

The background of the slide is a photograph showing a close-up of a garden bed. The left side is covered with a thick layer of light brown wood mulch, while the right side is bare, sandy soil. The text is overlaid on this image.

Whole Orchard Recycling (WOR) in Walnut

Clarissa Reyes, Cliff Buemel, Amanda Hodson, Becky-Wheeler Dykes, Brent Holtz

Tehama Walnut Day | March 6, 2025

Outline



PROBLEM



BENEFITS



PRACTICE



RESEARCH



WOR, what is it good for?

Alternative practice to burning orchard trees at the end of their life

What to do with retired trees ?

- Burning restrictions in San Joaquin Valley
 - Biomass power plant closure
- Need new outlets for tree residues

Benefits of WOR:

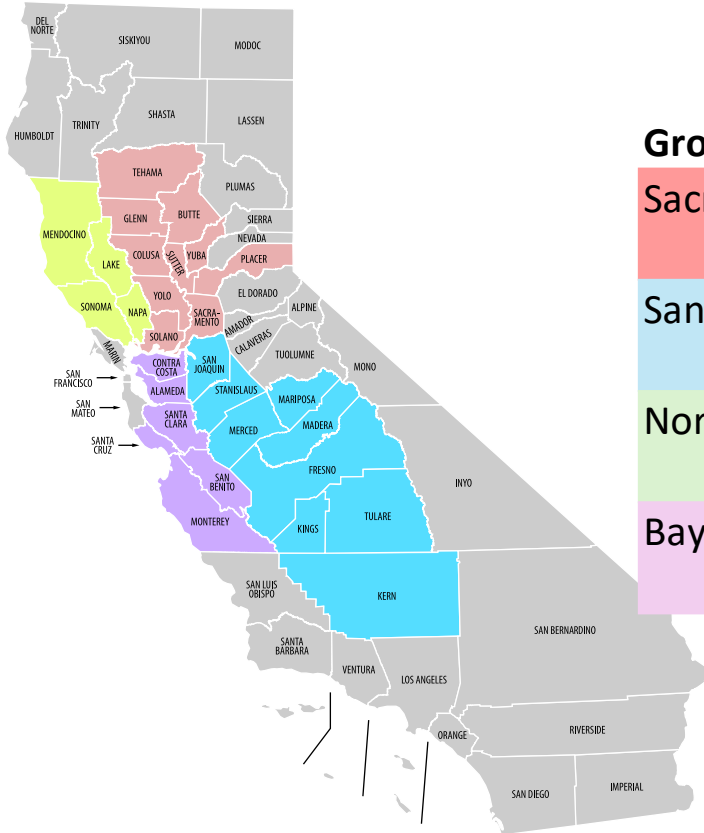
- Recycle biomass and nutrients (Carbon, Nitrogen)
- Multiple potential co-benefits to soil health
- Improve sustainability and drought resilience of the walnut industry

Burning vs. Recycling

- Burning releases carbon, nitrogen, sulfur, phosphorus, etc. from trees to the air instead of returning to soil as plant nutrients
- Carbon from burned trees could be re-incorporated as organic matter back to soil
- Alkaline nutrients in the ashes (e.g., Ca, K, Mg) are usually not spread around → other spots lose nutrients and become acidic



Current walnut removal



Growing region	Standing acres	Removed 2024	% Removed
Sacramento Valley	218,076	6,989	3%
San Joaquin Valley	154,210	10,519	7%
North Coast	4,277	55	1%
Bay Area	2,459	225	9%

2024 CWB+C Acreage report

Whole Orchard Recycling Benefits

- Improve soil health
 - Nutrient content
 - Microbial communities
 - Aggregation
 - Porosity
- Increase water-use efficiency
- Provide ecosystem services
 - Reduce nitrogen leaching potential
 - Improve carbon sequestration

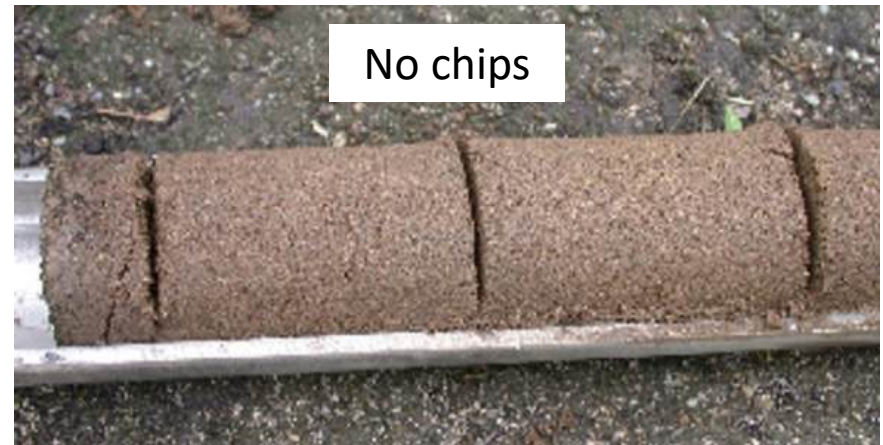
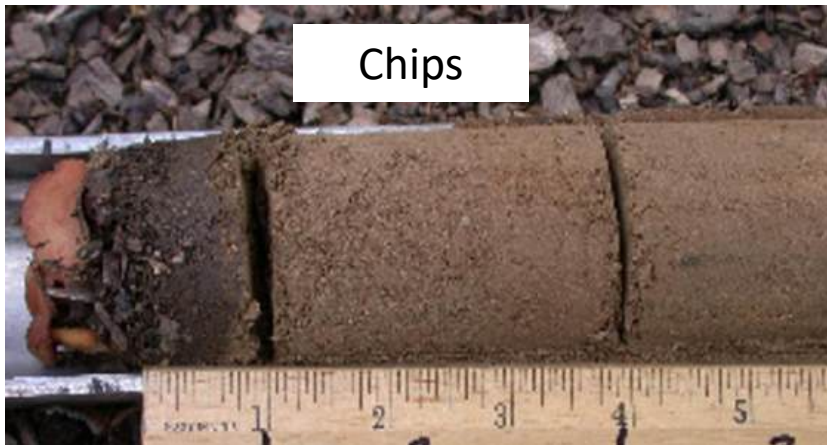
Improved soil health

Aggregation

Porosity

Water holding capacity

Microbial communities



WOR in practice



Excavate trees



Grind



WOR in practice



WOR in practice



Spread chips



Disc in

Measuring amount of chips

Lay out sheet trays



Spread chips



Weigh trays



Cost of WOR (10 acres)

Description	Rate	Amount
Excavating	9,122.00	
Chainsaw	3,368.00	
Grinding services	7,878.00	
Shearing	2,158.00	
Piling	4,220.00	
Mobilization	2,000.00	

(moving chipping machine because it had to be brought especially for the job)

Chipping subtotal 28,476.00

Description	Rate	Amount
42 hours of tractor loader work + 1 man	40.00	1,680.00
84 hours of spreaders + 2 men	70.00	2,940.00

