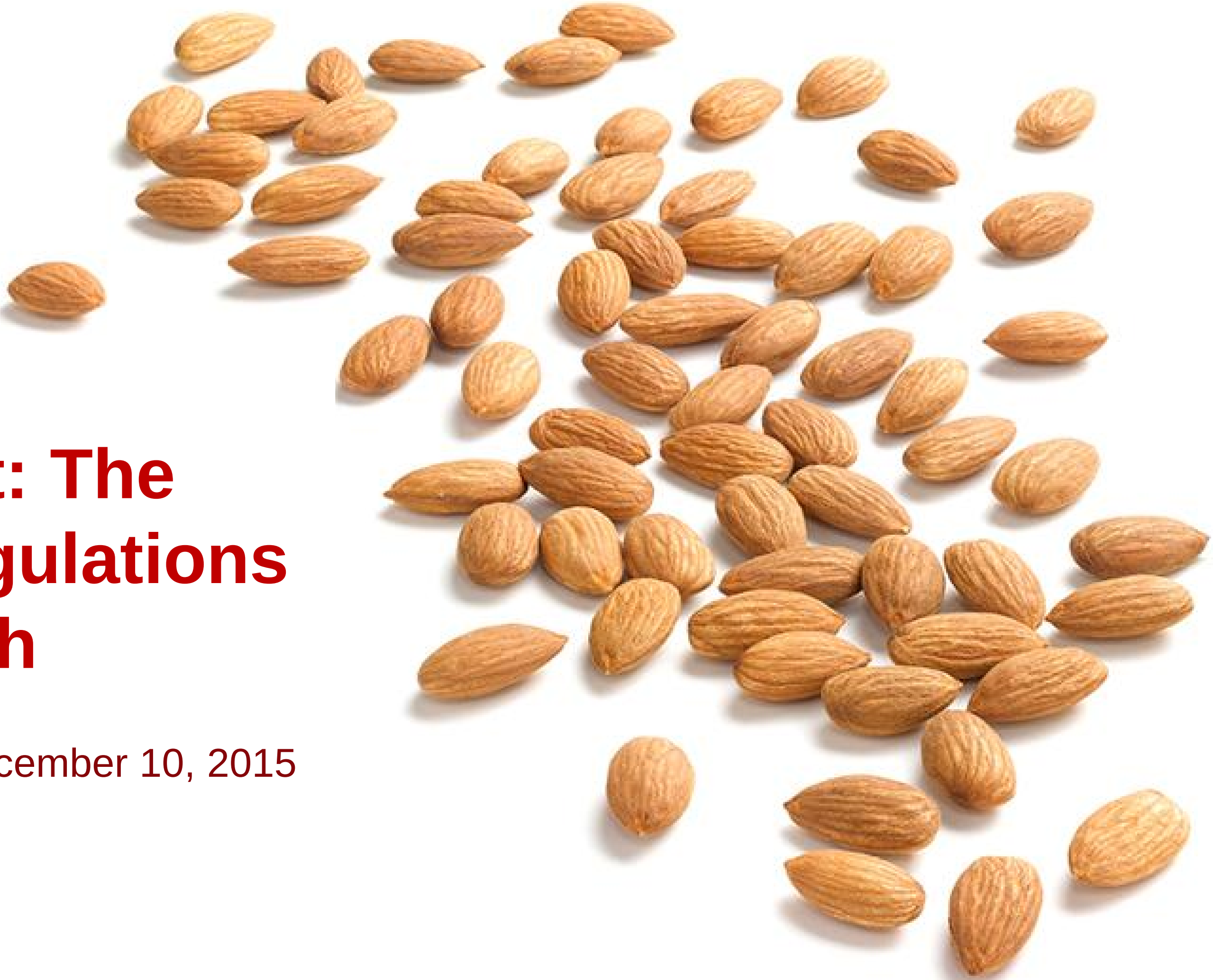
Soil Pest Management: The Latest in Regulations and Research

December 10, 2015



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Speakers

Gabriele Ludwig, Almond Board (Moderator)

Randy Segawa, DPR

Suduan Gao, USDA-ARS, Parlier

Greg Browne, USDA-ARS, Davis

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Randy Segawa, DPR

Regulatory Update for Soil Fumigants

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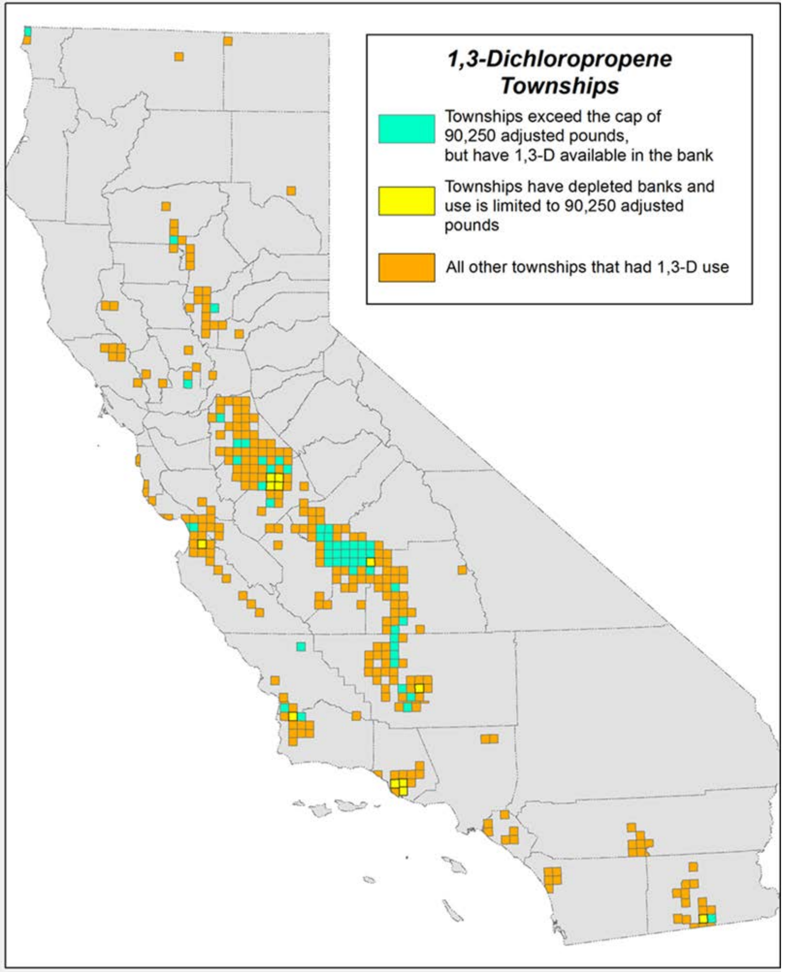
Overview

- 1,3-dichloropropene (1,3-D; Telone)
- Chloropicrin
- 3 regulations in progress
- EPA registration review

1,3-D (Telone) Township Cap

- Goal: air concentration ≤0.14 ppb (70-yr avg) to mitigate cancer risk
- Allocation of 90,250 lbs/yr for each township (6x6 mi), unused amount “banked”
- Max use of 180,500 lbs/yr, if bank available
- 12 townships with depleted banks (yellow), 54 with >90,250 lbs in 2014 (blue)
- DPR will revise cap in early 2016 after completing risk assessment



Chloropicrin Recommended Permit Conditions

Requirement	Current Labels	DPR
Max buffer distance	Untarped: 1990 ft	Untarped: 1x – 6x of label
Min buffer distance	25 ft	Untarped: 100 ft
Buffer credits	11 credits	**Only DPR-approved 60% credit tarp**
Max acres	120–160 ac block	40 ac block
Overlapping buffers	Prohibited for 12 hrs	Buffer based on combined acres for 36 hrs
Tree hole limits	None	50–200 holes/ac, 40 ac max
Fumigation time limits	None	1 hr after sunrise, 3 hrs before sunset

