the Almond Conference 2019

Alternatives for Managing Replant Pests and Problematic Weeds

california almonds

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Anaerobic Soil Disinfestation for Almond Replant: *Components, Process, Responses, & Outlook*

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Acknowledgements:

- Almond Board of California
- California DPR
- TriCal, Inc.
- KARE and CSUF Staff
- Wonderful Orchards

USDA Agricultural Research Service

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Components: substrate

Ground carbon source	Estimated $ / ton	Rate Tons / trt. ac.	Estimated material $ / ac for "50% strips"
Mustard seed meal	$1,700	3	$2,550
Rice bran	$283	9	$1,274
Almond hull	$192	9	$864
Tomato pomace	$185	9	$833
Grape pomace	$155	9	$698
Pistachio hull	$150	9	$675
Olive pomace	$115	9	$518
Almond hull/shell, "pollinator"	$104	9	$468
Almond shell	$80	9	$360

Perspectives on nutrients in alternative substrates

Substrate	Total C (%)	C:N ratio	N (%)	P (%)	K (%)	N.F. Carb. (%)	Starch (%)	A.D. Lignin (%)	pH	N in 9 (or 65) tons (lb)	P in 9 (or 65) tons (lb)	K in 9 (or 65) tons (lb)
Mustard meal	45	7	6.1	0.81	0.8	22	2.9	1.4	5.1	1091	146	151
Rice bran	45	19	2.4	1.77	1.4	32	15.3	3.0	6.2	427	318	246
Tomato pomace	46	19	2.5	0.31	1.0	10	6.4	16.7	5.0	445	55	180
Grape pomace	45	24	1.9	0.23	1.5	35	0.44	12.4	4.1	340	41	270
Pistachio hull	50	28	1.8	0.08	1.1	17	0.94	20.6	5.3	324	14	198
Olive pomace	50	26	1.9	0.21	1.7	9	0.1	21.0	4.7	344	38	306
Almond hull and shell	41	60	0.9	0.10	2.1	43	0.4	6.7	4.8	156	19	372
Almond hull only	40	59	0.7	0.09	2.1	52	<0.01	4.1	4.9	122	16	378
Almond shell only	43	63	0.7	0.05	1.5	22	0.3	11.9	5.0	122	9	270
Whole orchard recycling chips	47	120.5	0.4	0.03	0.1	14	0.62	11.1	4.8	(507)	(39)	(156)

Process: spreading substrate

Process: substrate incorporation

Process: installing auxiliary irrigation system, tarp





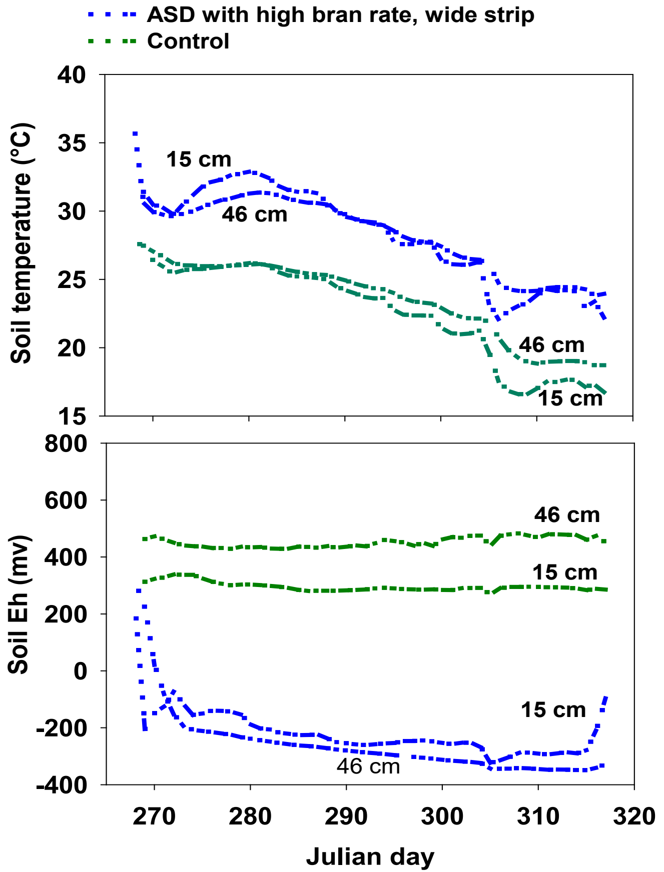

Process: clean up, planting, assessment






Responses: soil parameters

During ASD process:



During ASD process:

- Increase in soil temperature
- Decrease in redox potential
- Microbial community shifts
- Reduction of pest populations
- Gen. of organic acids, volatiles
- Reduction in soil pH

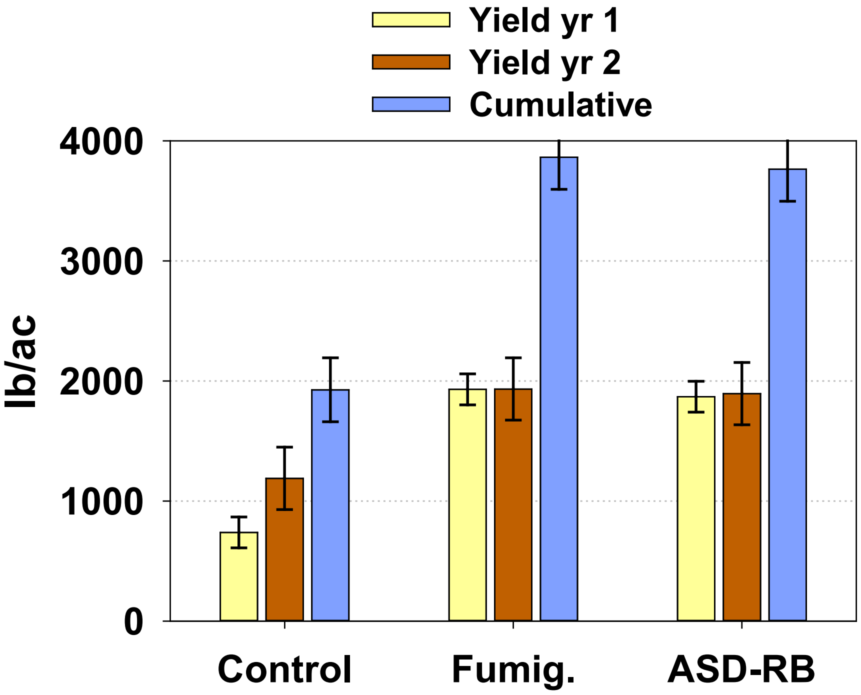
After ASD process:

- Microbial community shifts
- Some reduction in soil pH
- Reduced soil pest populations (weeds, pathogens)
- Increased levels of some nutrients (NPK)

Responses, orchards performance

KARE trials, planted 2014

Tree growth → **Kernel yield**



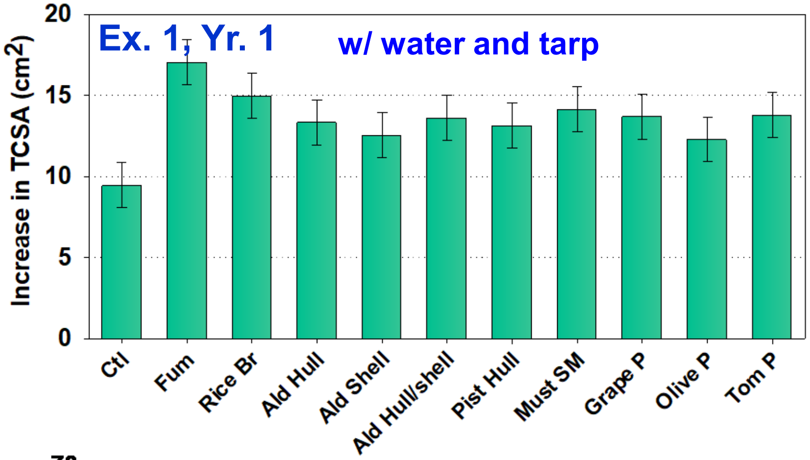
The cost challenge: $ estimates, ASD vs. Fumigation