Spreading subtotal 4,620.00

10 acres total 33,096.00

**does not include cost of incorporating (i.e. discing in) chips*

CDFA Healthy Soils Requirements

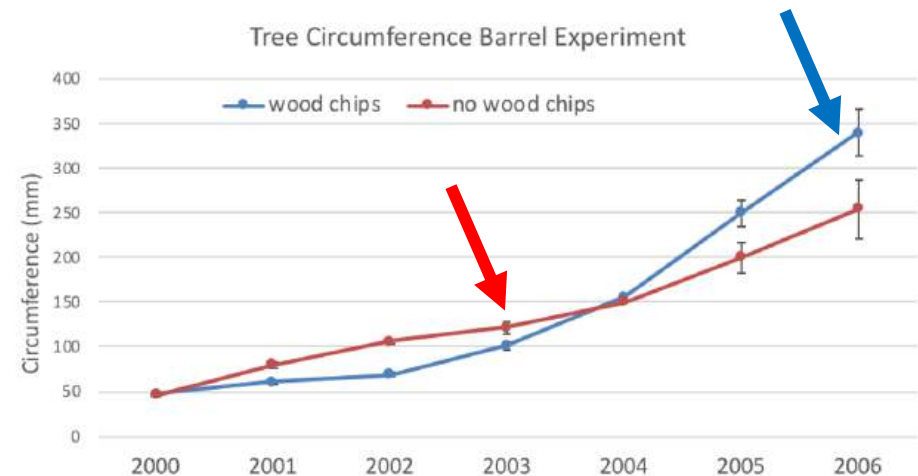
- Trees must be at least 10 years of age.
- After chip incorporation, land must be fallowed or replanted with trees within 3 years.
- Orchards must be chipped and incorporated in place on the field in which they were grown.
- Initial soil organic matter can't be >20%.
- Chips must be evenly distributed.
- Chips must be incorporated into the soil at least 6".

Early WOR Research

- Began in almond
- 1/3 wood chips, 2/3 soil
- Placed in 35 gallon containers
- One almond tree per barrel
- 10 with chips, 10 without

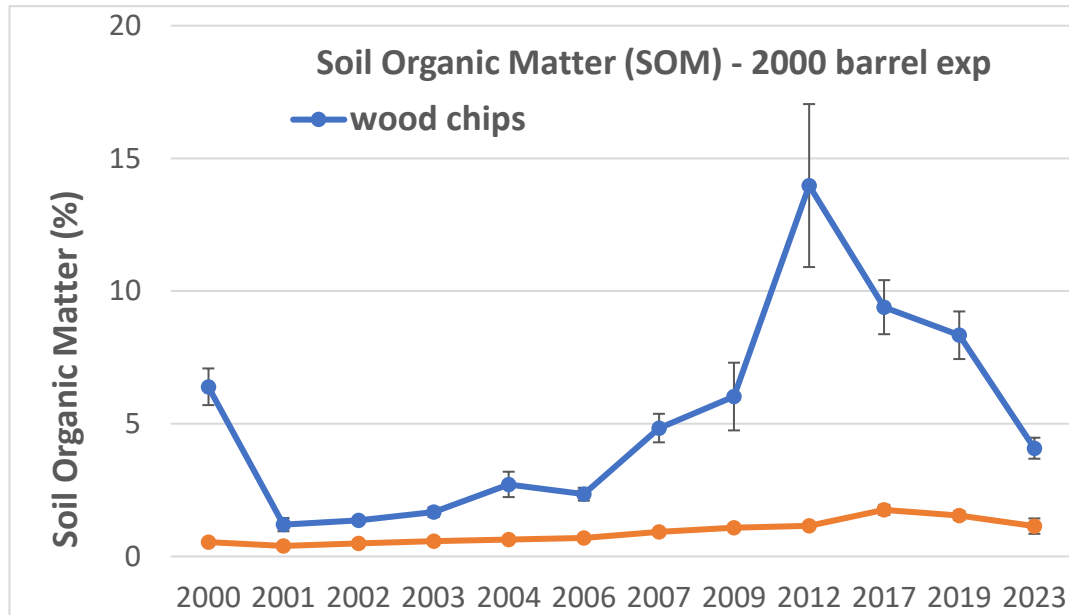


Early WOR Research



49 ppm Nitrate in the water

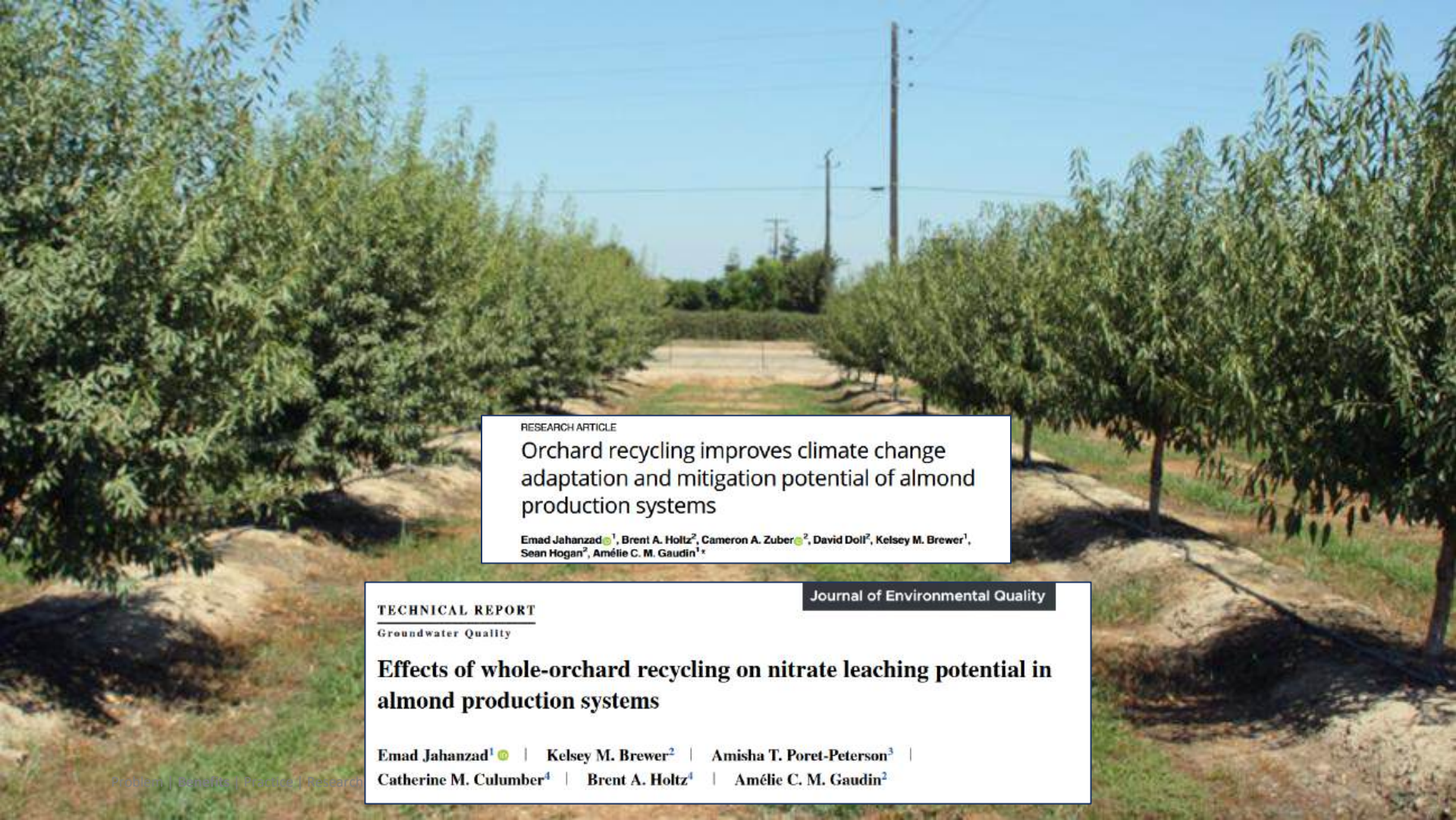
Early WOR Research



Compared to no chips,
WOR soil has better

- Soil organic matter
- Plant-available N
- Other nutrients (Ca, Mg, Zn, K, P)