Methyl Bromide and Volatile Organic Compounds (VOCs)

- Current VOC regulations require low-emission fumigation methods in San Joaquin Valley during May-Oct to reduce ozone

- Proposed regulation
  - Reconciles methyl bromide regulations with Phase 2 label revisions
  - Adds more low-emission fumigation methods for other fumigants using **“totally impermeable film”**

- Regulation will go into effect by May 2016

Totally Impermeable Film (TIF)

- TIF is a multi-layer tarp, usually with an ethylene vinyl alcohol (EVOH) core
- TIF tarps reduce emissions of most fumigants by 60% or more, resulting in
  - Greater fumigated acreage with same 1,3-D township cap
  - Smaller chloropicrin buffer zones
  - Lower VOC emissions

Other Field Fumigants

- Methyl isothiocyanate (MITC; Vapam, K-Pam, Sectagon) generators
  - No changes
- Allyl isothiocyanate (AITC; Dominus)
  - DPR will conduct health risk assessment as part of registration evaluation
- Dimethyl disulfide (DMDS; Paladin)
  - Registrant withdrew California application for registration

Other Regulations in Progress

- **Schools regulation**
  - – Regulation will require notification and restrictions of agricultural pesticides used near schools
  - – DPR plans to notice regulation for public comment by end of 2015

- **Fumigant notification regulation**
  - – Regulation will require notification to residences, other sites
  - – Workshops in 2016

EPA Registration Review Schedule for All Fumigants

Milestone	Timeframe
Registrant Data Call-In	August 2014
Data Submission	Summer 2016 – 2017
Risk Assessment	2018
Decision	2018 – 2019

Questions and Additional Information

- www.cdpr.ca.gov
  - “QUICK LINKS” tab
  - “Air” link

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Suduan Gao,
USDA-ARS, Parlier

Emission Reduction and Nematode Control from Soil Fumigation

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Research Soil Scientist
USDA, Agricultural Research Service
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Research Cooperators

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- Brad Hanson, CE Specialist, UC Davis
- Ruijun Qin, Research Project Specialist, UC Davis
- Sadikshya Dangi, Postdoctoral Research Associate, UC Davis
- J. Alfonso Cabrera, Research Scientist, Bayer CropScience, Fresno
- James Gerik, Research Pathologist, USDA-ARS, Parlier
- Greg Browne, Research Pathologist, USDA-ARS, UC Davis
- Dong Wang, Research Soil Scientist, USDA-ARS, Parlier

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Soil fumigation for perennial specialty crops:

Pre-plant soil fumigation to control

- parasitic nematodes
- replanting disease

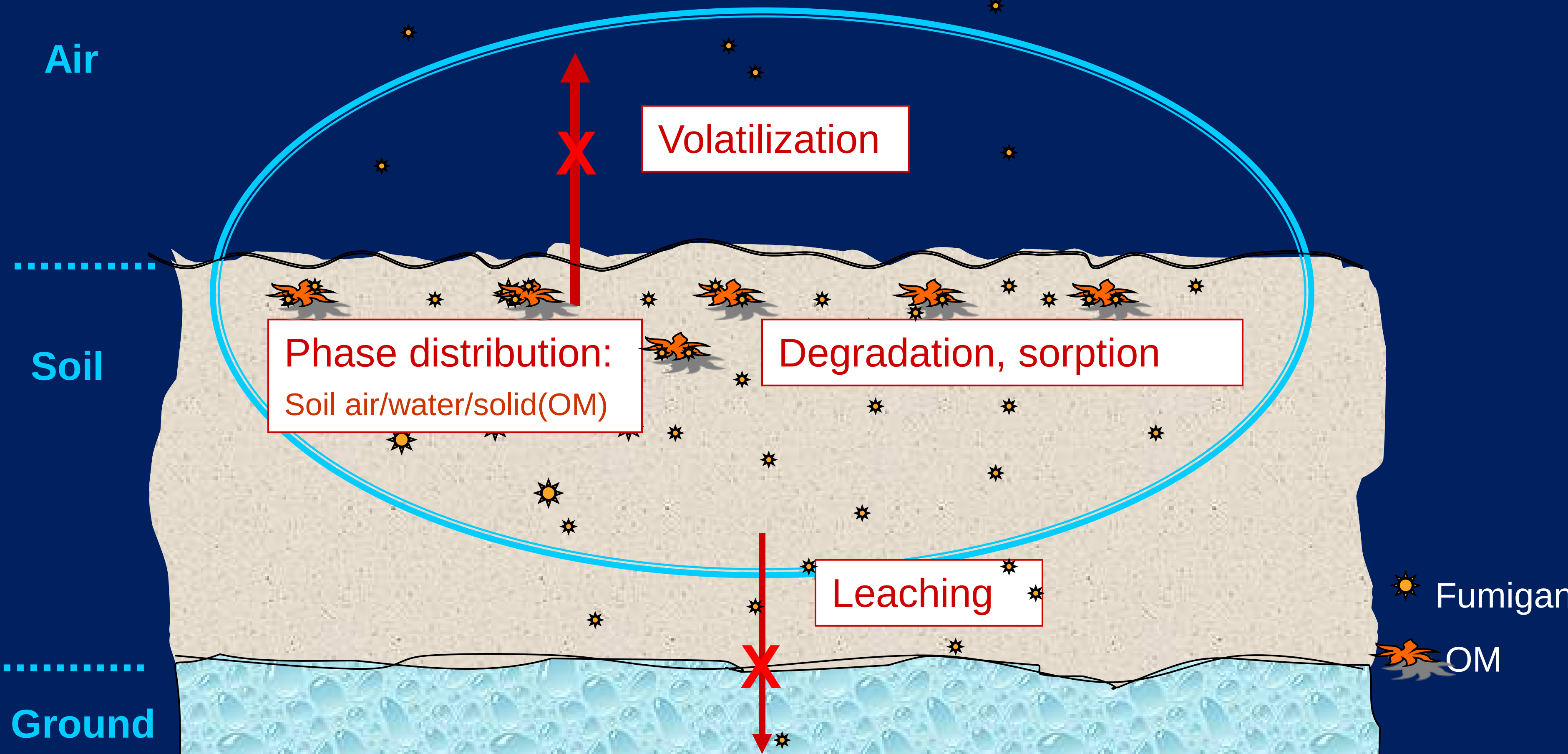
Regulatory issues on fumigant emissions

Ozone non-attainment areas (NAAs)

- Exposure risk: buffer zones; township cap for Telone®

- Volatile organic compounds (VOCs): low-emission fumigation methods during May-Oct in NAAs

Processes affecting the fate of fumigant in Soil



Goals of soil fumigation

- Minimize emission
- Maximize efficacy
- Reduce fumigation costs
- Maximize yield

Emission reduction methods:

- Application Methods:
  - Deep injection (shank design)
  - Drip vs. shank
  - Target area treatment (strip shank; spot drip)
- Surface Treatment:
  - Plastic tarp
    - (standard PE; low permeability – VIF, TIF)
  - Irrigation (water seals; pre-irrigation)
  - Organic amendment (manure)
  - Chemical Treatment (e.g., thiosulfate)

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2011-15 Research Objectives:

Demonstrate the ability of TIF to reduce emission and improve efficacy as well as the potential of using reduced rates in soil fumigation for perennials