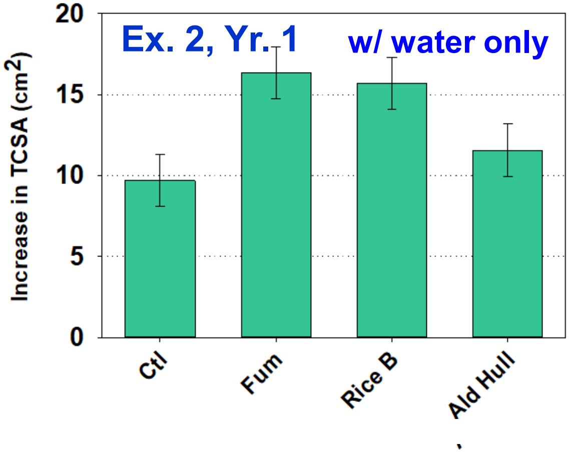
ASD Substrate	Material amounts and costs						Application costs ($/ orchard acre)				Total cost ($/orch ac)
	Rate (t/trt.ac)	Proportion land treated	t/orch. ac	Material ($/t)	Freight ($/t)	Total substrate cost ($/orch ac)	Spreading @10$/ton	Incorp.	Auxillary Irrigation system (6 tape lines/row)	TIF tarp (0.5 roll/ac)	
Rice bran	9	0.5	4.5	283	20	**1,364**	45	20	200	400	**2,029**
Ground almond hull and shell	9	0.5	4.5	100	20	**540**	45	20	200	400	**1,205**

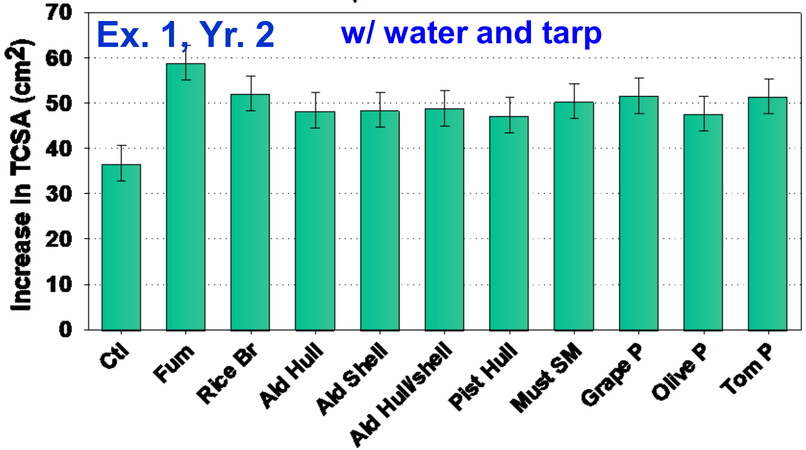
Fumigation Treatment	Total cost ($/orchard acre)
Telone II broadcast + Cpic 0.38 strip	**1,278**
Telone II broadcast + Cpic 0.15 spot	**1,190**
Telone II strip + Cpic 0.15 spot	**797**
Cpic 0.5 strip	**614**

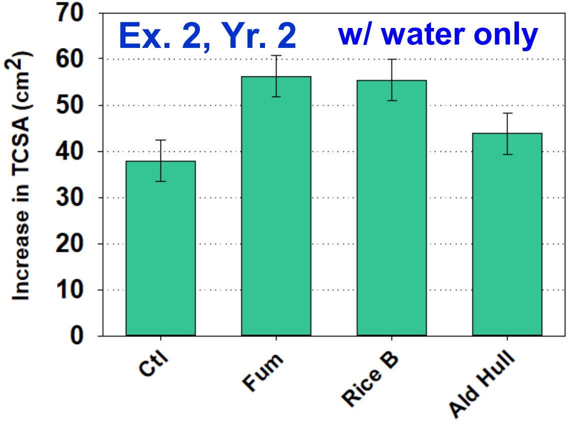
Responses: Alternative substrates can work