Almond WOR at Kearney



RESEARCH ARTICLE

Orchard recycling improves climate change adaptation and mitigation potential of almond production systems

Emad Jahanzad¹, Brent A. Holtz², Cameron A. Zuber², David Doll², Kelsey M. Brewer¹, Sean Hogan², Amélie C. M. Gaudin^{1*}

TECHNICAL REPORT

Groundwater Quality

Journal of Environmental Quality

Effects of whole-orchard recycling on nitrate leaching potential in almond production systems

Emad Jahanzad¹ | Kelsey M. Brewer² | Amisha T. Poret-Peterson³ |
Catherine M. Culumber⁴ | Brent A. Holtz⁴ | Amélie C. M. Gaudin²

Problem | Benefits | Practice | Research

Adoption



San Joaquin Valley
AIR POLLUTION CONTROL DISTRICT

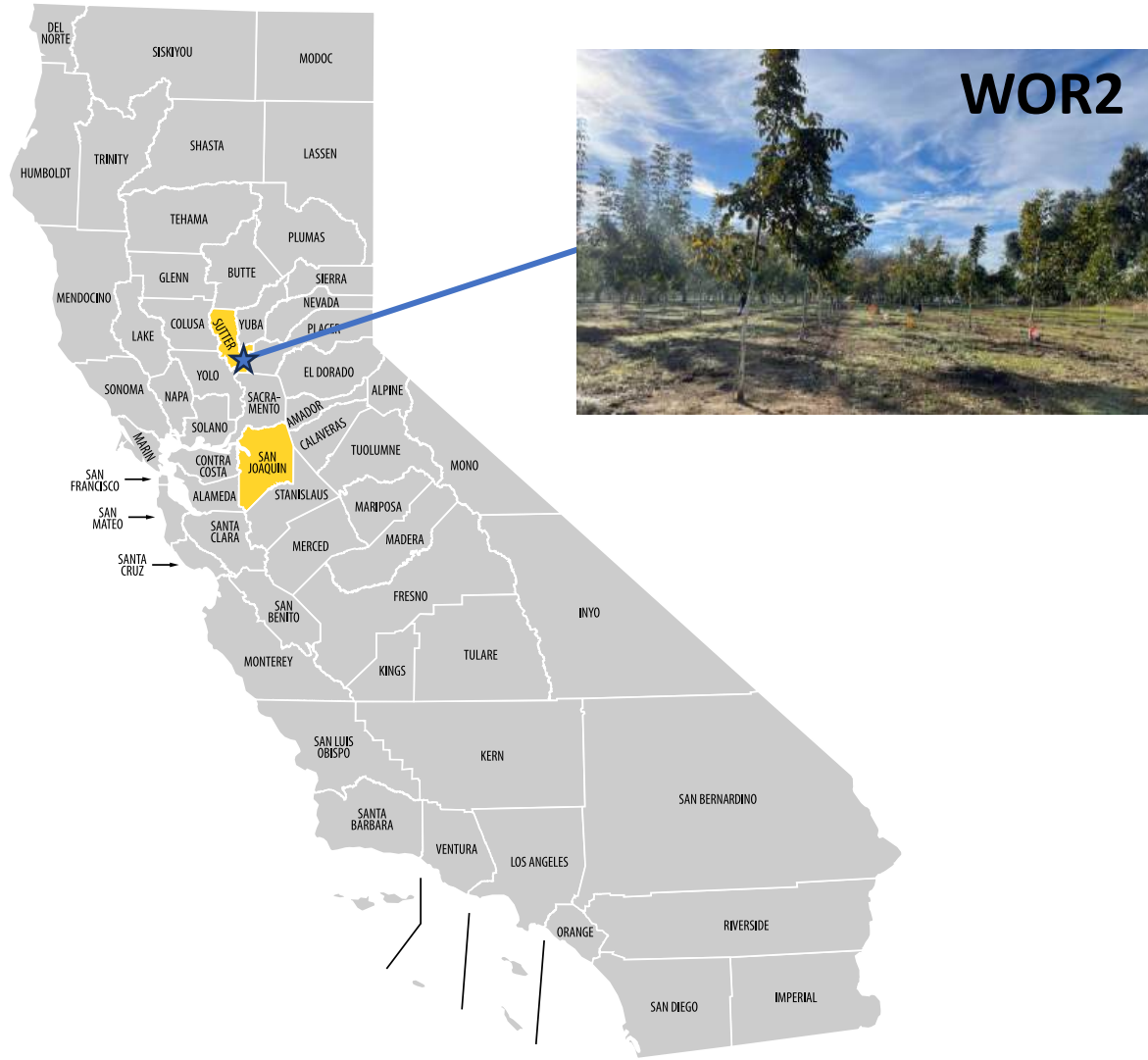


HEALTHY AIR LIVING™

Participation by Crop Type (All Time)

Crop Type	Executed Projects	Acres	Tons of Material	Tons of Material (% Valley Total)
Almonds	2,215	163,882	4,916,450	67%
Grapes	1,149	52,883	793,246	11%
Walnuts	632	22,792	683,764	9%
Citrus	333	8,455	253,643	3%
Peaches	256	4,738	142,128	2%
Plums	182	4,192	125,769	2%
Cherry	125	3,281	98,424	1%
Nectarines	154	2,392	71,754	1%
Pistachio	22	1,894	56,817	1%
Olives	59	1,481	44,436	1%
Apricots	45	1,373	41,196	1%
Other	72	2,172	63,726	1%
Total	5,244	269,534	7,291,353	100%

Current WOR sites in Walnut



WOR2 (Sutter County)