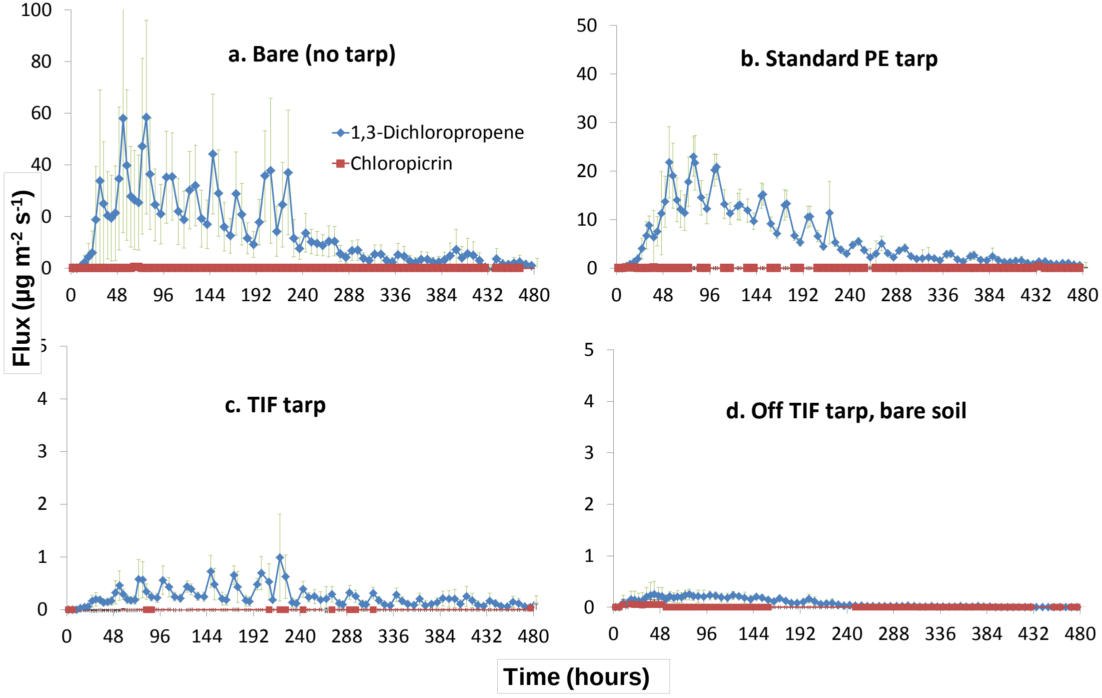
Conducted three large field trials:

1. Oct 2011 Parlier trial (USDA-ARS)
2. Nov 2012 Merced trial (Bluff Ranch)
3. Dec 2014 Ballico trial (Littlejohn's Farm)

Field Treatments

Telone® C-35 rate	Bare	Std PE	TIF
0 (control)	x	x	x
33% (16 gal/ac)	x	x	x
66% (32 gal/ac)	x	x	x
100% (48 gal or 540 lb/ac)	x	x	x

Low permeability tarp reduce emissions



From shank injection of Telone® C35 (407 kg/ha);
Hanford sandy loam ripped down to 3 ft depth

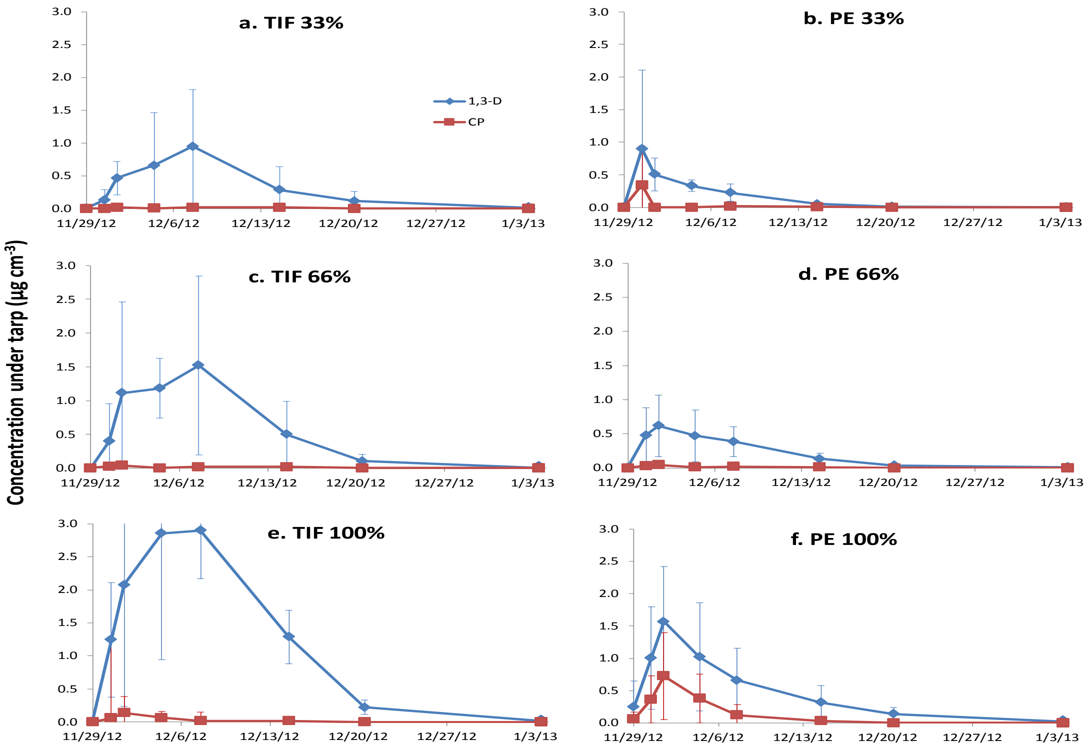
Cumulative loss (% of applied)

Surface seal	1,3-D	Chloropicrin
Bare	53.5	0.5
PE	38.3	< 0.5
TIF	1.9	< 0.5
Off TIF tarp in bare soil*	0.6	< 0.5

* Assuming the same application rate was applied.

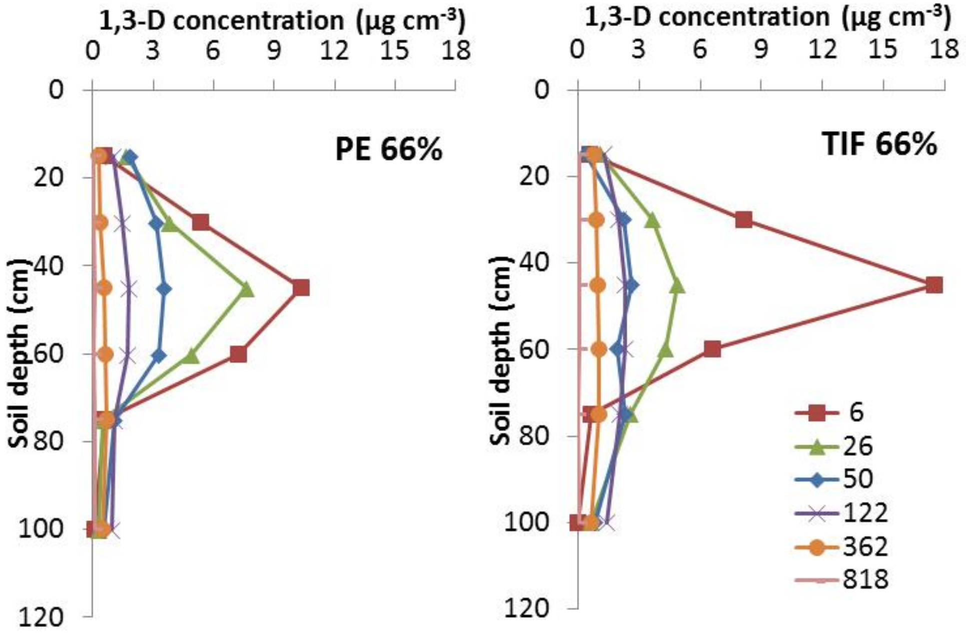
Fumigant concentration under tarp

(2012 Merced trial; Snelling sandy loam)



Fumigant distribution in soil profile

(2012 Merced trial)



- 1,3-D and chloropicrin do not move as well as methyl bromide
- Soil (Snelling sandy loam) was not cultivated well

