Management of Almond Root Diseases:
"A Tale of Killers and Stunters"

Greg Browne

Southern SJV Almond Symposium, Kerman , CA, 29 May 2014

Phytophthora

Replant Disease

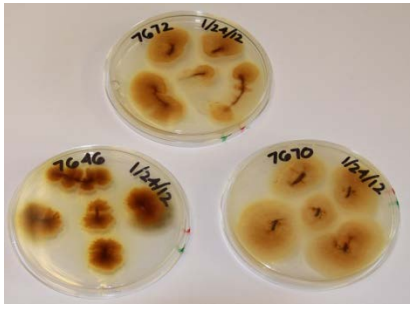
Some chapters in the tale

- ***Phytophthora*,**

  A multi-dimensional killer:
  - **Symptoms**
  - **Biology**
  - **Management**

- **Replant disease,**

  A hidden stunter:
  - **Symptoms, & other RP's**
  - **Research on causes**
  - **Management <u>with</u> fumigants**
  - **Management <u>without</u> fumigants**
  - **Perspectives**



Phytophthora crown and root rots, symptoms

P. niederhauseri, Fresno Co.

P. cactorum, Kern Co.

Phytophthora syringae, a “cool-temperature Phytophthora”, cause of bundle rot, first-year death, pruning wound cankers

Phytophthora crown and root rots, symptoms

***P. niederhauseri*, Stanislaus Co.**

Phytophthora crown and root rots, symptoms

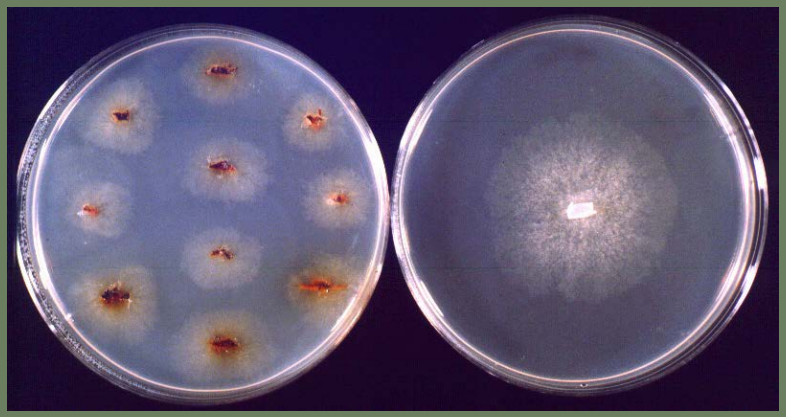
P. megasperma, Kern Co.

Perennial Phytophthora canker disease
P. cactorum, P. citricola; Kern Co.

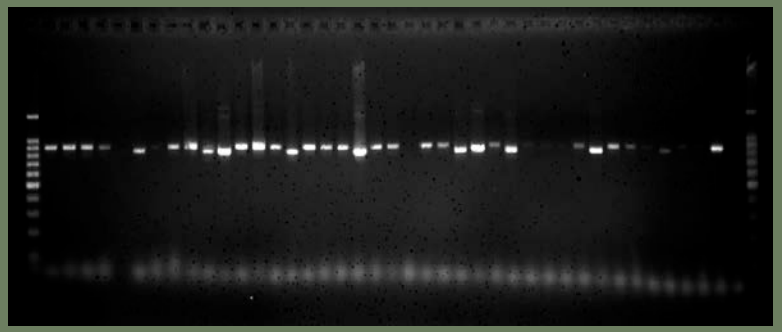
“Perennial Phytophthora canker”