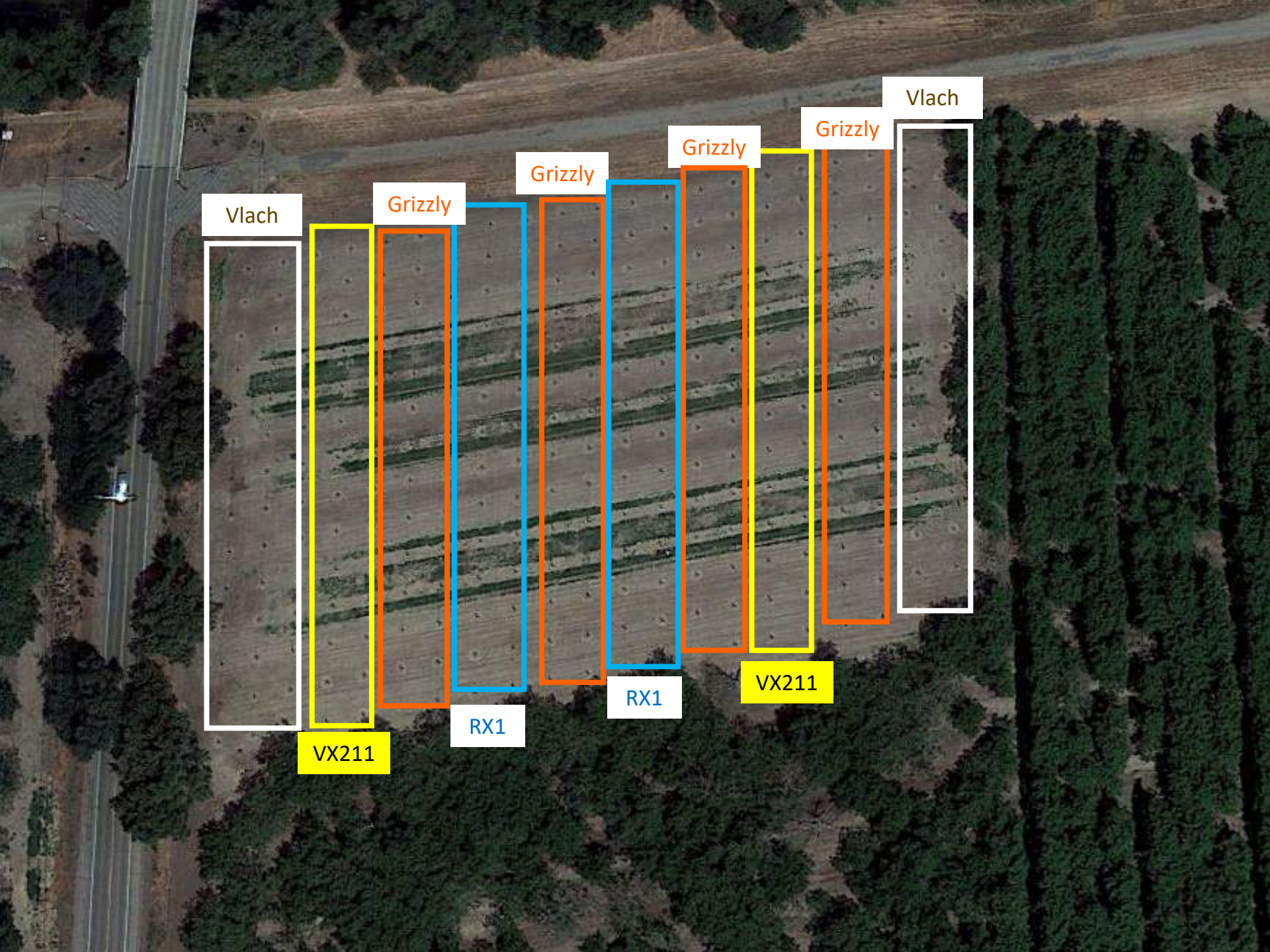
Site details:

- Planted 2021 (not fumigated)
- Chips: 91 tons/acre
- Chandler on 4 commercial rootstocks (Grizzly, RX1, Vlach, VX211)
- Site history of lesion nematode, crown gall, oak root fungus
- Additional N added in first year based on WOR research in almond



An aerial photograph of a large, rectangular field. The field is divided into four horizontal sections by three red-outlined rectangles. The top and bottom sections are light brown and appear to be bare soil or dry grass. The middle two sections are darker green and appear to be planted with crops. To the left of the field is a paved road with a white car driving on it. To the right of the field is a dense line of trees. The word "Chips" is written in red text on a white background, positioned near the road on the left side of the field.

Chips



Vlach

Grizzly

Grizzly

Grizzly

Grizzly

Vlach

VX211

RX1

RX1

VX211



WOR2 data collection

Soil

- Nutrients
- Nematodes (Hodson Lab)
- Both: 0-18 inches

Trees

- Survival
- Growth – tree circumference
- Nutrient uptake – July leaf tissue
- Yield

Soil properties at WOR2 (4th leaf)

WOR	pH	CEC	Organic Matter %	Organic N (ppm)	Organic C:N	Clay	Sand	Silt
Control	6.5 ^a	6.1 ^a	1.06 ^a	7.64 ^a	11.12 ^a	15.0 ^a	72.6 ^a	12.4 ^a
Chips	6.9 ^a	6.3 ^a	1.36 ^a	11.00 ^a	10.60 ^a	13.8 ^a	73.2 ^a	13.0 ^a

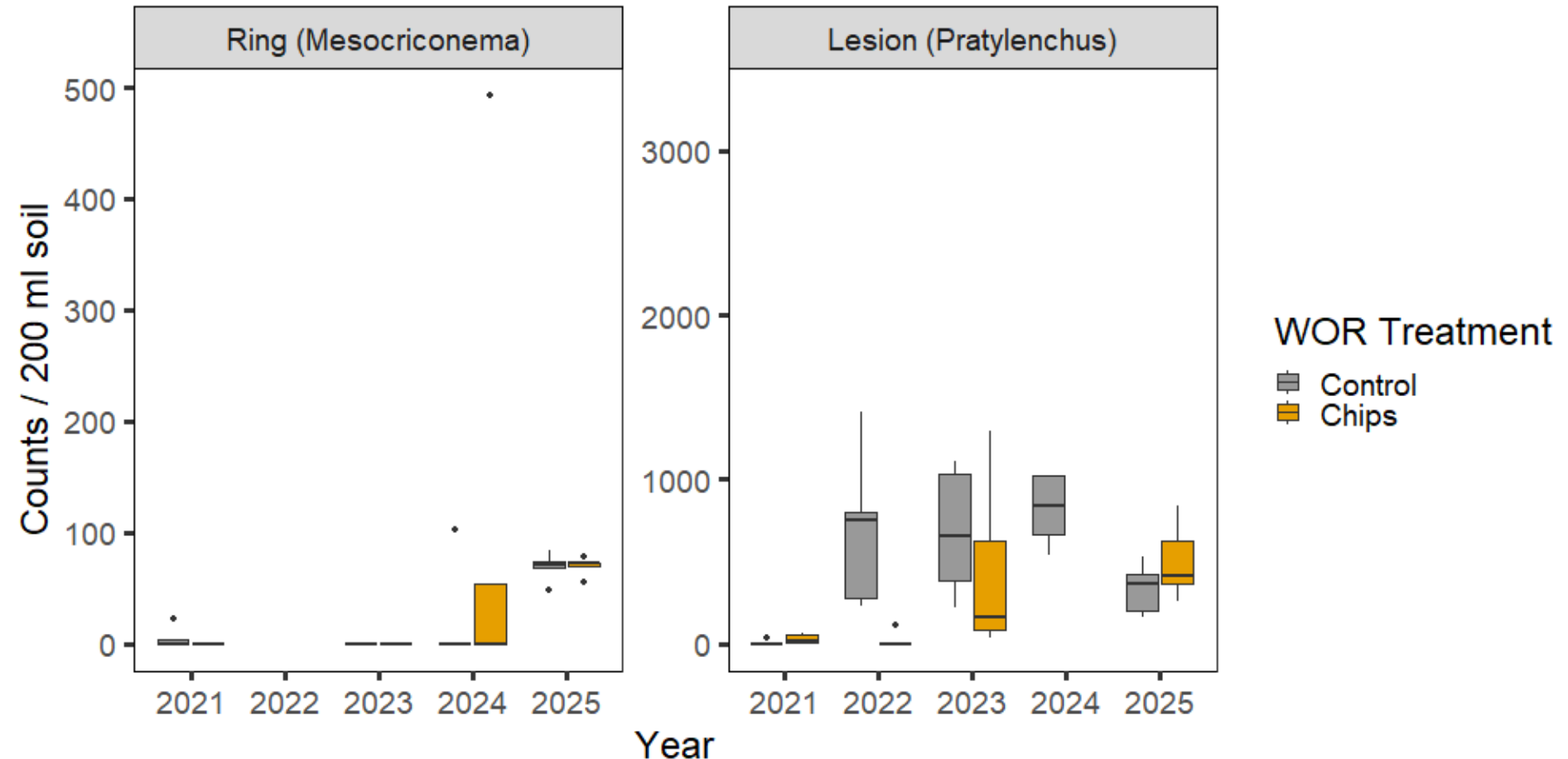
Soil physical properties aren't statistically different... yet