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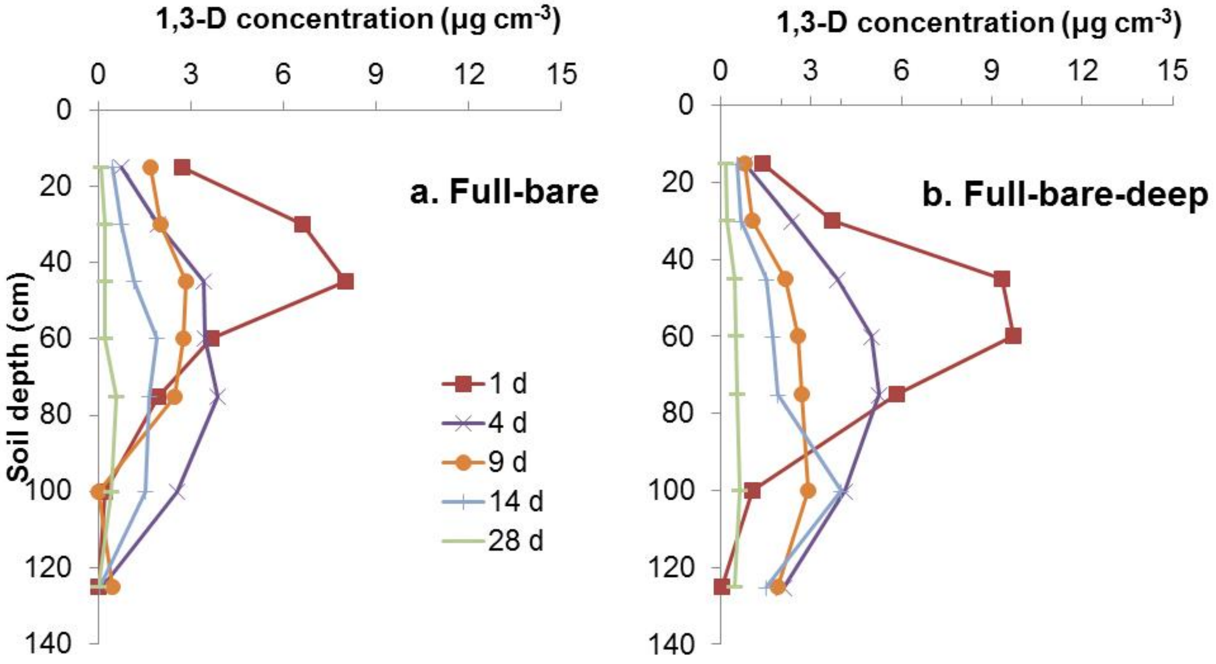
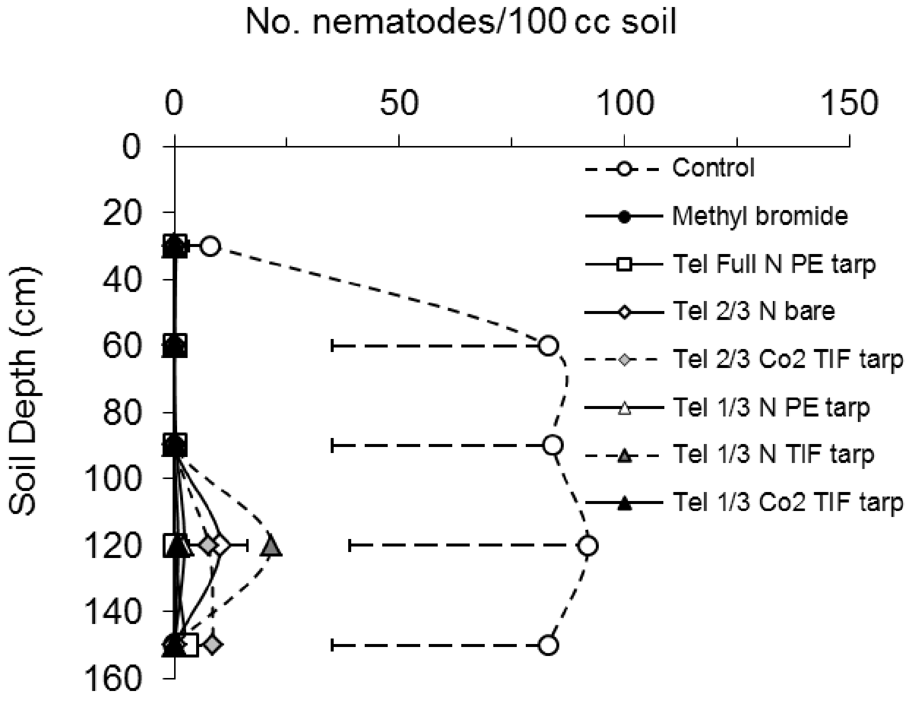
Deep injection to deliver fumigants

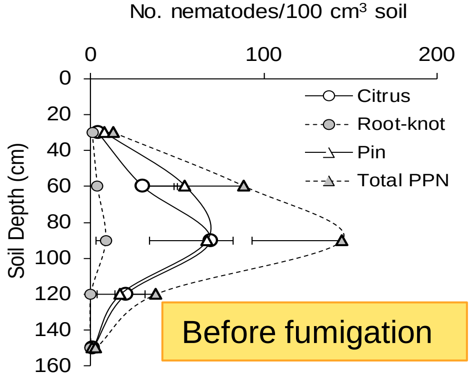
(2014 Ballico trial; Delhi Sand)



Nematode survival after fumigation

(2011 Parlier trial; Hanford Sandy loam; data from Alfonso Cabrera)

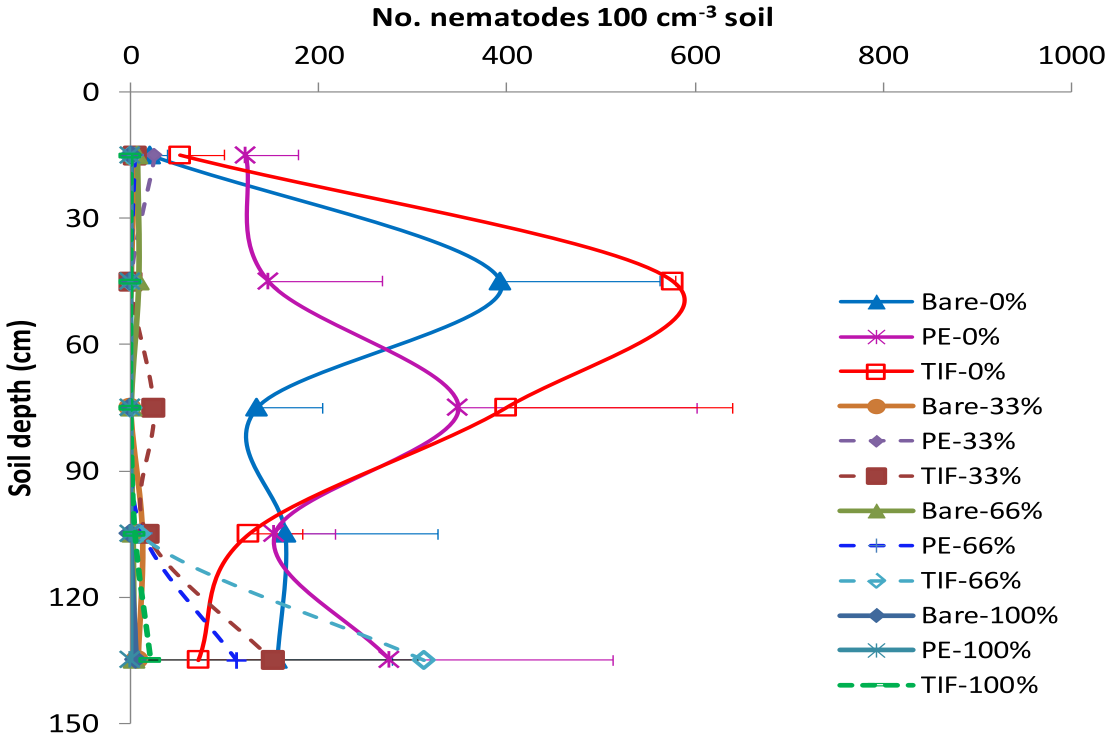


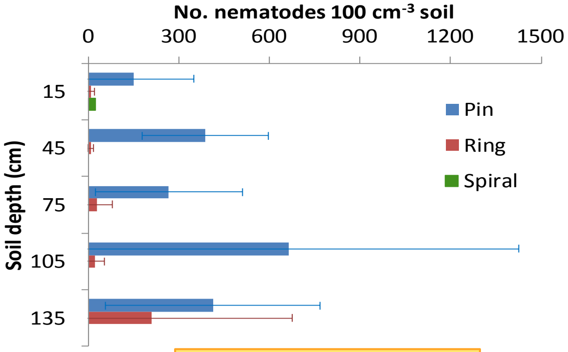


Plotted are sum of Citrus, Root-knot, Pin, Dagger, and Ring nematodes found in different treatments after fumigation