Tree growth, KARE trial, planted 2017







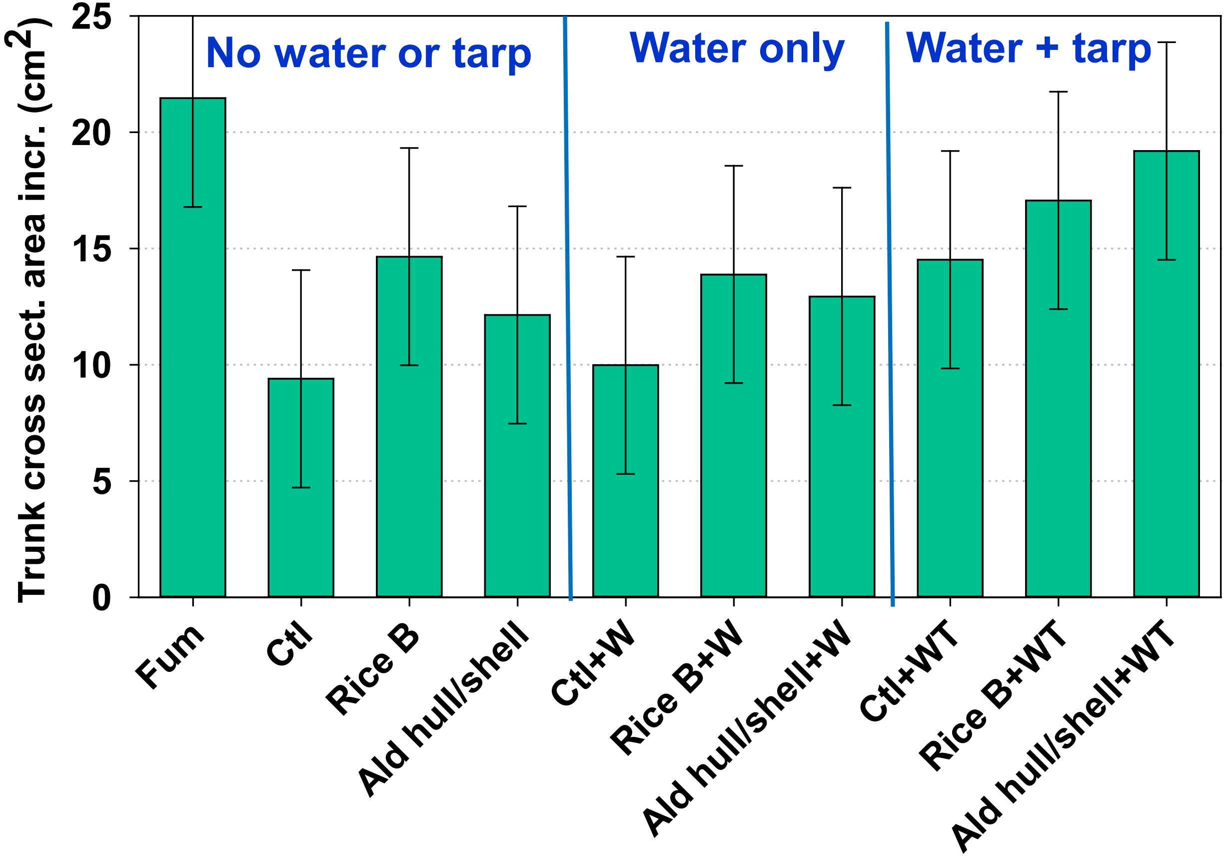


Responses: CSUF trials,

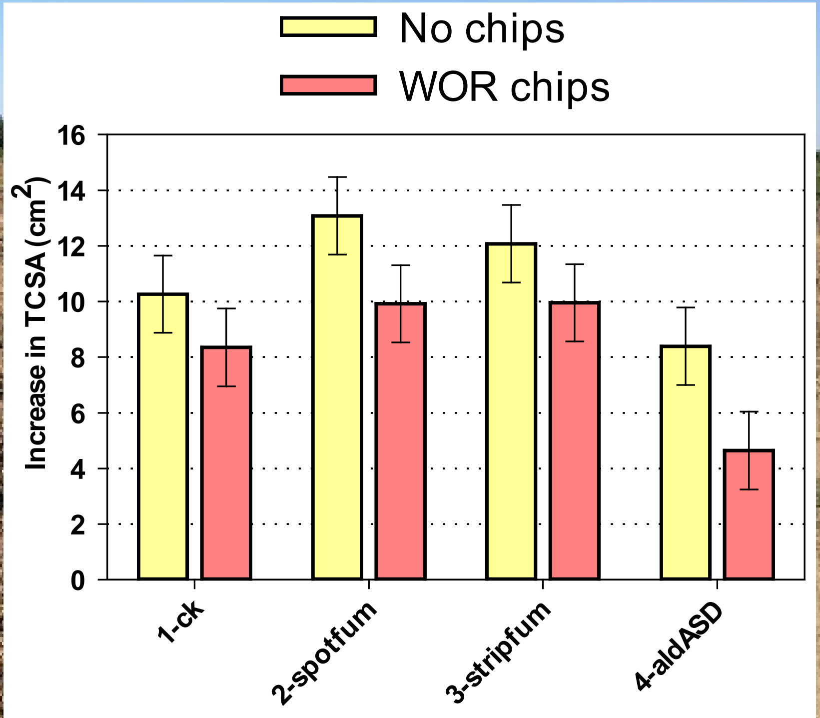
- More tests of alternative substrates, water, tarp.
- Tested with WOR chips
- Planted 2018

Responses to ground almond hull+shell vs. rice bran substrate

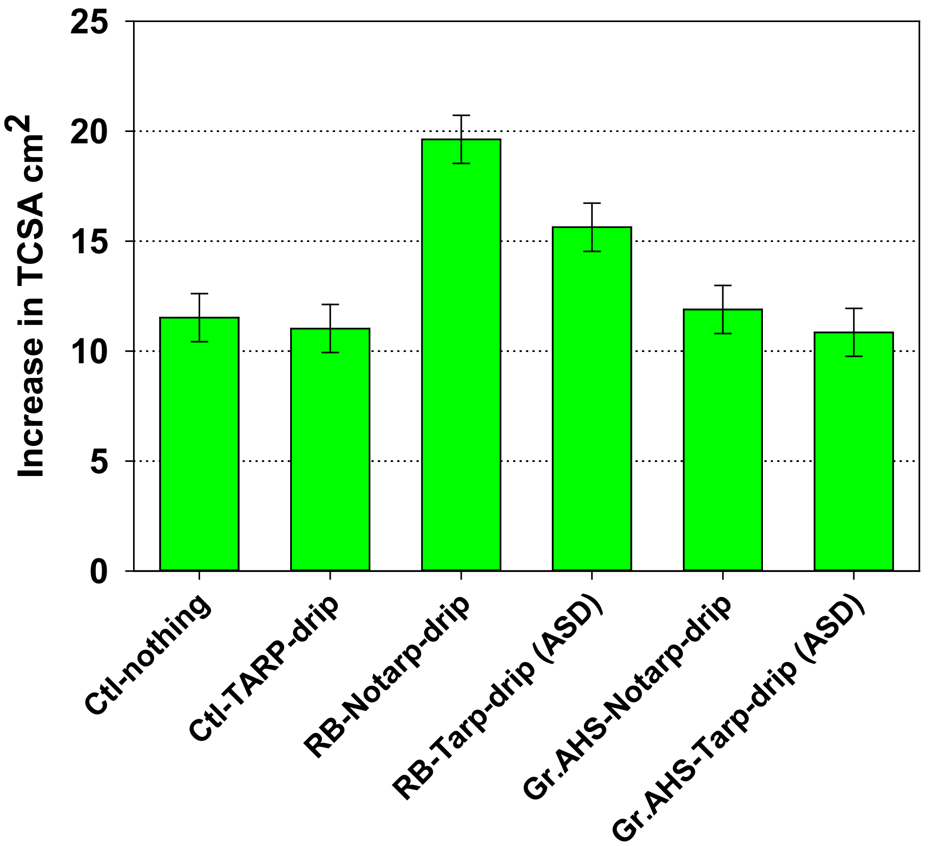
Tree growth at CSUF, yr 1



Negative growth impact of ASD based on ground almond hull and shell in one fumigation x WOR trial, Kern Co

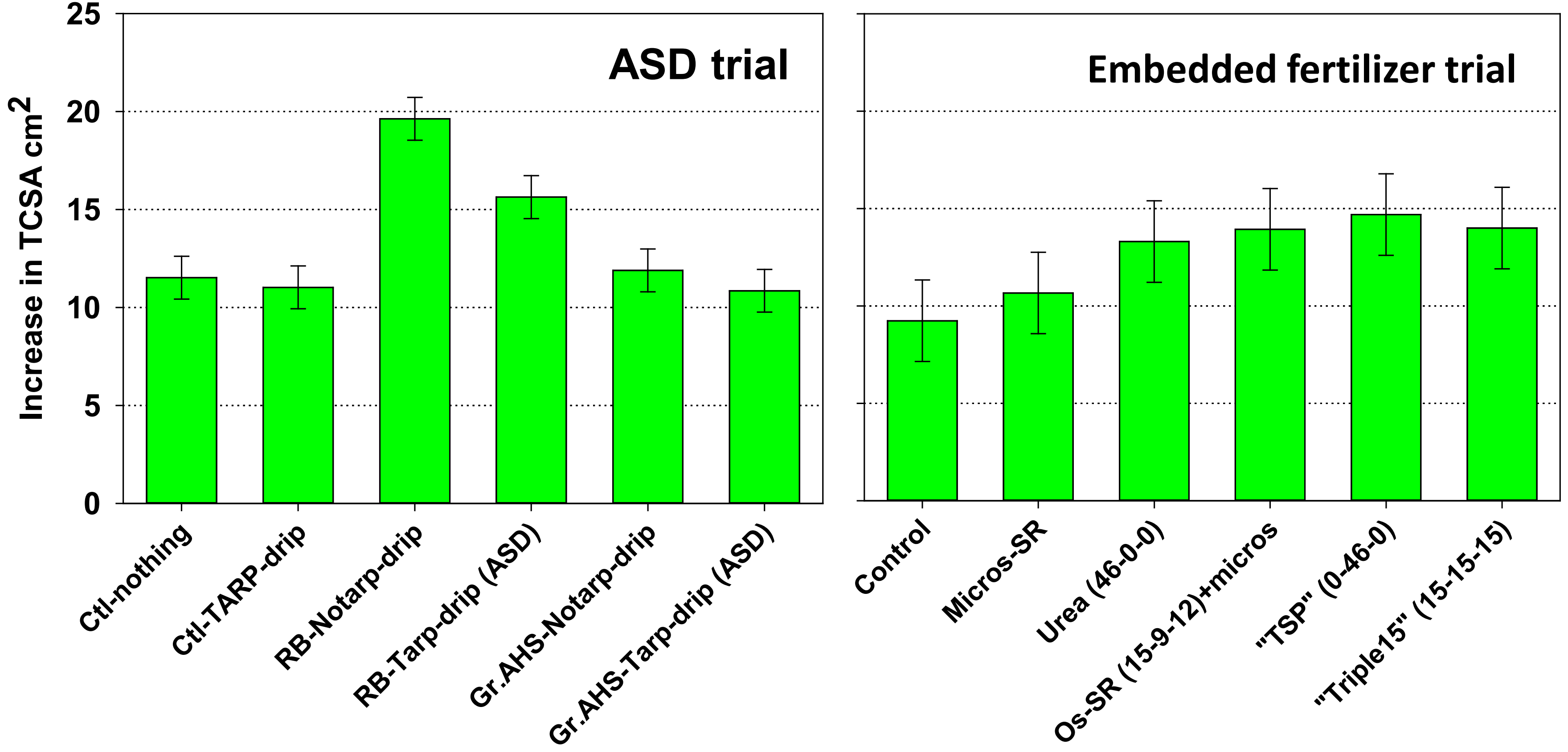


Responses: to substrates, water and tarp; Chowchilla Trial, planted 2019



Responses: ASD / substrate trts. vs. postplant fertilizers

Chowchilla, planted 2019



Thank you!