WOR	Nitrogen-NO ₃ (ppm)	Phosphorous (%)	Potassium (ppm)	Sulfur (ppm)	Calcium (ppm)
Control	7.88 ^a	48.66 ^a	92.40 ^a	10.86 ^a	784.20 ^a
Chips	13.51 ^a	52.08 ^a	98.00 ^a	13.00 ^a	1004.00 ^a

WOR	Magnesium (ppm)	Zinc (ppm)	Manganese (ppm)	Copper (ppm)	Boron (ppm)	Chloride (%)
Control	108.60 ^a	2.94 ^a	3.3 ^a	13.73 ^a	0.29 ^a	9.06 ^a
Chips	114.40 ^a	4.14 ^b	3.7 ^a	13.82 ^a	0.34 ^a	11.26 ^a

Relatively higher nutrient content in soil with chips

Soil properties at WOR2 (4th leaf)

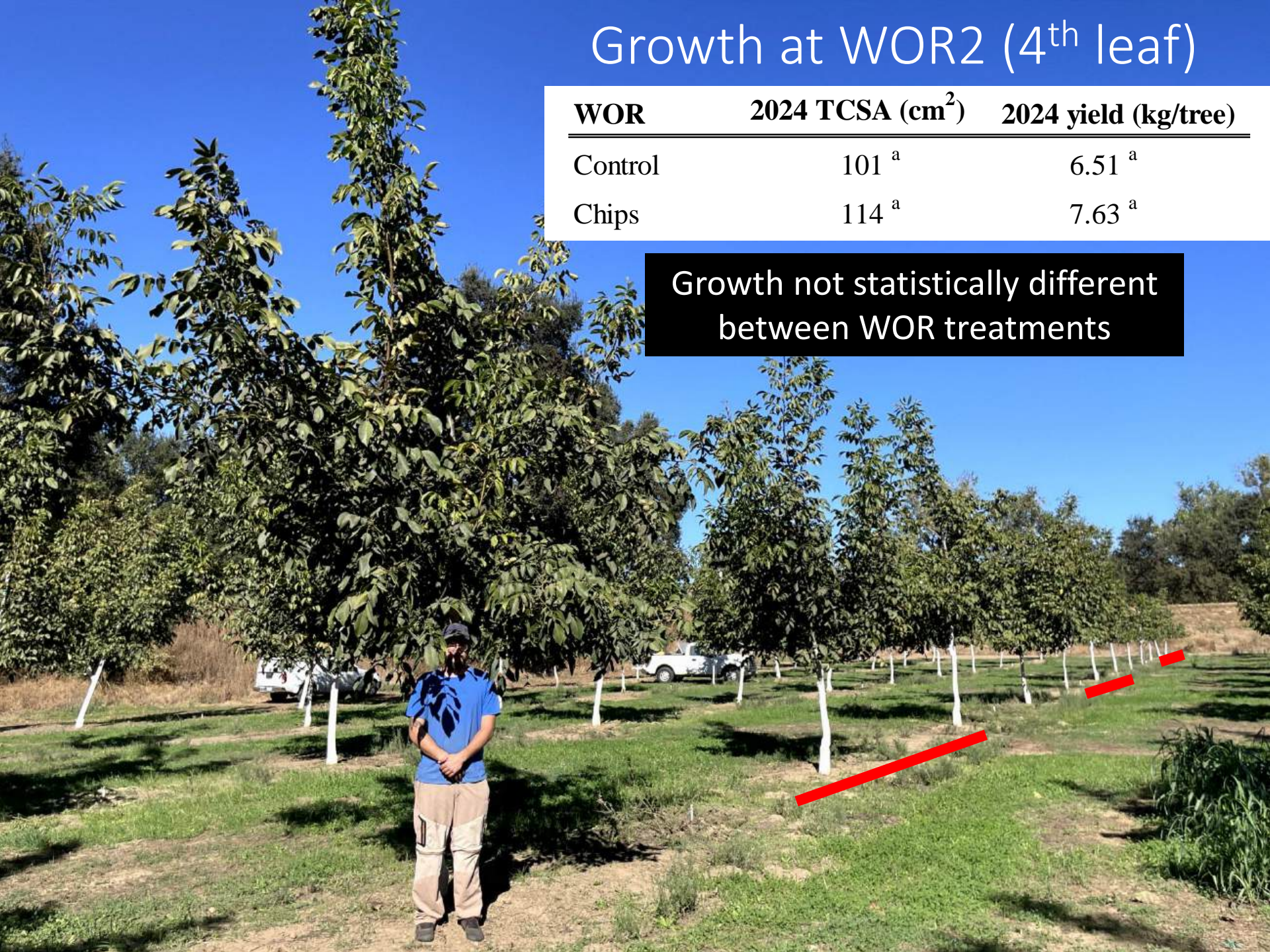


Unclear data about WOR on nematode suppression

Growth at WOR2 (4th leaf)

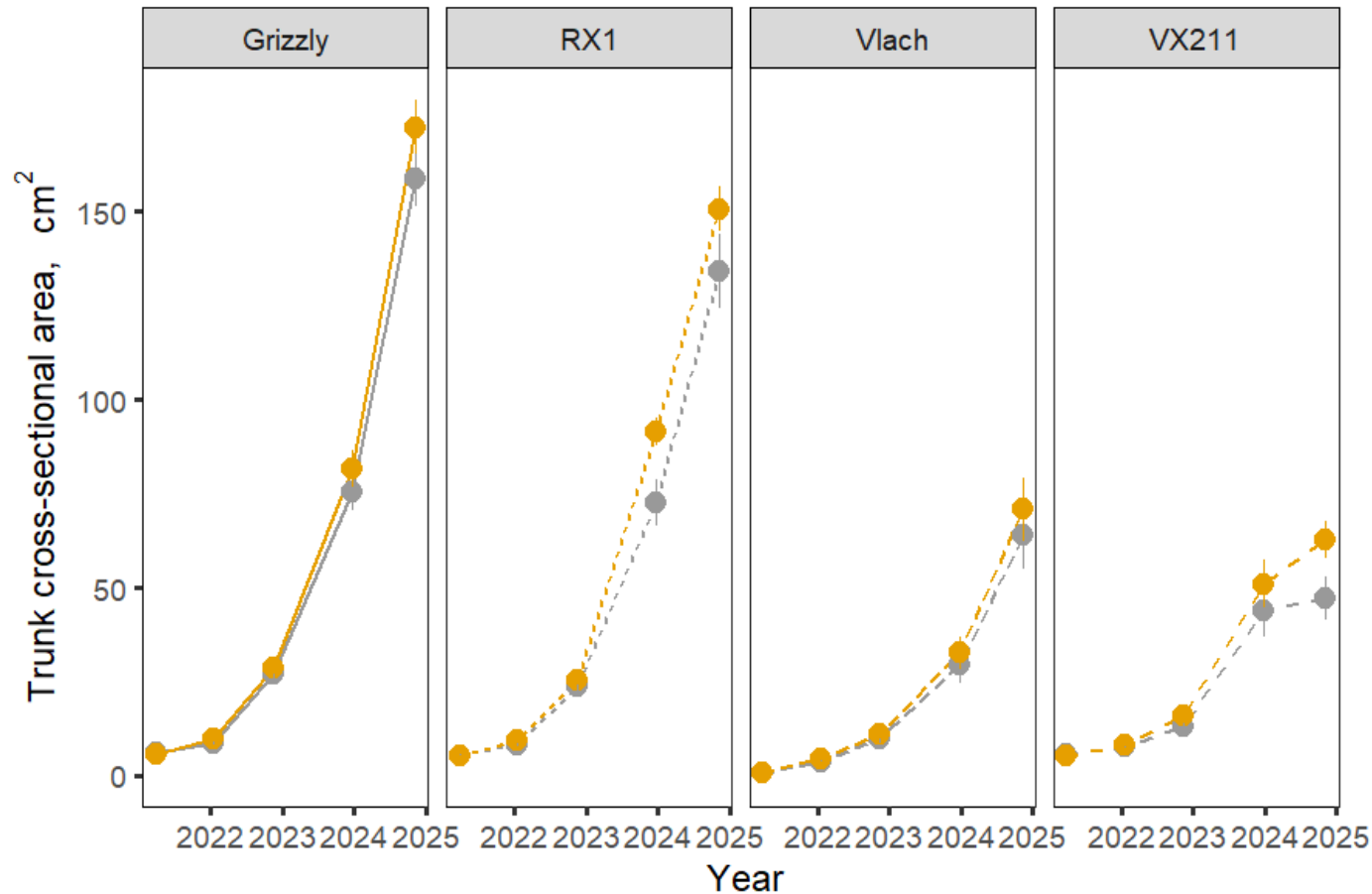
WOR	2024 TCSA (cm²)	2024 yield (kg/tree)
Control	101 ^a	6.51 ^a
Chips	114 ^a	7.63 ^a