Nematode survival after fumigation

(2012 Merced Trial; Snelling sandy loam)





Before fumigation

Nematode survival after fumigation

(2014 Ballico Trial; Delhi Sand)

Sum of Ring, Lesion, Root-knot, Pin and Stubby (no/100 cc) in all non-fumigated plots*

Soil depth	Alive	Dead
	Ave (stdv)	Ave (stdv)
0-1 ft	10 (11)	22 (25)
1-2 ft	8 (17)	1 (17)
2-3 ft	4 (4)	10 (7)
3-4 ft	5 (12)	4 (7)
4-5 ft	3 (5)	8 (14)

* All fumigation treatments provided 100% kill except 1 sample (0-1 ft depth; PE tarped full rate) with live root-knot nematode (out of 135 samples)

Almond tree growth and yield (planted Feb. 2013, Merced trial; from David Doll)

Treatment (Telone® C-35 rate & tarp type)		Tree diameter[a] (mm)		Yield[b] (field wt, lb/tree)
	3/8/2013	12/15/2013	11/14/2014	8/7/2015
100% no tarp	11.4	46.3 a	87.2 a	38.2 a
100% PE	10.6	46.2 a	86.4 a	37.3 a
100% TIF	10.8	45.6 a	85.1 a	36.3 a
66% no tarp	11.2	44.1 ab	87.0 a	38.2 a
66% PE	11.0	45.5 a	87.0 a	34.4 a
66% TIF	11.6	45.7 a	85.9 a	35.1 a
33% no tarp	11.1	43.2 abc	82.8 ab	31.2 ab
33% PE	11.1	43.8 ab	84.4 a	31.9 ab
33% TIF	11.4	43.1 abc	82.8 ab	30.4 ab
0% no tarp	10.8	37.6 d	73.9 c	19.0 c
0% PE	11.0	39.3 bcd	75.9 bc	21.5 bc
0% TIF	10.4	38.2 dc	74.5 dc	22.1 bc

[a]Different letters in the same column indicate significance at $P<0.05$; [b]The weight includes the hull, kernel and shell

Key points

- Almond tree growth and yield show positive response to fumigation.
- Minimizing emissions with low permeability tarp not only satisfy regulatory requirement but also increase fumigation efficiency.
- There is no difference between full rate (540 lb/ac) and 2/3 rate of Telone® C35 when injected to 18” soil depth. Fumigant distribution is the key to nematode control.
- Cultivate the soil for the best possible soil fumigation: 1,3-D and chloropicrin do not move well in soil. Deep injection shows some improvement on fumigant delivery to soil below 3 ft depth.
- Research continues addressing improvement of fumigant delivery and/or distribution in soil profile in perennial fields (ARS-UCD-UCANR collaborative project supported by CDFA-SCBGP 2015-2018)

Acknowledgements

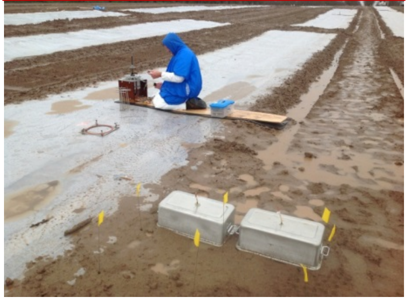
Funding:

- California Department of Food and Agriculture - Specialty Crop Block Grants Program (CDFA-SCBGP) (10/2011-6/2014)
- NIFA Methyl Bromide Transition Grants Program (10/2010-2/2015)
- Almond Board of California (2005-present)

In-kind donation:

- TriCal Inc.
- Growers – Bluff Ranch, Little John's Farm, Sierra Gold Nursery; Bright's Nursery, Jost/Thiesen Orchard

Thanks to the dedicated research staff



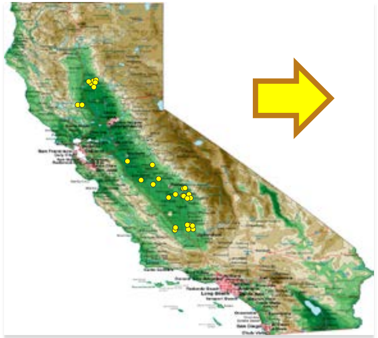
Greg Browne, USDA-ARS, Davis

Potential for Managing Replant Problems Without Soil Fumigants

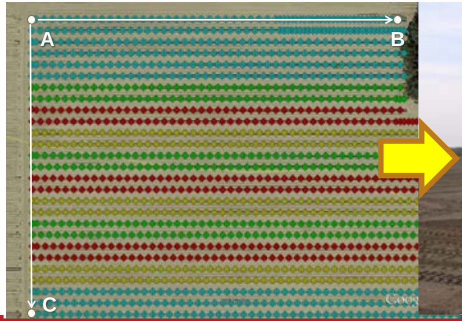
Greg Browne
Natalia Blackburn
Hossein Gouran
Gurreet Brar
Brent Holtz
David Doll
Andreas Westphal
Amelie Gaudin