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Summary, Outlook

- ASD is a multicomponent process with complex chemical and biological impacts
- ASD approached/matched fumigation for PRD control, but at sig. higher cost; more time needed to assess nematode control
- There is good potential to reduce cost of ASD
- Ground almond hull / shell a less expensive substrate than rice bran; worked well, but less dependably than rice bran
- ASD work suggests further N and P studies
- **ASD is worth a try in buffer areas that can not be fumigated; treat in summer**

Soil and tree responses to biosolarization using almond residue amendments

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Department of Food Science and Technology

University of California, Davis

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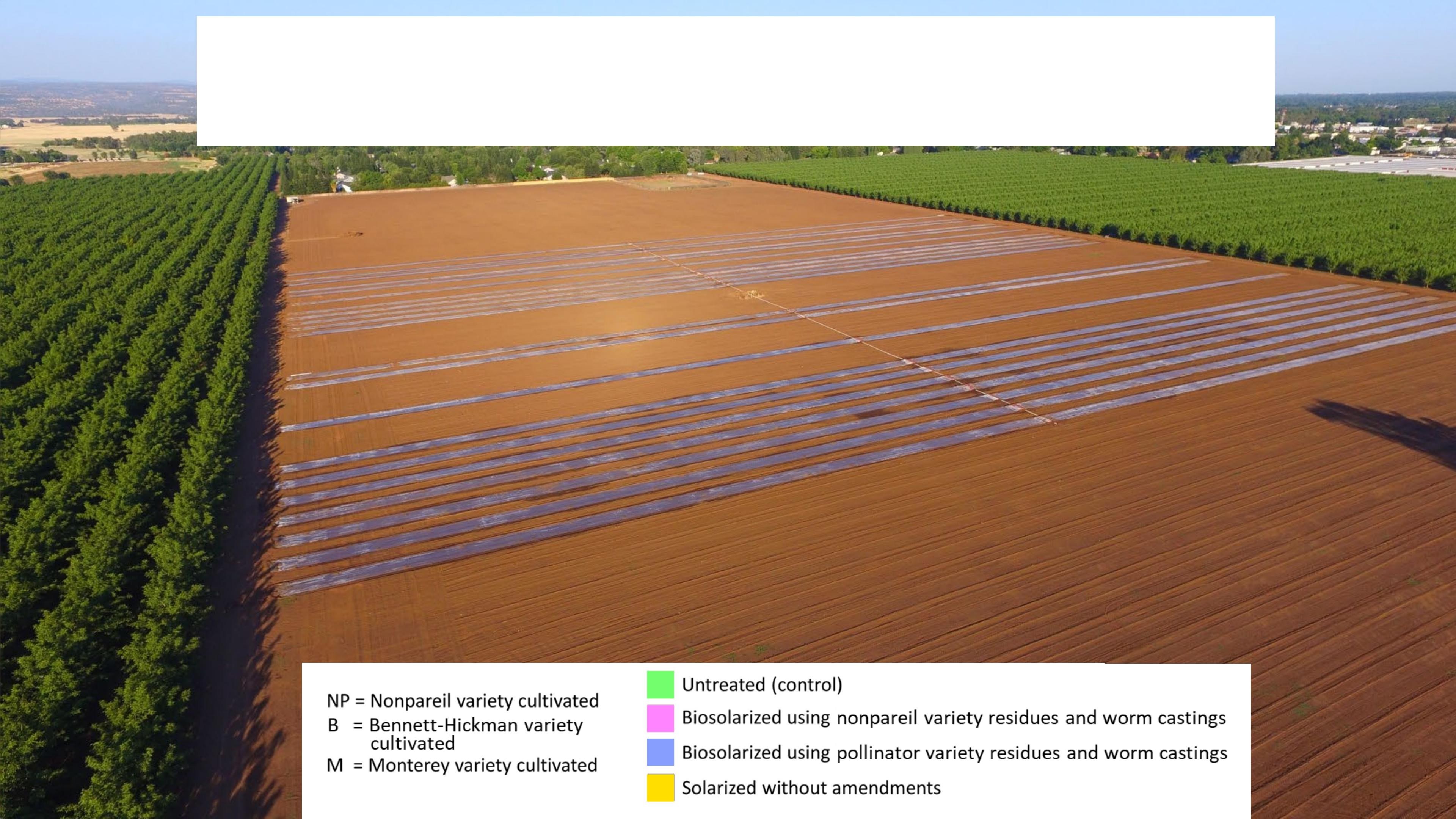
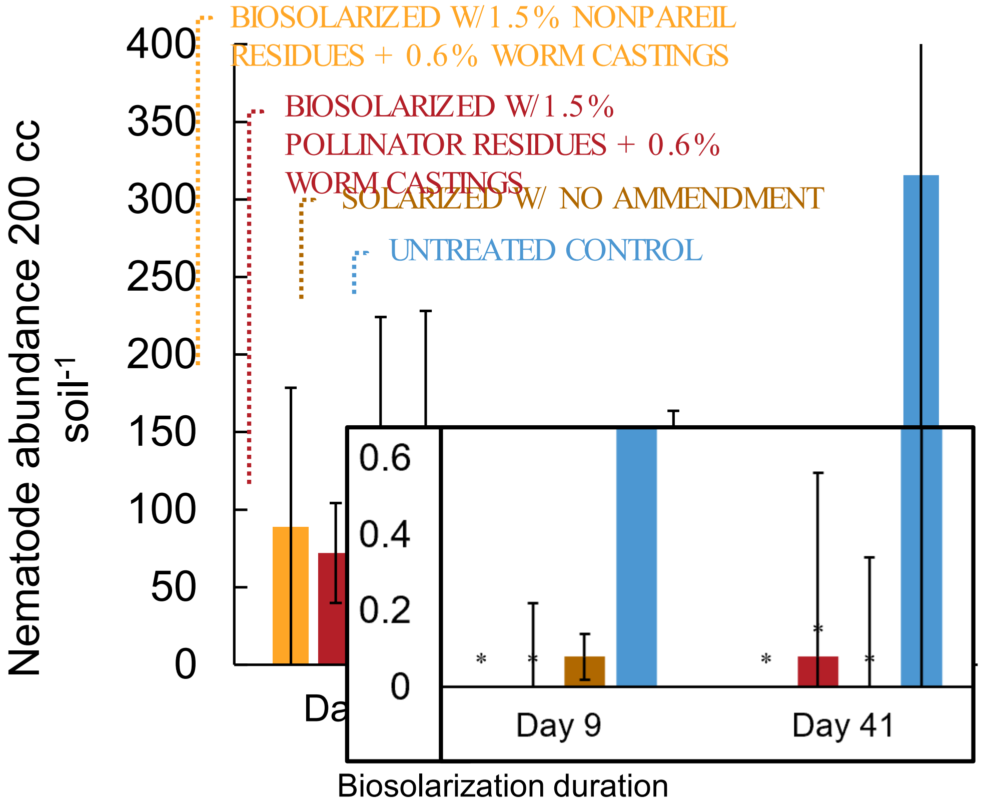
A biosolarization field trial was conducted at a pre-plant orchard site in summer of 2017.