Growth not statistically different
between WOR treatments



Growth at WOR2 (4th leaf)

WOR	2024 TCSA (cm ²)	2024 yield (kg/tree)
Control	101 ^a	6.51 ^a
Chips	114 ^a	7.63 ^a



Grizzly



RX1



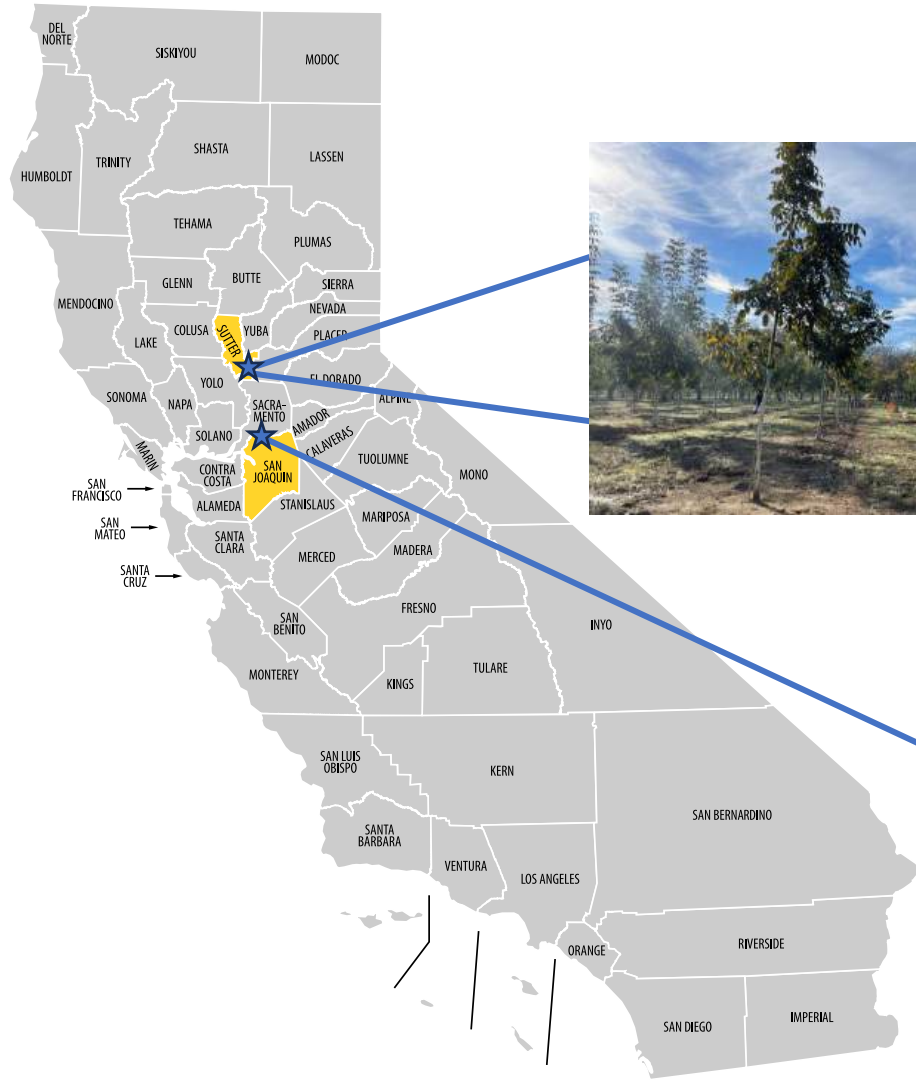
Vlach



VX211



Current WOR sites in Walnut



WOR3 (San Joaquin)



Site details:

- Planted Dec 2023
- Chips: 60 tons/acre – incorporated with ripper
- Fumigated with Telone after chip incorporation
- Wolfskill on Grizzly
- Organic establishment

WOR3 (San Joaquin)

Chips spread



Incorporated by ripper



WOR3 (San Joaquin)




WOR4 (Rio Oso)

Aug 4, 2024



WOR4 (Rio Oso)

Aug 4, 2024



Site details:

- Planted Jan 2024
- Chips: 82 tons/acre
- Wolfskill on Grizzly
- No fumigation

WOR4 (Rio Oso)



Weed survey at WOR4

Jocelyn & Becky

22'