Potential for Reducing Fumigation Use for Replant Disease

1. Predictive assays, diagnostics

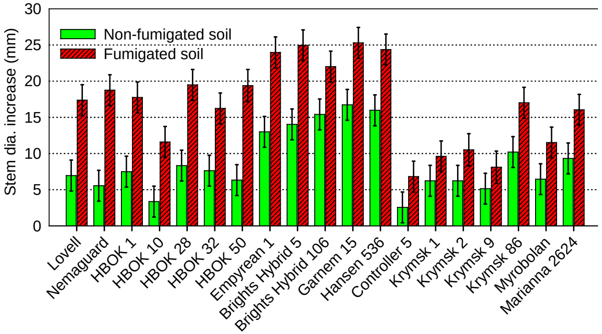


2. "Spot" fumigation, rate reduction

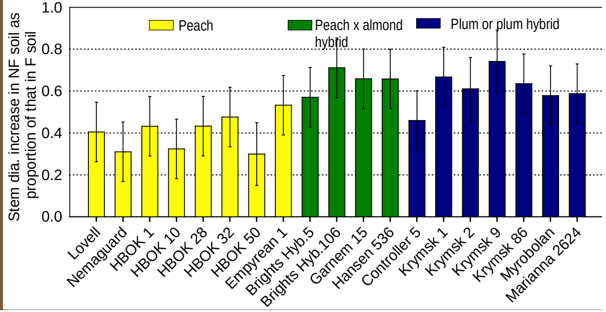


3. Tolerant / resistant rootstocks

Relative impact of PRD on different almond and stone fruit rootstocks



2011-12 trial



KAC Trials : Potential for Replacing Fumigant Use

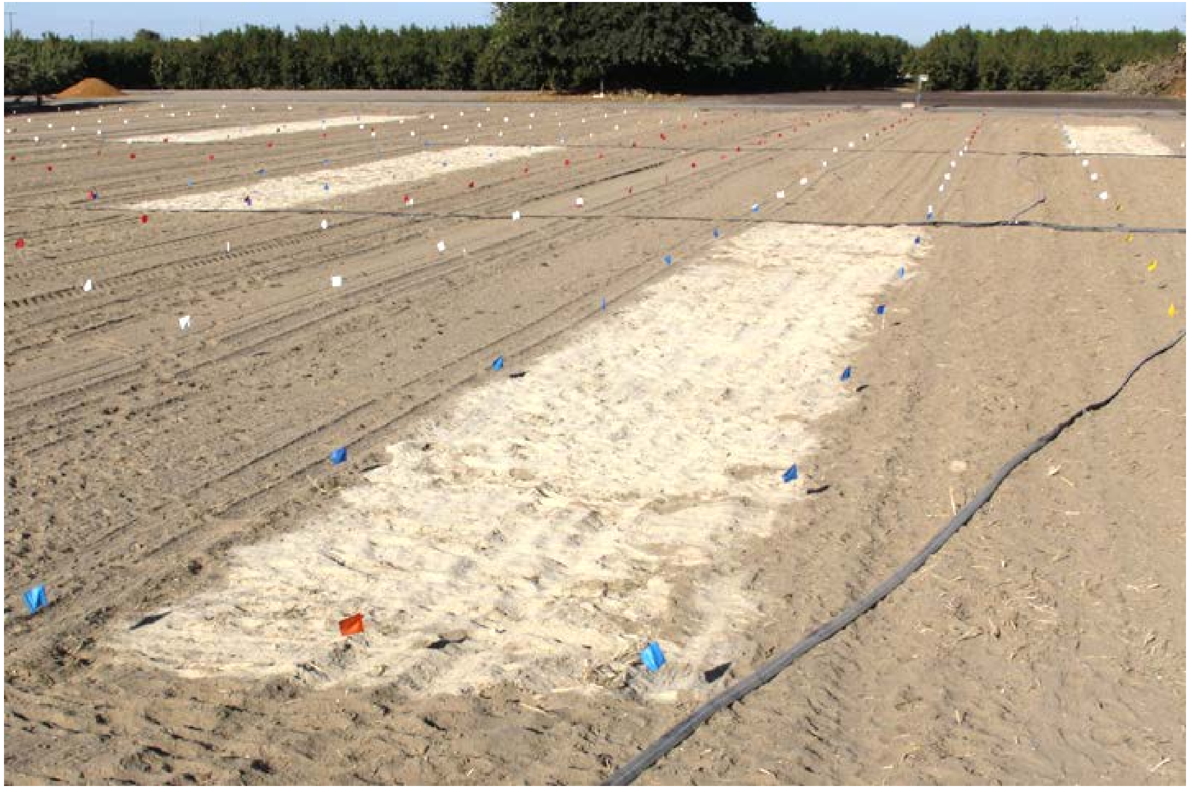
Non-fumigant soil remediation potential, KAC Parlier, 2013-15

Preplant treatments included:

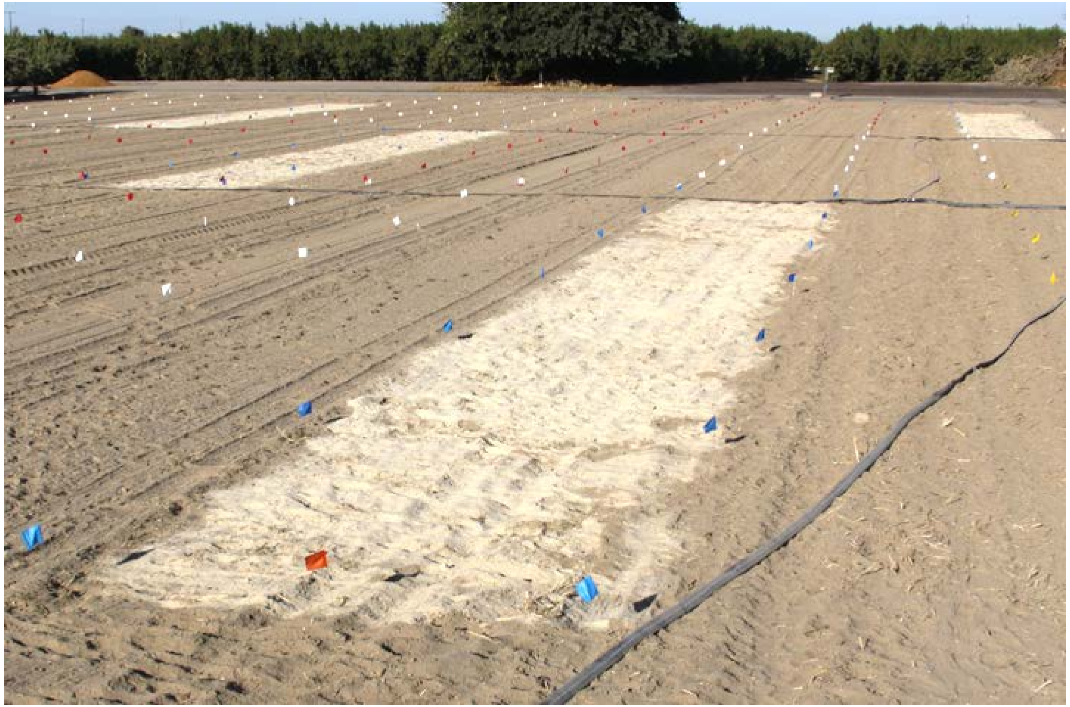
- Control
- Early removal / fallow or Sudan rotation
- Deep soil ripping
- Anaerobic soil disinfestation (ASD)
- Early and late season fumigation

Anaerobic Soil Disinfestation (ASD)

- Developed in Japan and Netherlands, being tested in CA strawberries
- Initiated by adding readily available carbon substrate to soil, covering with clear tarp, keeping soil moisture near field capacity for several weeks; heat facilitates
- Mechanism incompletely understood, but ASD is lethal and/or suppressive to many pathogens



ASD Treatments at Kearney Ag Center (KAC), Parlier



Details of ASD Trial Treatments and Methods in 2014-15 Report to Almond Board of California

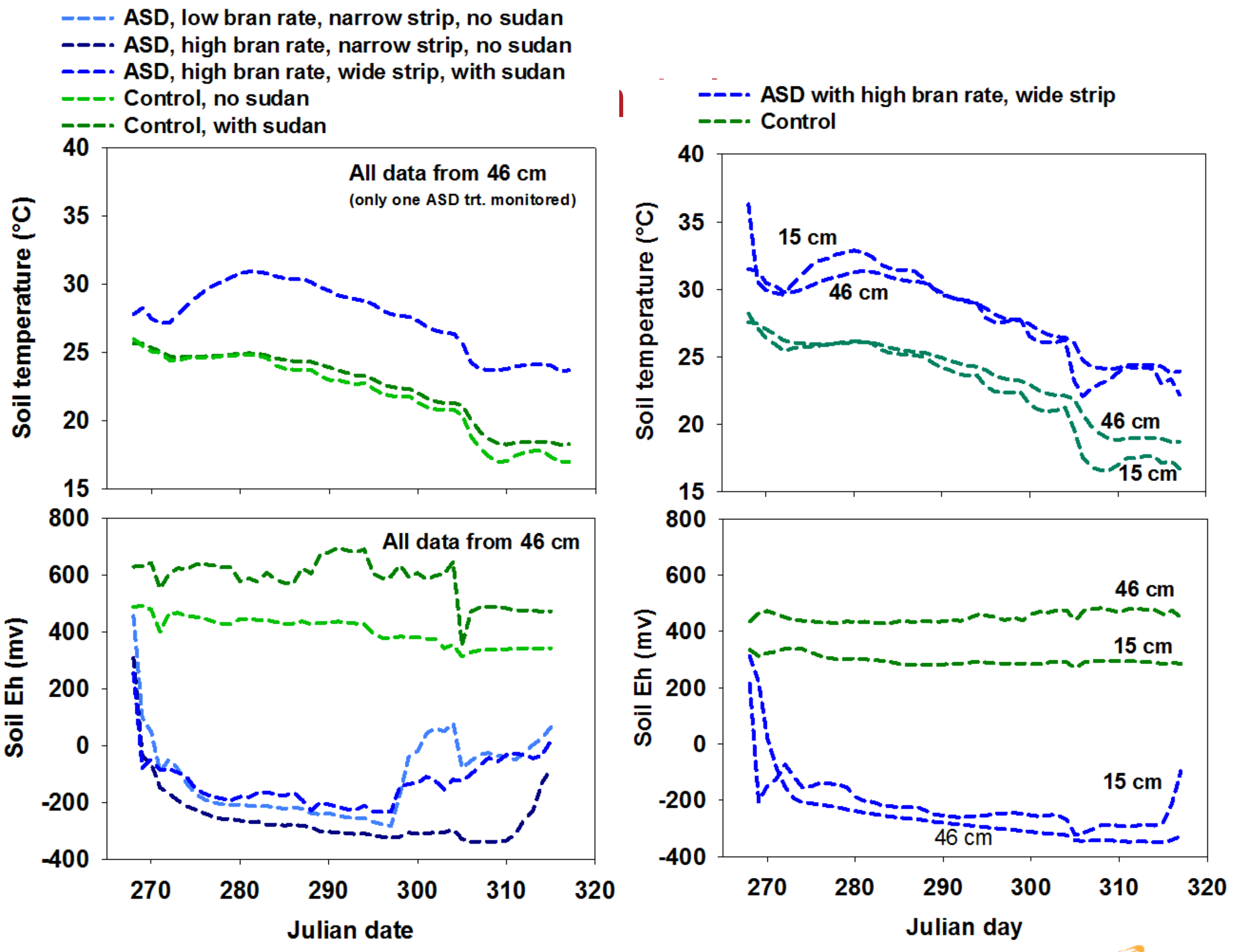
- **2 experiments started in 2014**
- **2 experiments started in 2015**