The trial was done in collaboration with Rory Crowley and George Nicolaus of the Nicolaus Nut Company at one of their Chico sites.


NP = Nonpareil variety cultivated
B = Bennett-Hickman variety cultivated
M = Monterey variety cultivated
Untreated (control)
Biosolarized using nonpareil variety residues and worm castings
Biosolarized using pollinator variety residues and worm castings
Solarized without amendments

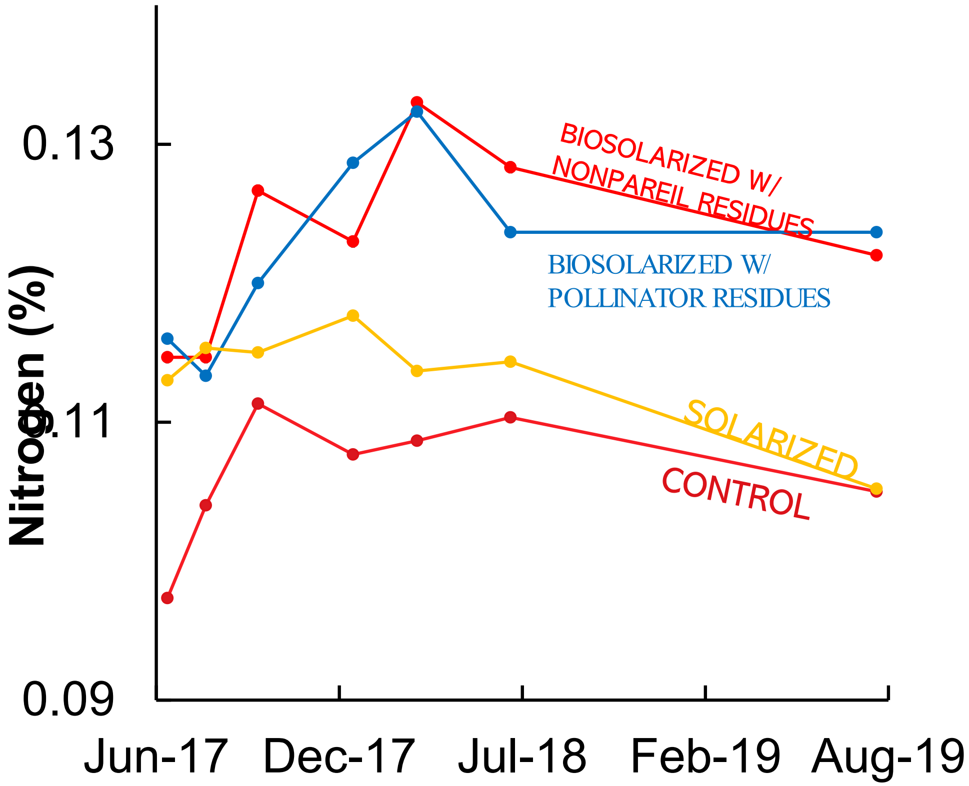
Root lesion nematode control

Root lesion nematode control observed within 9 days of biosolarization.



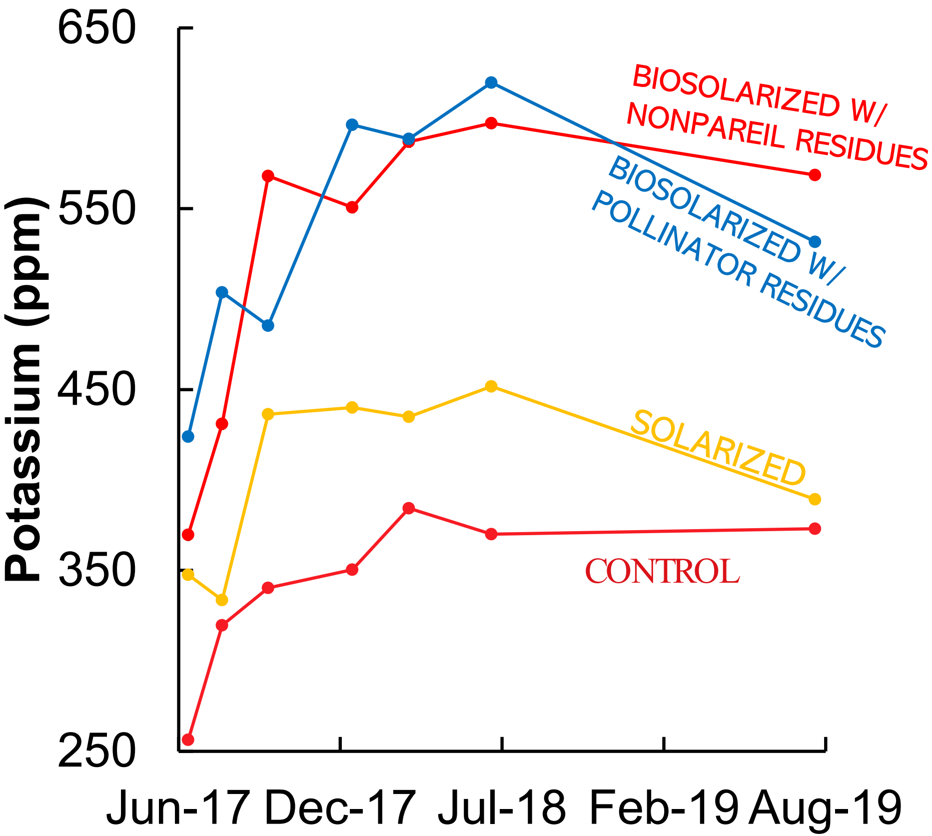
Soil nitrogen

Nitrogen levels have been significantly elevated in both biosolarized treatments for almost 2 years.



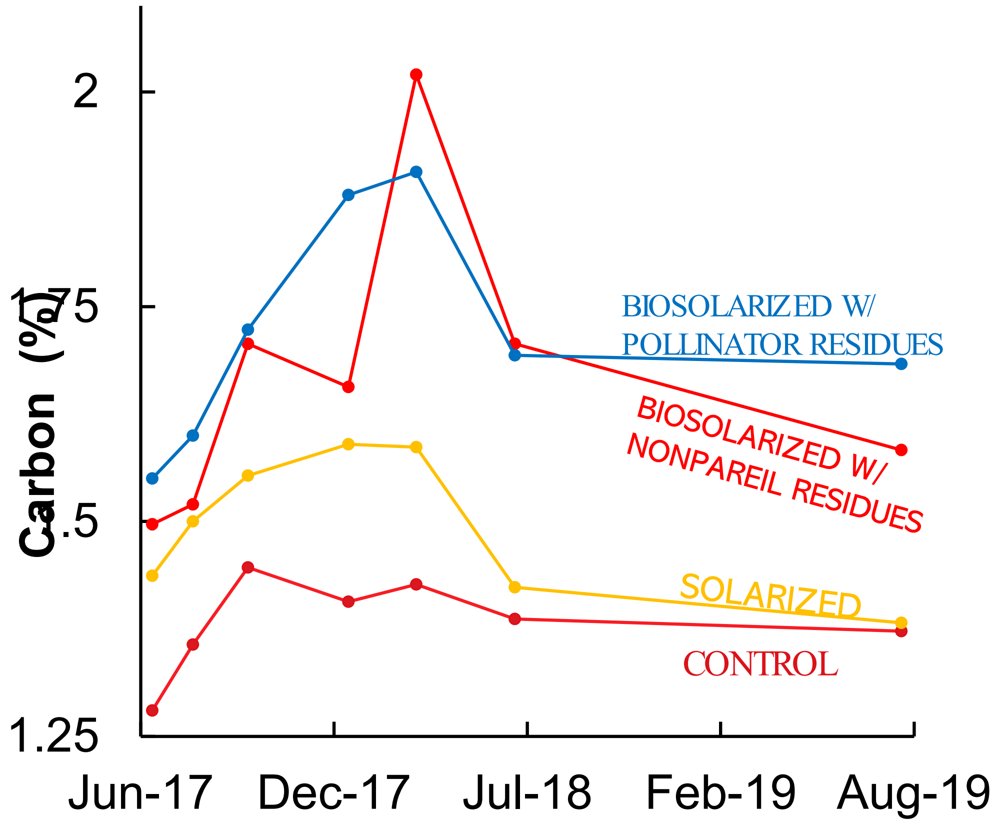
Soil potassium

Potassium levels have been significantly elevated in both biosolarized treatments for almost 2 years.