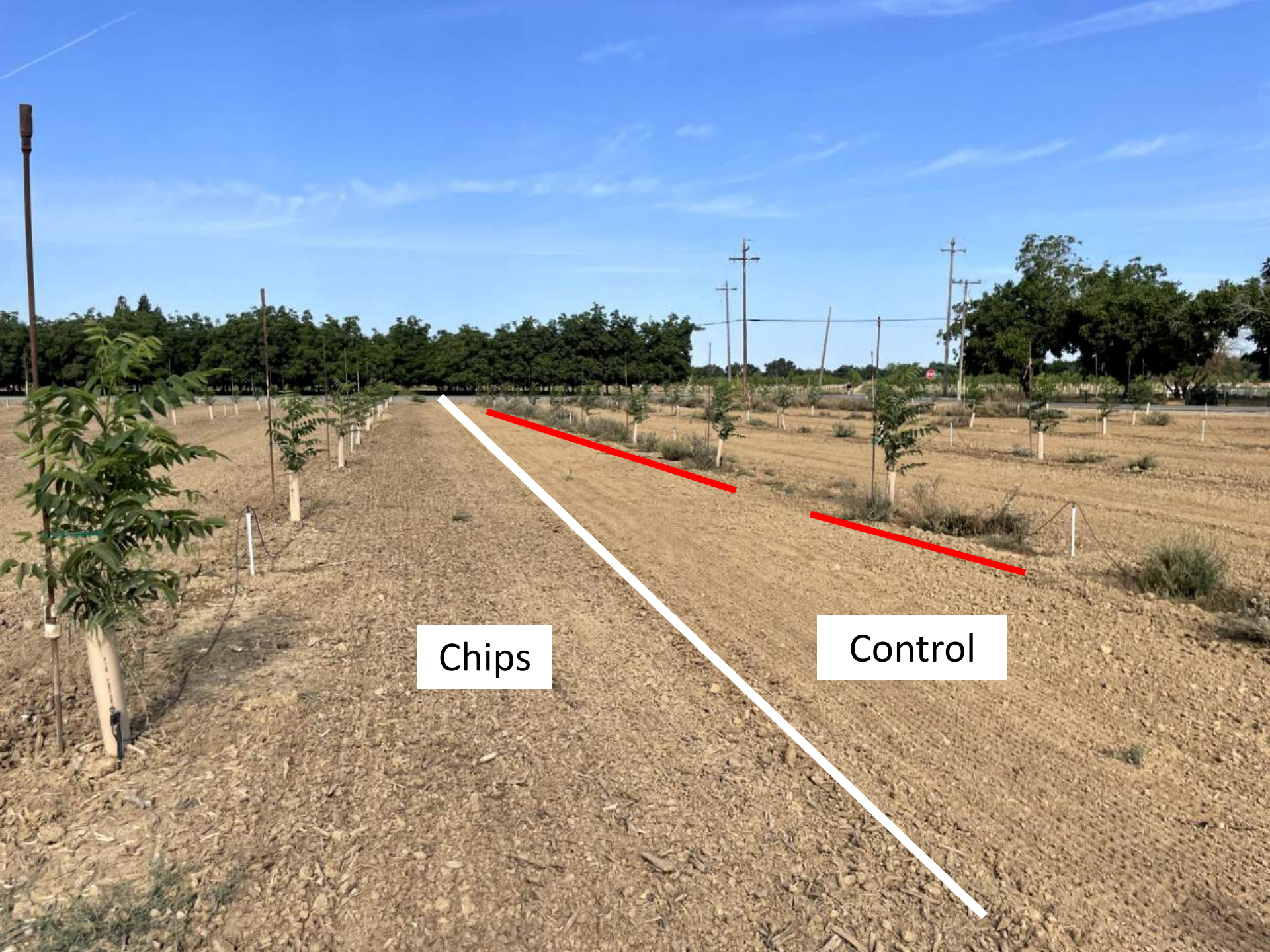


Control
58.1 %



Chips
14.2 %

	Control	Chips
Average weed coverage (%)	58.1 ^a	14.2 ^b
Species	Control (% incidence)	Chips (% incidence)
Bindweed	8	0
Burclover	4	0
Crabgrass	0	0
Dallas Grass	36	4
Fleabane	40	0
Foxtail	0	8
Orchard Grass	80	92
Purslane	4	0
Rye Grass	0	4
Shepherd's Purse	4	0
Willowherb	32	0
Wireweed	100	84
Unknown	4	4



Chips

Control

WOR3 & WOR4 objective: determine nutrient requirements at orchard establishment

Nutrient recommendations in almond WOR:

2.6-6x ounces of nitrogen per tree in first year after WOR (FREP: 1-3 oz N; Brent: 6-8 oz N)

CDFA-FREP fertilization guidelines for walnut

Tree age	N application rate		
	(lbs/acre)	(lbs/tree) ¹⁾	(oz/tree)
First season	10-20	0.2-0.3	2-5
Second season	25-50	0.4-0.8	6-12
Third season	50-100	0.8-1.5	12-25
Fourth season	63-125	1-19	16-31
Fifth season	75-150	1.2-2.3	18-37

WOR2 fert regime / tree

0.50 lb N + 0.58 lb P & 0.38 lb K

0.93 lb N + 0.5 lb P & 0.35 lb K

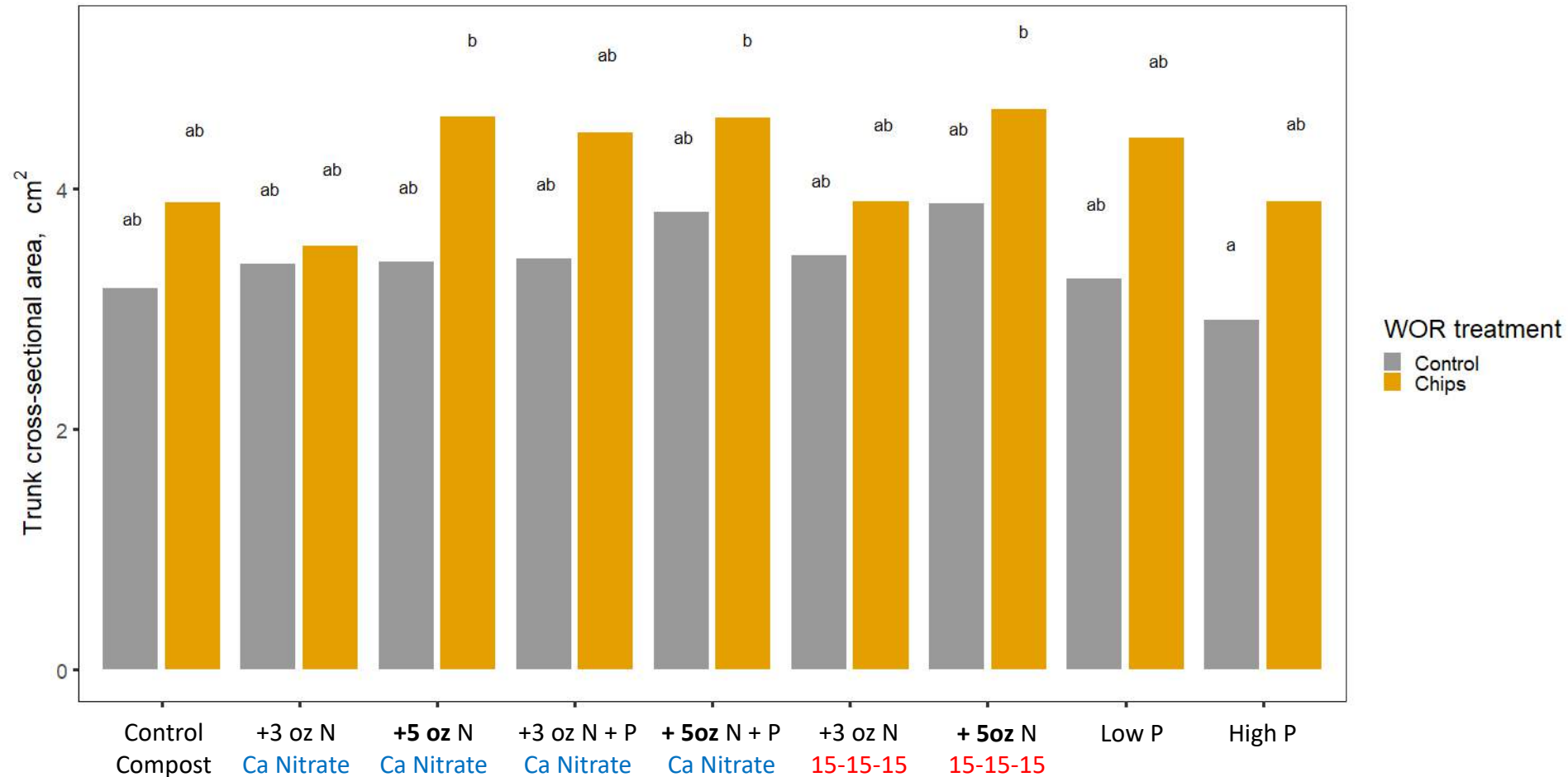
FREP recommendation

Tree age	N application rate		
	(lbs/acre)	(lbs/tree) ¹⁾	(oz/tree)
First season	10-20	0.2-0.3	2-5