Year	Expt.	Trt. no.	Treatment name	Month of old orchard tree removal	Month of sudan rotation	Fall/winter soil disinfestation treatment
2013	1	1	Control, no sudan	Sep	None	None
		2	Control, with sudan	May	May-Oct	None
		3	ASD, high bran rate, wide strip, with sudan	May	May-Oct	ASD, 20 metric tons /treated ha, 3.0-m-wide strips
		4	Fumigation in Oct, no sudan	Sep	No	Telone C35, 600 kg/treated ha in Oct, 3.4-m-wide strips
		5	Fumigation in Oct, with sudan	May	May-Oct	Telone C35, 600 kg/treated ha in Oct, 3.4-m-wide strips
		6	Fumigation in Dec, no sudan	Sep	None	Telone C35, 600 kg/treated ha in Dec, 3.4-m-wide strips
	2	1	Control, no sudan	May	None	None
		2	ASD, high bran rate, wide strip, no sudan	May	None	ASD, 20 metric tons /treated ha, 3.0-m-wide strips
		3	Fumigation in Oct, no sudan	May	None	Telone C35, 600 kg/treated ha in Oct, 3.4-m-wide strips
2014	3	1	Control, no sudan	Sep	None	None
		2	Control, with sudan	May	May-Oct	None
		3	ASD, high bran rate, wide strip, with sudan	May	May-Oct	ASD, 20 metric tons /treated ha, 3.0-m-wide strips
		4	ASD, high bran rate, narrow strip, no sudan	Sep	None	ASD, 20 metric tons /treated ha, 1.8-m-wide strips
		5	ASD, low bran rate, narrow strip, no sudan	Sep	None	ASD, 12 metric tons /treated ha, 1.8-m-wide strips
		6	Fumigation in Oct, no sudan	Sep	None	Telone C35, 600 kg/treated ha in Oct, 3.4-m-wide strips
		7	Fumigation in Oct, with sudan	May	May-Oct	Telone C35, 600 kg/treated ha in Oct, 3.4-m-wide strips
	4	1	Control, no sudan	May	None	None
		2	ASD, high bran rate, wide strip, no sudan	May	None	ASD, 20 metric tons /treated ha, 3.0-m-wide strips
		3	Fumigation in Oct, no sudan	May	None	Telone C35, 600 kg/treated ha in Oct, 3.4-m-wide strips

Included in all four KAC experiments with ASD:

Impacts of ASD or
and Temperature

Treatment period was late Sep through Nov



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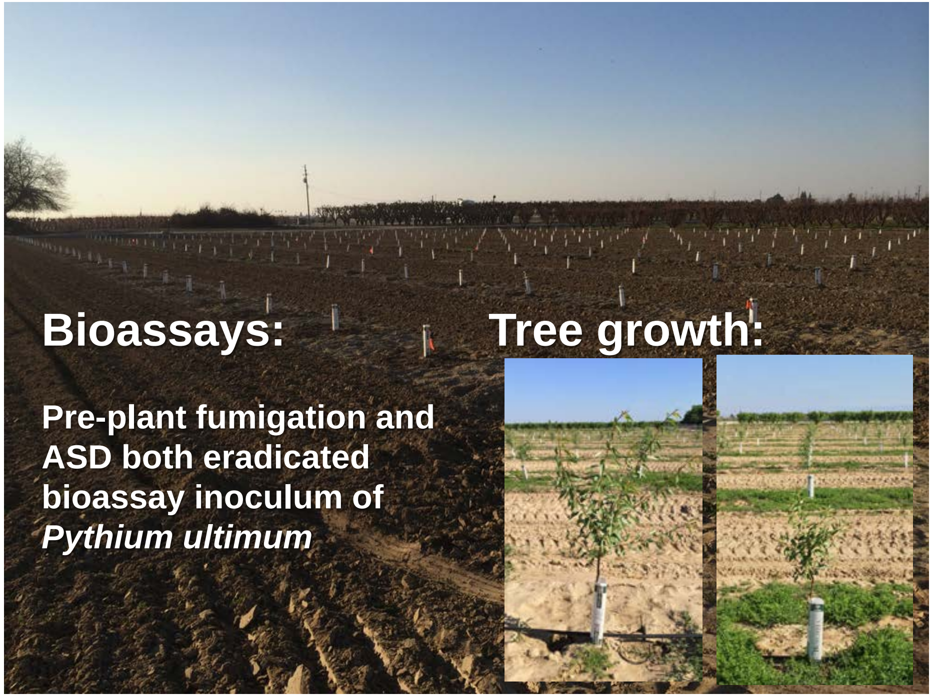
Assessing Impacts of ASD

Growing season 1

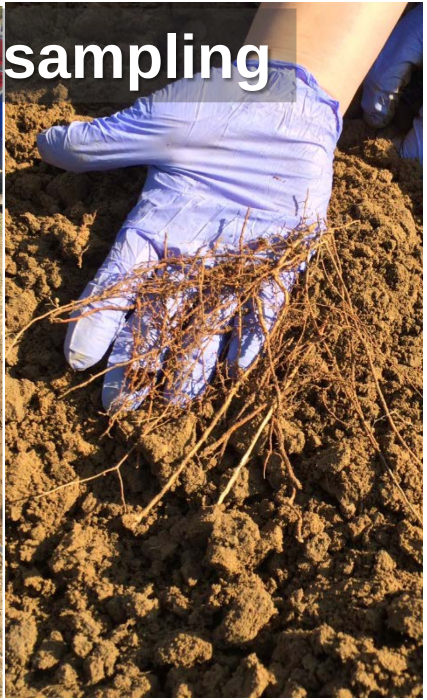


Bioassays:

Pre-plant fumigation and ASD both eradicated bioassay inoculum of *Pythium ultimum*

Tree growth:

Microbial sampling

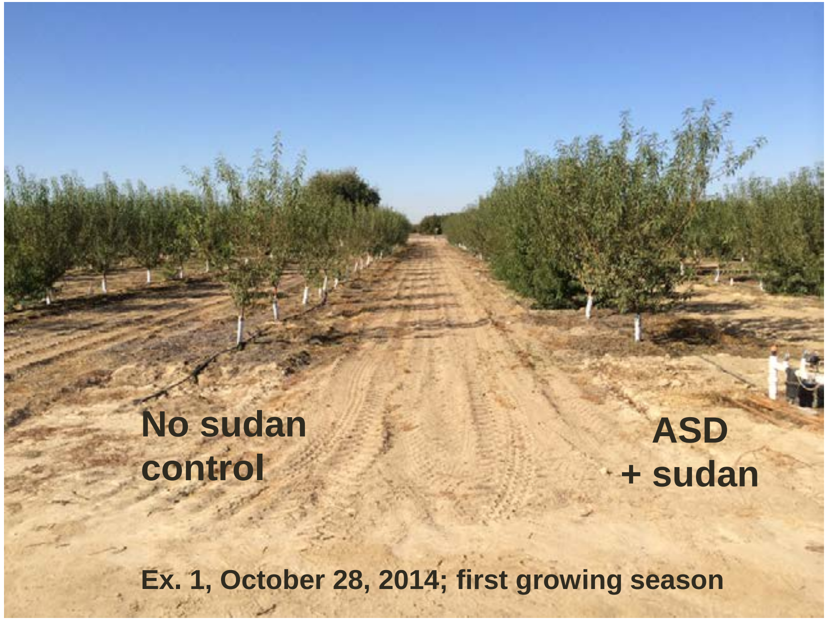


Assessing Impacts of ASD

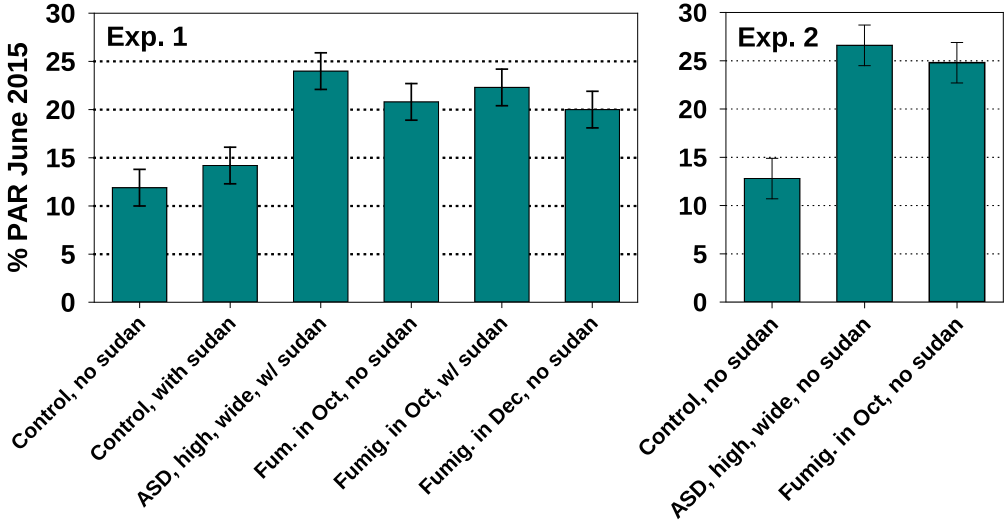
Growing Season 2

Experiments 1 and 2 with ASD

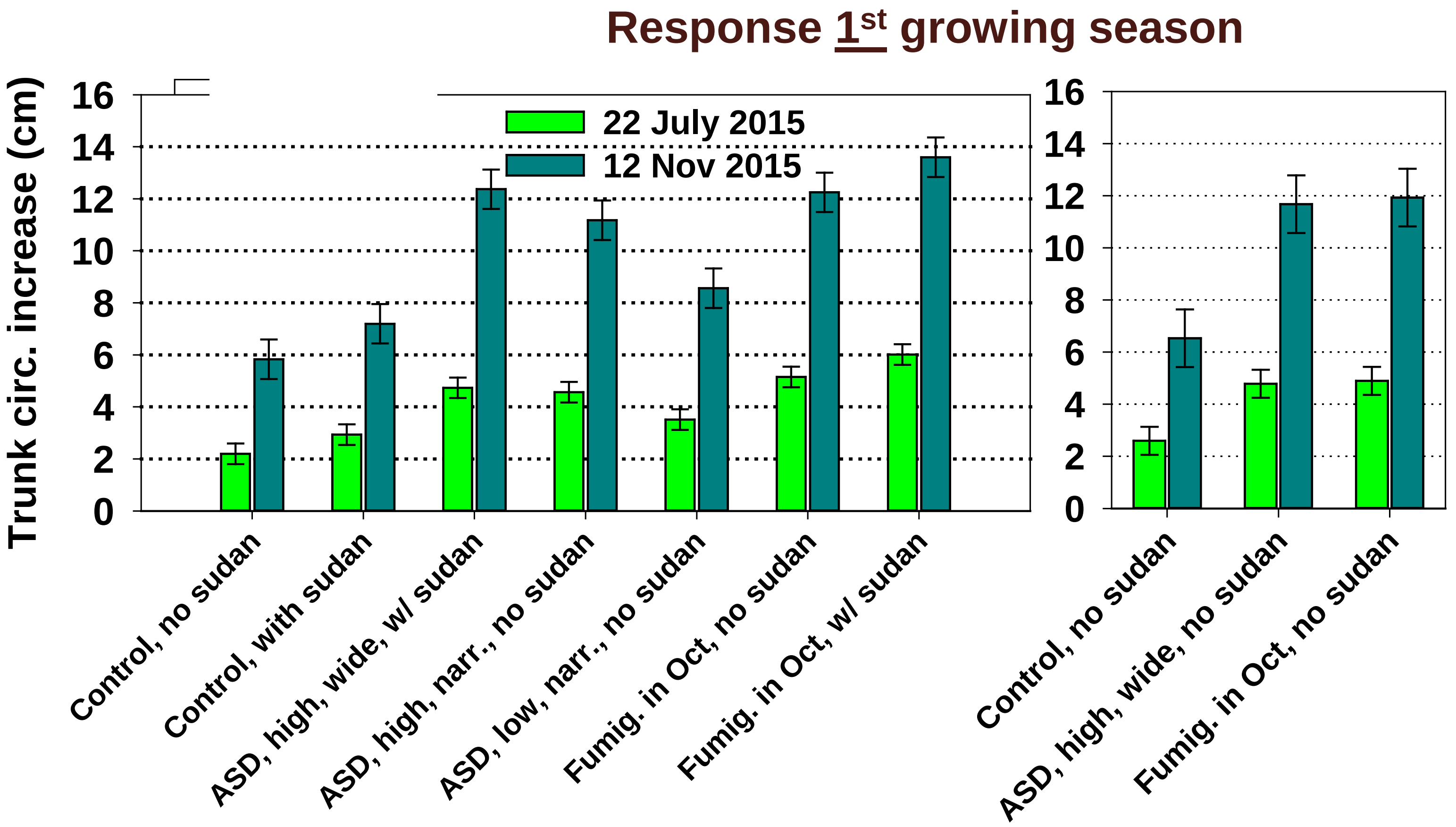
Response 1st growing season



Response 2nd growing season



Experiments 3 and 4 with ASD



Conclusions ASD:

ASD works for PRD control in SJV sandy loam but is logistically challenging & expensive; optimization and expanded testing needed.

Estimated cost of full rate rice-bran based ASD: $2439 / acre
(50% strips; all materials, application);

Estimated cost of Telone C35: $1143 / acre
(50% strips; all materials and application, no tarp)

2015 results suggest can reduce ASD costs by up to 40% with low rates, narrow strips

The Promise of Alternative, Less-expensive Carbon Substrates…

A Valuable Opportunity ?

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Thank You!

Acknowledgements:

- **Almond Board of California**
- **Calif. Dept. Pesticide Regulation**
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- **Duarte Nursery, Inc.; Burchell Nursery, Inc.**

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