Soil carbon

Carbon levels have been significantly elevated in both biosolarized treatments for almost 2 years.



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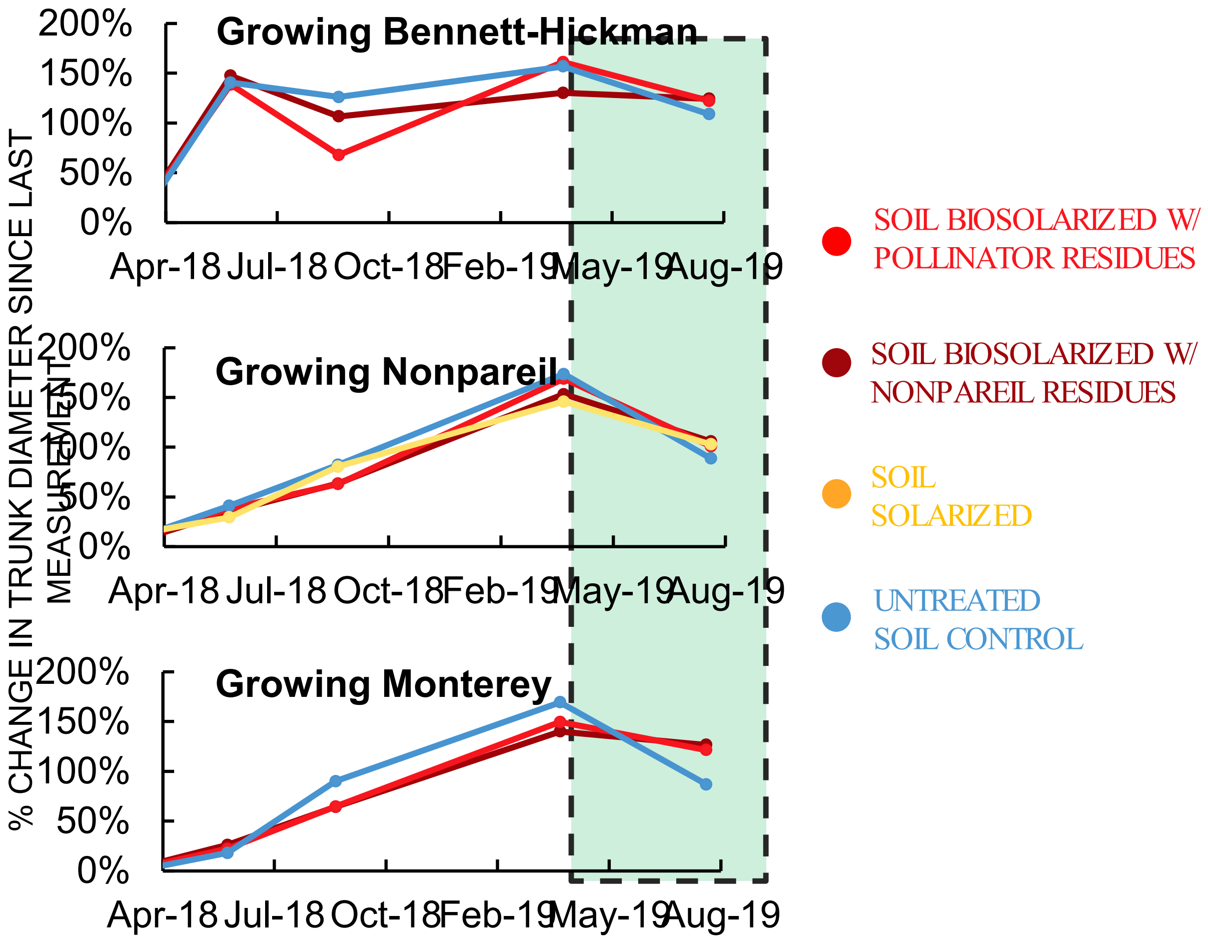
Tree growth

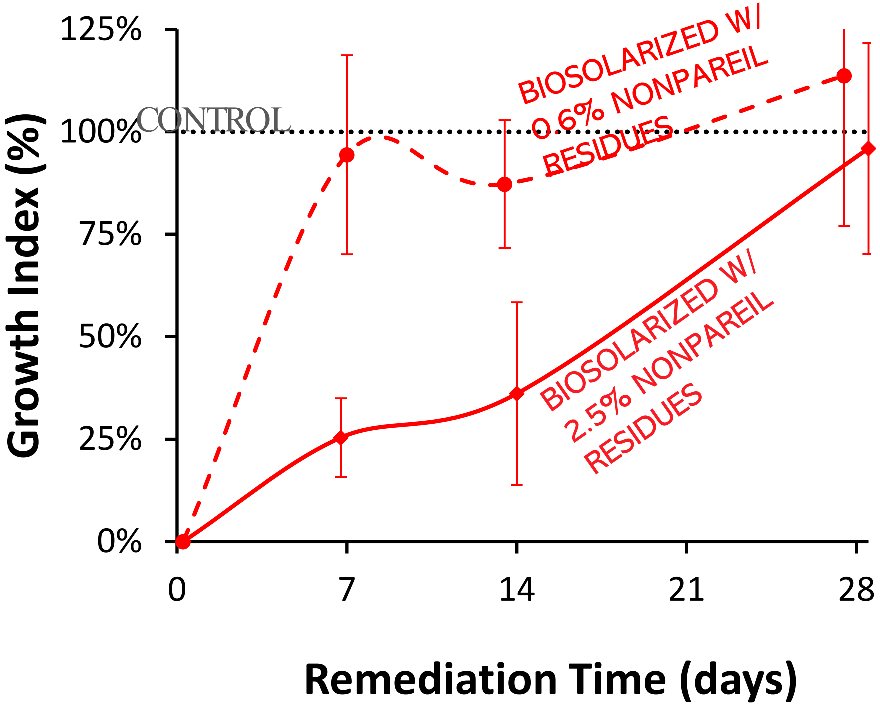
In the first year, trees in the biosolarized plots showed slower growth as they adapted to the soil

In their second year, trees in biosolarized plots showed increased growth rate compared to trees in untreated soil.