Treatment	N Source	WOR3		WOR4	
		oz N/tree	oz P/tree	oz N/tree	oz P/tree
1 Control	WOR3: Compost / WOR4: CAN-17	?	?	3.9	0
2 Low N	Ca Nitrate	3	0	5.0	0
3 High N	Ca Nitrate	5	0	7.1	0
4 Low N + Low P	Ca Nitrate	3	3	5.0	3
5 High N + High P	Ca Nitrate	5	5	7.1	5
6 Low N	NPK 15-15-15	3	3	-	-
7 High N	NPK 15-15-15	5	5	-	-
8 Low P		0	3	-	-
9 High P		0	5	-	-

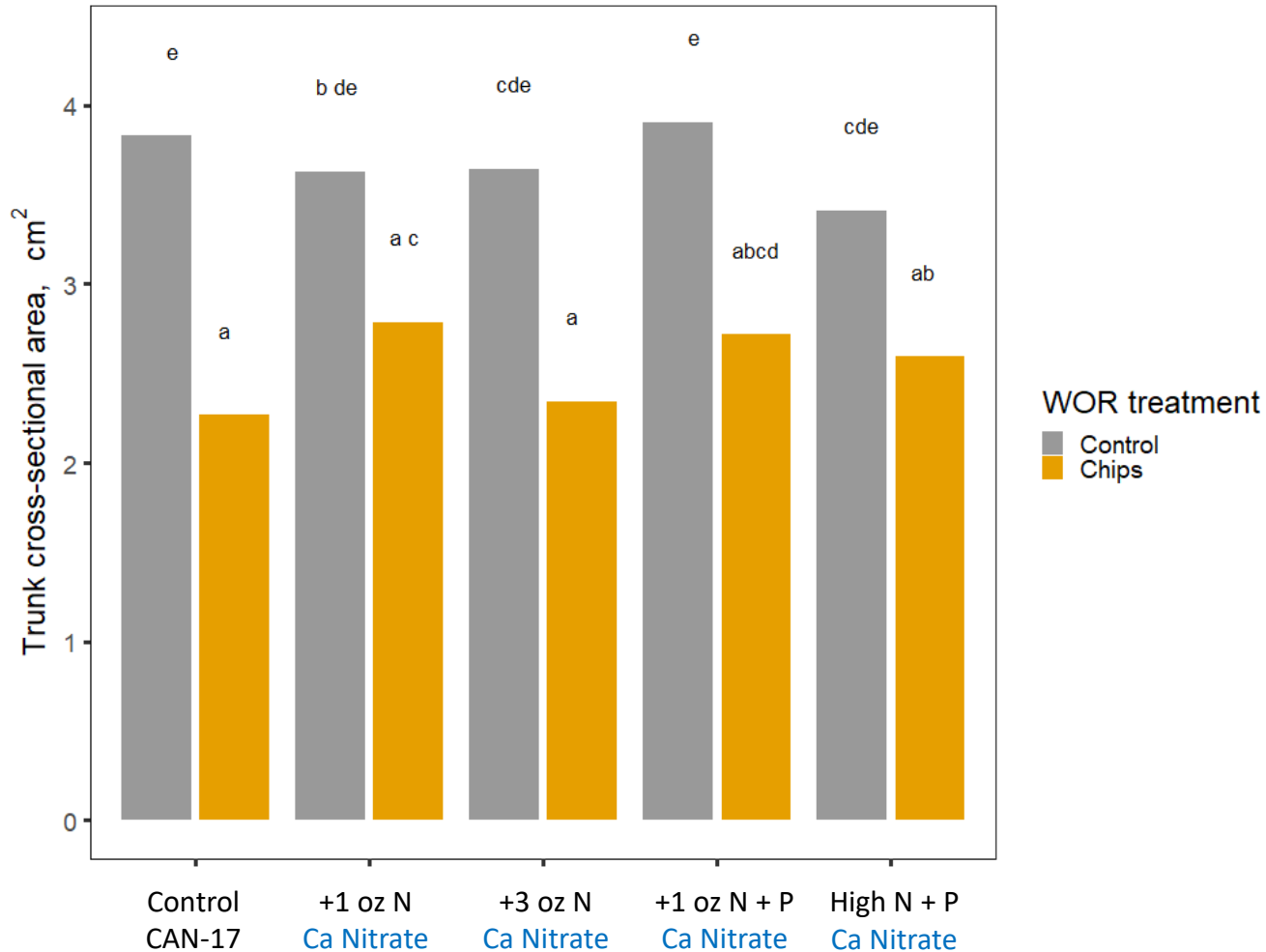
WOR3: didn't end up applying much more than FREP guidelines, but chips have been there longer
 WOR4: 1 - 1.4x FREP guidelines

WOR3 (San Joaquin)



Growth in chipped treatments higher than control

WOR4 (San Joaquin)



Growth stunted in chipped treatments –
will increase supplemental N next year

Other research projects



Walnut Variety Trial at CSU Chico University Farm

Established May 2023



Rootstock Trials



Crown gall

clareyes@ucanr.edu



Nematodes

UC
CE

Soil health assessments in Sutter-Yuba counties

Objective: determine which soil health indicators can be most useful to growers, specific to our region

- **Seeking growers who can provide two fields that reflect your BEST and WORST soils**
- We will sample soil in both places and provide info about:
 - Infiltration rates
 - Organic matter estimate
 - Total C and N
 - nitrate-N, P, K, Mg, Ca,
 - Texture
 - Potentially mineralizable nitrogen
 - Active carbon
 - Wet aggregate stability
 - Microbial respiration

Soil health assessments in Sutter-Yuba counties

Objective: determine which soil health indicators can be most useful to growers, specific to our region

- We want observe how these various soil health measurements align with growers' personal assessments
- See if there are specific indicators that might more or less indicative of soil health and optimal performance
- *Ex: if all "best" fields have specific threshold of organic matter*

Extension activities

- Newsletters
- SacValleyOrchards.com
- Growing the Valley podcast
- Grower meetings and field days
WOR2/Rootstock field day this
summer!

Succession Planning Workshop

Lawyers to provide planning framework and options

Tracy Schor to discuss how Prop 19 can affect property transfer

Tim Koopmann to talk about his own experience with keeping his ranch

AG LEGACY *Symposium*

Thursday, March 27, 2025 at 5:30 pm

UC Cooperative Extension Office
142 Garden Hwy A, Yuba City, CA 95991



Legal



Policy



Family



Financial



Vision



Third Thursdays: Things from the Field

Monthly grower meeting informed by farm calls or seasonal activities

Managing Burrowing Rodents

*Dr. Roger Baldwin,
UCCE Human-Wildlife Conflict
Resolution Specialist*

April 3, 11:30 PM - 1:30 PM
UCCE Sutter-Yuba
142A Garden Hwy, Yuba City



Thank you

- California Walnut Board & Commission
- Conant Farms
- Souther Walnuts
- Cliff Buemel & Agromillora Nursery

Questions?



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