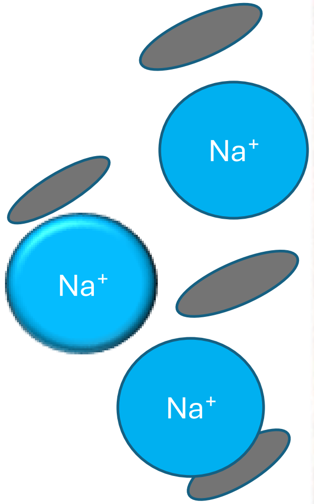


Sodicity and soil structure

Granular Structure



Crusting Poor Structure

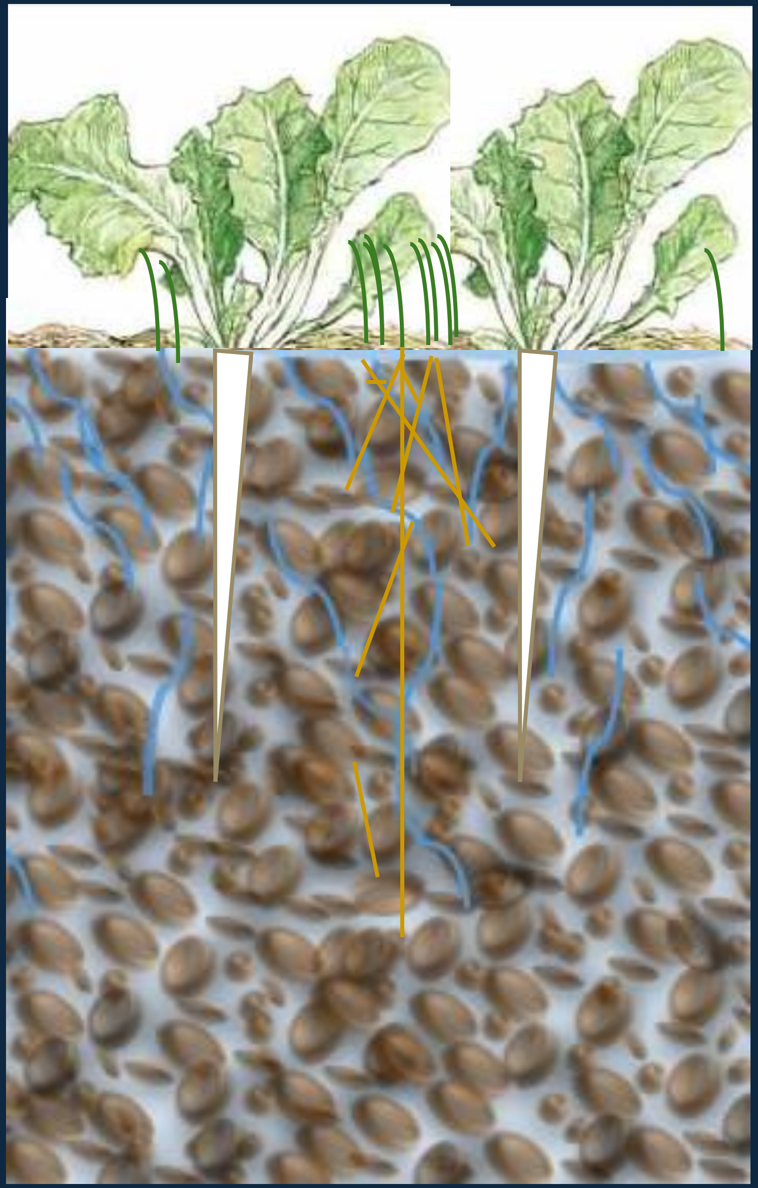


Soil amendments for salinity management

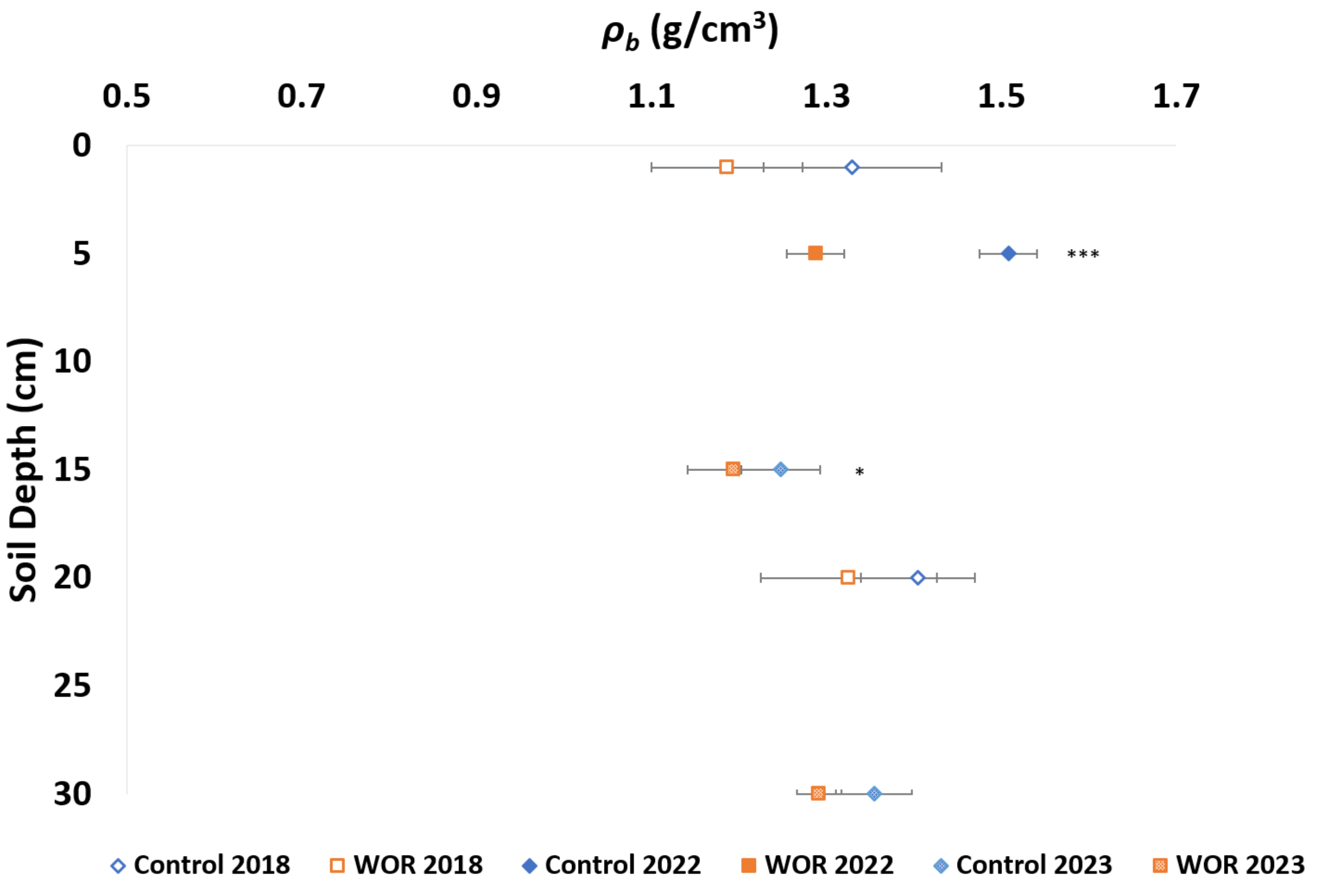
- Provide a source of calcium to replace sodium and remove it from the rootzone
- Calcium also aggregates soil and improves structure
- Acids neutralize soil lime, reduce pH, and improve nutrition
- Important to use soil and water analyses to determine the correct type and rate of materials

Cover crops, mulches and other organic matter inputs:

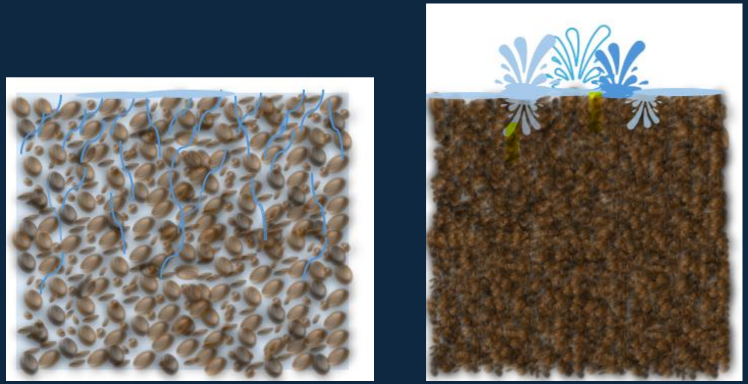
- protect the soil surface from rain droplets, reduce crust formation
- enhance microbial activity that aggregates soil
- improves infiltration
- enhance the effectiveness of other amendments