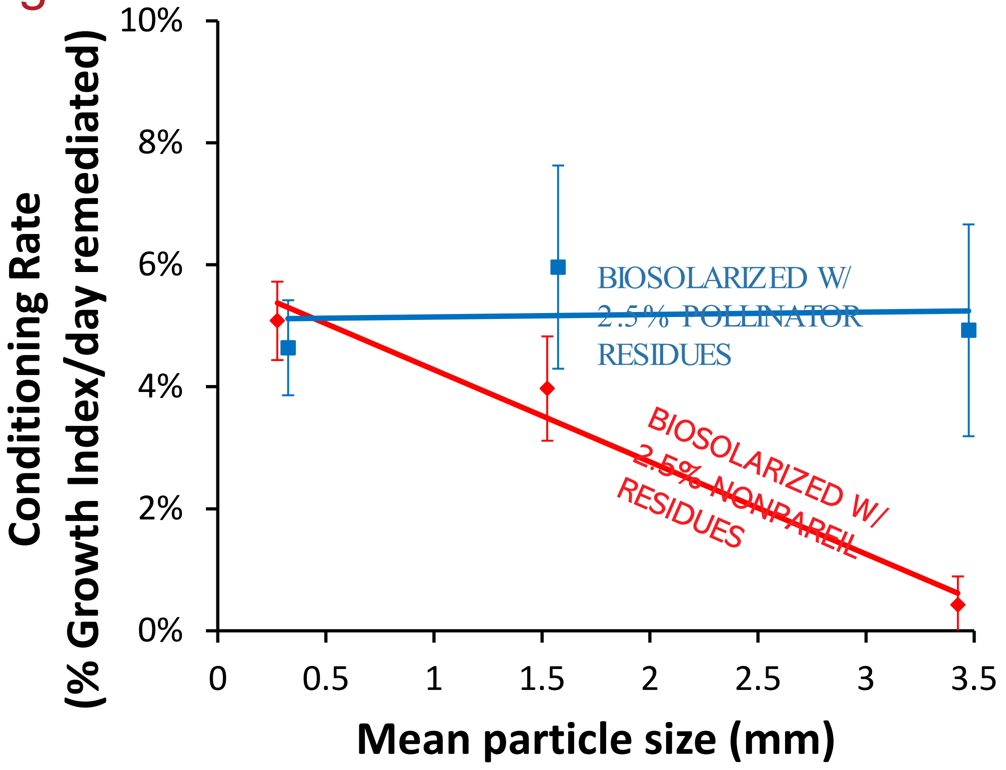
Soil conditioning ahead of planting

Conditioning time is proportional to quantity of biomass amended to soil.



Soil conditioning ahead of planting

Conditioning time depends on both the type of amendment used and its particle size.



Challenges and future work

More data is needed to demonstrate broad spectrum control of all pests targeted by fumigation.

Additional data is needed regarding biosolarization/ASD performance across a variety of soil types, weather and climate conditions, and almond varieties.

Technoeconomic studies are needed to clarify the cost per acre to use biosolarization/ASD.

Alternatives for Managing Problematic Weeds

Brad Hanson, UC Davis

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Inputs for weed management

- Herbicides
- Effort / labor
- Cultural practices / management
- Fuel
- Technology

CA almond herbicide use

	Top active ingredients	2017 treated acreage
1	glyphosate	1,654,398
2	oxyfluorfen (Goal, Goaltender)	846,623
3	glufosinate (Rely)	625,175
4	paraquat (Gramoxone)	513,050
5	saflufenacil (Treevix)	508,432
6	indaziflam (Alion)	227,848
7	pendimethalin (Prowl H2O)	214,582
8	rimsulfuron (Matrix)	186,146
9	carfentrazone (Shark)	101,922
10	sethoxydim (Poast)	93,654
11	penoxsulam (PindarGT)	81,711
12	flumioxazin (Chateau)	73,143
12	pyraflufen (Venue)	69,630
14	2,4-D	63,689
15	clethodim (SelectMax)	50,410
16	oryzalin (Surflan)	43,176

~1.3 million total acres 2017

Herbicide-resistant weeds

Glyphosate resistance in CA orchards

Confirmed

- Broadleaves
  - Horseweed (mostly winter)
  - Fleabane (mostly winter)
  - Palmer amaranth (summer)
- Grasses
  - Ryegrass (fall/winter)
  - Annual bluegrass (fall/winter)
  - Junglerice (summer)

Suspected or questionable

- Broadleaves
  - Lambsquarters (summer)
- Grasses*
  - Threespike goosegrass (spring)
  - Feather fingergrass (summer)
  - Windmillgrass (summer)
  - Sprangletop (summer)
  - Witchgrass (summer)

*Resistance in the world in several other Elusine, Chloris, Leptocloa, Echinocloa, Eragrastis spp.

Multiple resistances

- Increasing issues with "stacked" resistance
- Widespread glyphosate-resistance in some species
- Starting to see gly-R plus resistance to some one or more other chemistries
  - Conyza, Lolium, Poa so far.
  - Paraquat, ACCase, some glufosinate reports

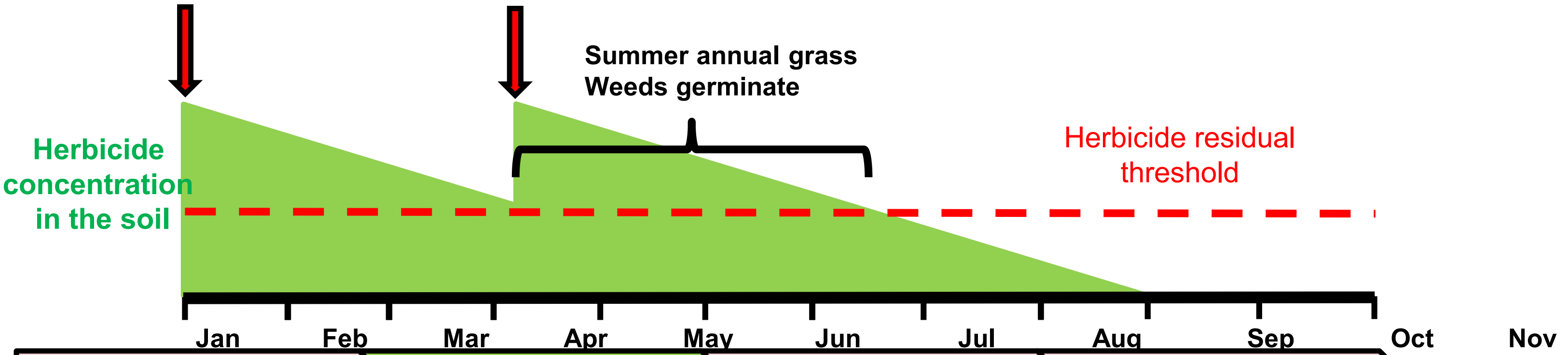
The future of almond weed management:
- a series of challenges, risks, and some opportunities

- Economic
- Environment (pesticides, dust, water, carbon, emissions, etc)
- Losses of key tools
  - Market-driven
  - Regulatory-driven
- The “three R’s”
- System requirements and expectations

Johnny Carson as **Carnac the Magnificent**

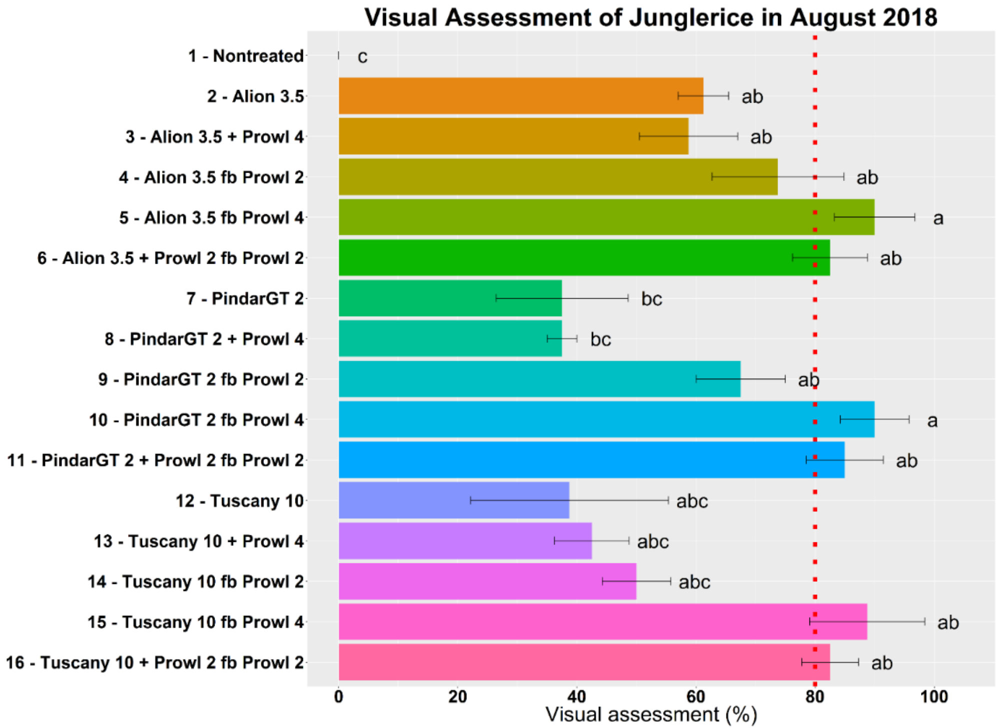
Example sequential PRE with Alion as foundation treatment