P. citricola, Madera Co.

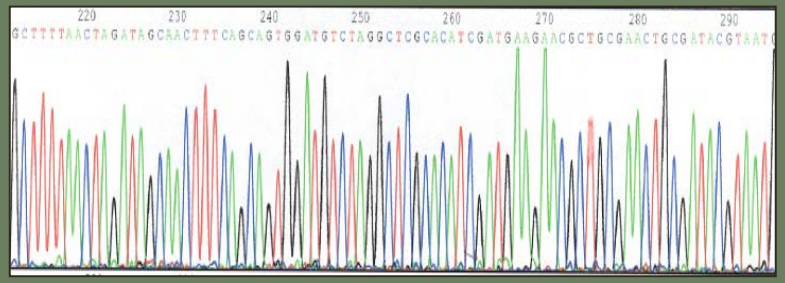
Phytophthora, diagnostics



PCR



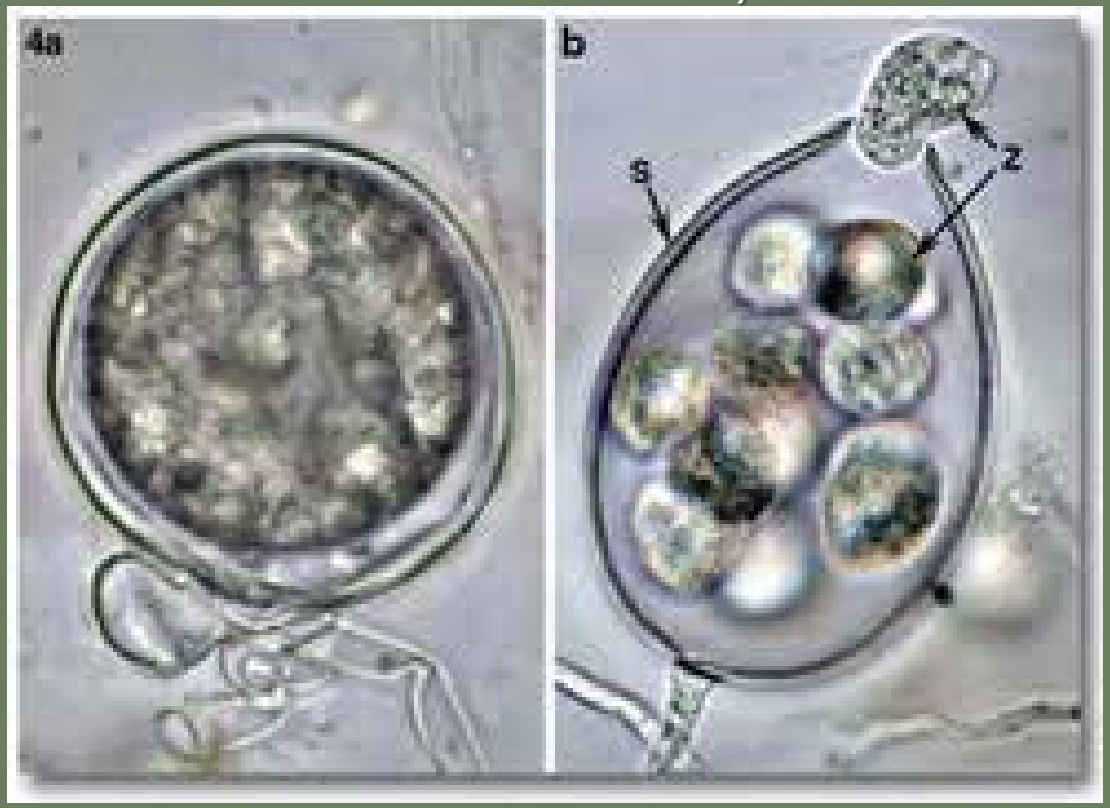
DNA Sequencing



Species identification

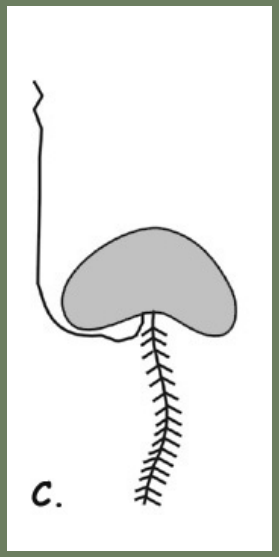
Phytophthora, biology

Photos: Wharton and Kirk, MSU



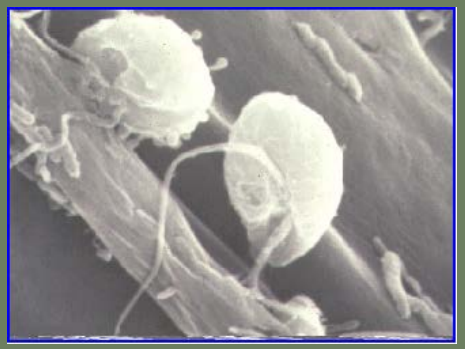
Oospore, note thick wall

Sporangium,
note zoospores,
(one swimming out)