Wood mulch reduces bulk density

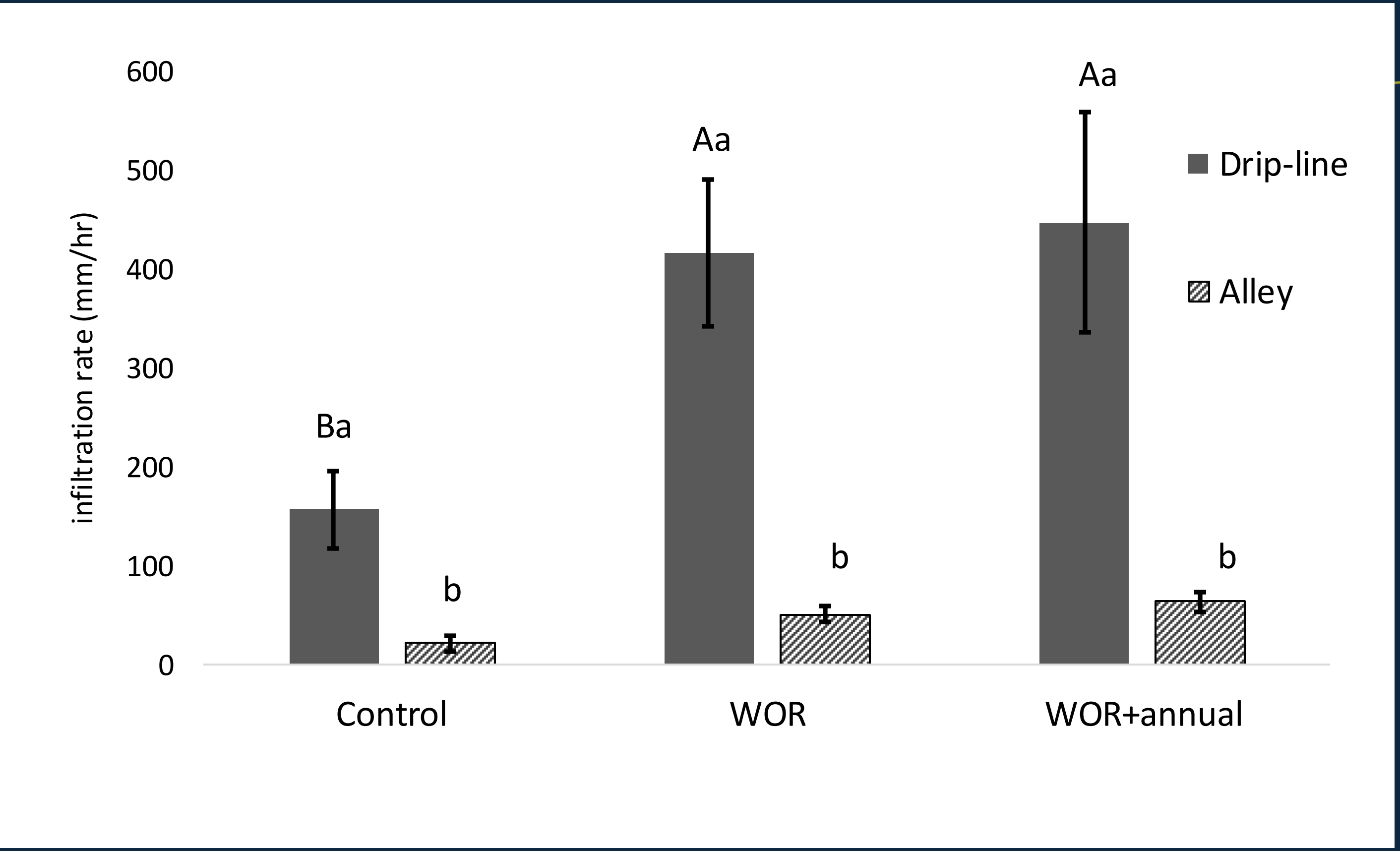


Thao et al. 2024



Bulk density is an indicator of soil compaction represented by the dry weight of soil to its volume

Wood mulch improves infiltration and reduces berm runoff



Orchard recycling increases soil organic matter and soil moisture

SOM levels significantly higher in 7 orchards after orchard recycling at 35 to 85 dry weight tons/ac

Soil moisture content significantly higher in the top 6“ and down to 48”