Winter treatment		Spring treatment
1 – Alion		
2 – Alion + Prowl 4 qt/A		
3 – Alion	fb	Prowl 2 qt/A
4 – Alion	fb	Prowl 4 qt/A
5 – Alion + Prowl 2 qt/A	fb	Prowl 2 qt/A



Background | Materials and Methods | Results | Conclusion

Brunharo and Hanson



Brunharo and Hanson

Water management / Chemigation

- Can we use existing technology differently to address specific weed management issues (e.g. summer weeds)?

Cover crop opportunities

Kern County - March 2018

Merced County - March 2018

Tehama County - March 2018

Soil mix

Haring, Creze, Gaudin et al.

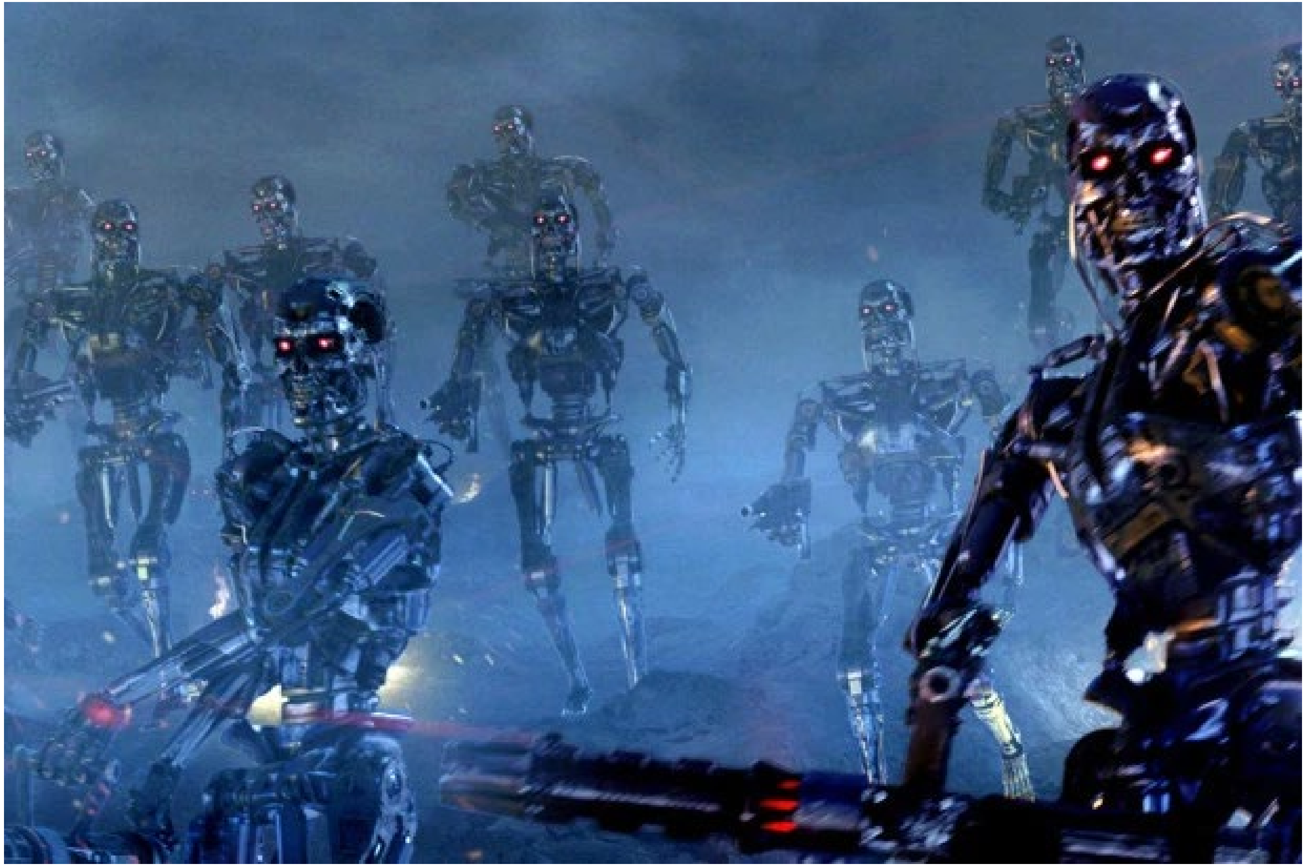
The “R” word (Roundup)

- Glyphosate classified as “probable carcinogen” in 2015
- IARC evaluation
  - New interpretation of existing data using a “hazard assessment”
  - Other agencies (USEPA, EU) previously interpreted these data – and more – differently using a “risk assessment” approach
- What does this mean for CA ag?
  - Added to CA Prop 65 list in 2017
  - I anticipate relatively little near term impact (ag) from a regulatory standpoint. But, considerable pressure from market forces in some sectors.
- Currently, a lot of litigation related to alleged glyphosate-caused cancer
  - Several important cases in CA state and Federal court jurisdictions
  - This will likely remain in the news for several years at least

Regulations

- Several important herbicides (and other pesticide classes) facing challenges driven by:
  - Toxicity and worker safety concerns (e.g. closed handling systems, applicator licensing changes)
  - Export market concerns with residues
  - Domestic market consumer/buyers leveraging changes to production systems
    - Organic, sustainably-produced, non-GMO, glyphosate-free and similar.
    - True also of other orchard-related goals (e.g. sustainability, healthy soils, etc).
- This is not likely to get easier for the grower! Sorry.

Robotics



Robotics

- Interesting work going on in autonomous vehicles for ag, including weed management tactics
- Likely will be opportunities for almond orchards

- Questions in my mind:
  - How are the weeds being controlled?
  - Can we use the technology to minimize
    our orchard weed control challenges
    and risks?
  - What is the trade off with regard to other challenges and risks?

Naio Tech: Dino vegetable crop weeder

Vibro Crop Robotti

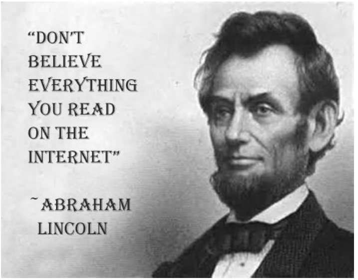
GUSS autonomous orchard sprayer

Tertill (Roomba-style string trimmer)

- System requirements and grower/industry expectations
  - Extremely high expectations for weed control will be a major limitation to significant changes
- Autonomous vehicles (so far) will change “who” is doing the weed control practice but not yet the practices themselves.

https://images.app.goo.gl/DjhFywB6Coa9VYqx9

- We cannot solve our problems with the same thinking we used when we created them.
  - Quote attributed to Albert Einstein



- Sometimes a bigger hammer isn't the best solution for our orchard weed management challenges.
  - Quote attributed to Brad Hanson (who is, admittedly, no Albert Einstein)

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UC Davis Weed Research and Information Center
http://wric.ucdavis.edu/
http://ucanr.org/blogs/UCDWeedScience/

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