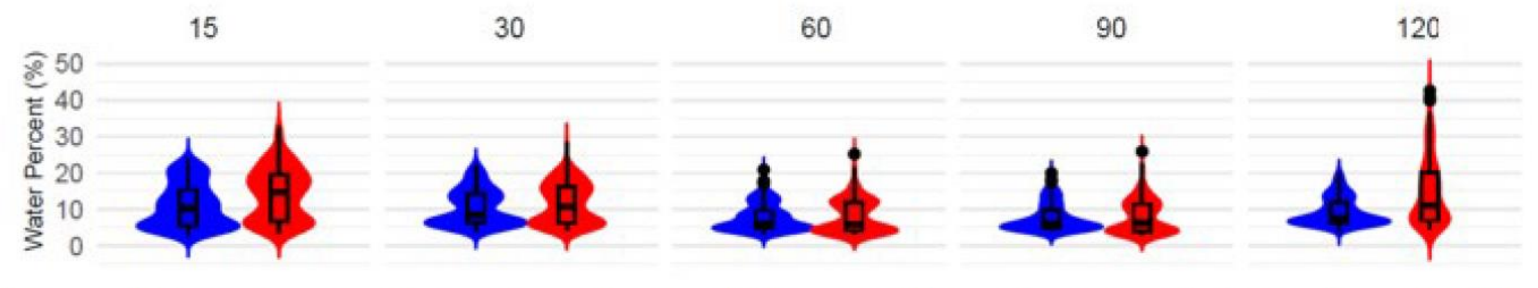
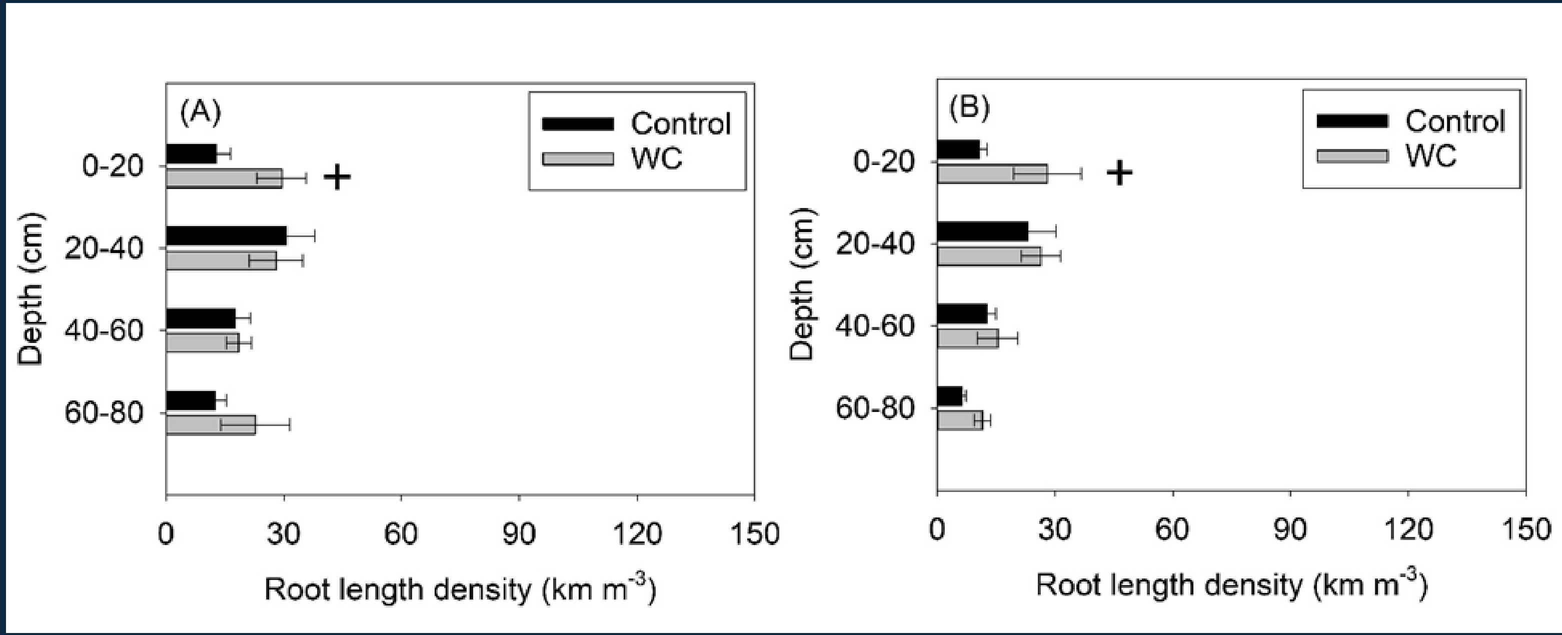


Figure 3. Density of average % moisture content for CN (blue) and WC (red/orange) with depth in the soil in 2023.

Orchard recycling increases root length density



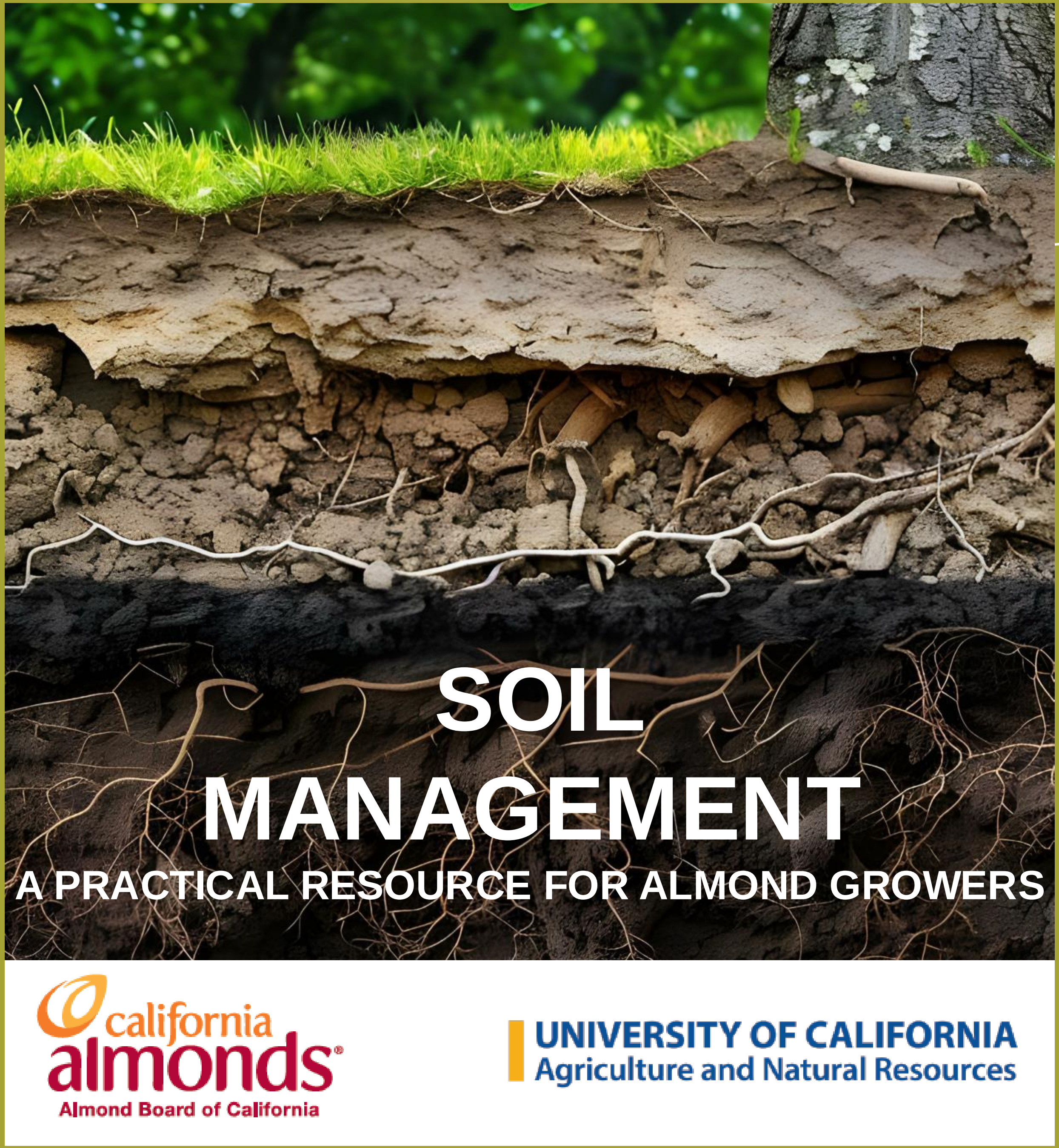
You et al. 2024 (in press)

Almond standing root length density 53% greater in the top 20 cm (8 inches) after WOR compared to controls with no wood chips

Summary

- Soil texture is determined by the composition of minerals and cannot be changed, but the structure of different soil types can be managed to improve the flow of water and air through soil
- Reducing cultivation passes, protecting the soil surface and increasing SOM with cover crops and mulches are the best tools for improving soil structure, increasing infiltration and water penetration, enhancing tree root growth, and promoting irrigation efficiency

Coming soon!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Q&A


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