Zoospore
drawing,
note flagella

Photo: Sullivan, NC State



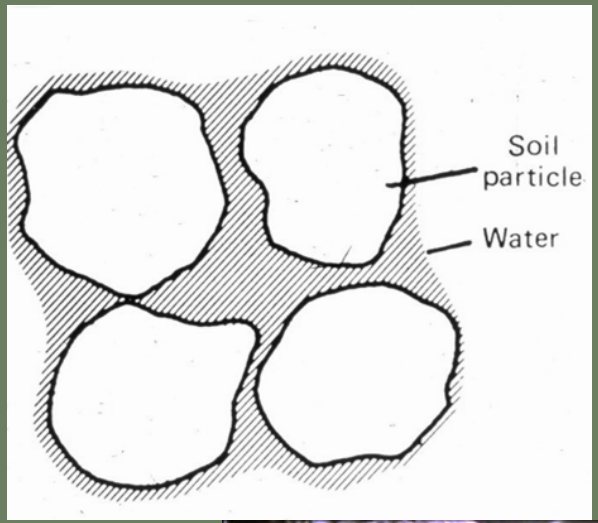
Zoospores on root

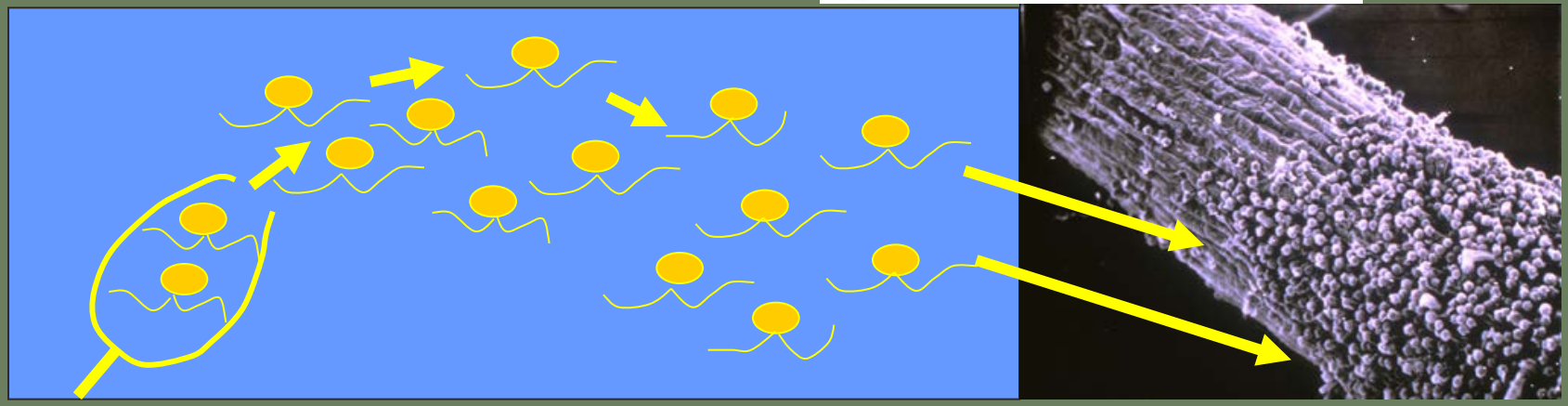
Phytophthora biology

Role of soil water saturation in local spread and root and crown infection:

(Soil) water saturation favors:

- sporangia production
- zoospore production
- zoospore dispersal
- zoospore attraction to roots

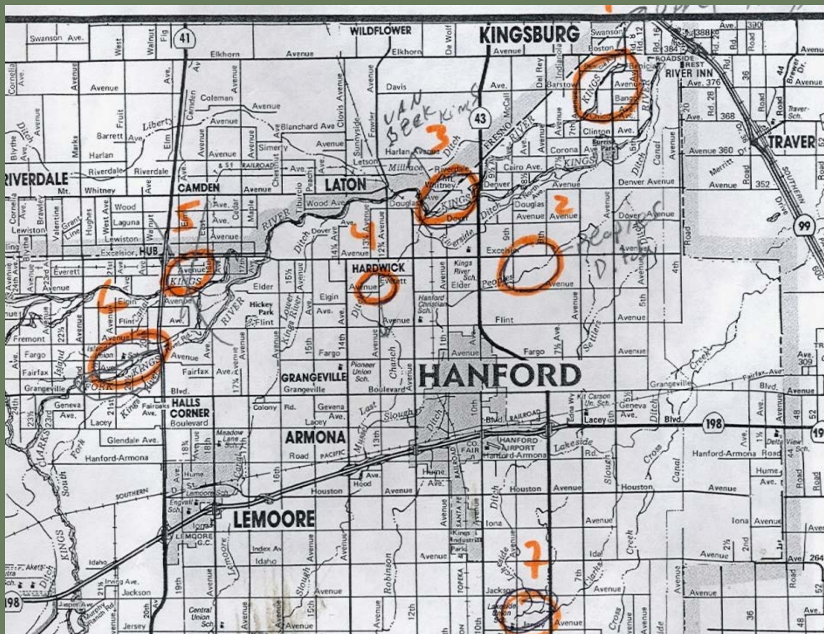




Phytophthora can “hitchhike”…

in nursery stock…

in water…


KINGSBURG
HANFORD
LEMOORE
ARMONA
LATON
HARDWICK
RIVERDALE
CAMDEN
GRANGEVILLE
HALLS CORNER
TRAVER
VAN BEEK KINGS


Lakeside Ditch


CAUTION AUTHORIZED PERSONNEL ONLY

in harvest debris…(it gets around!)

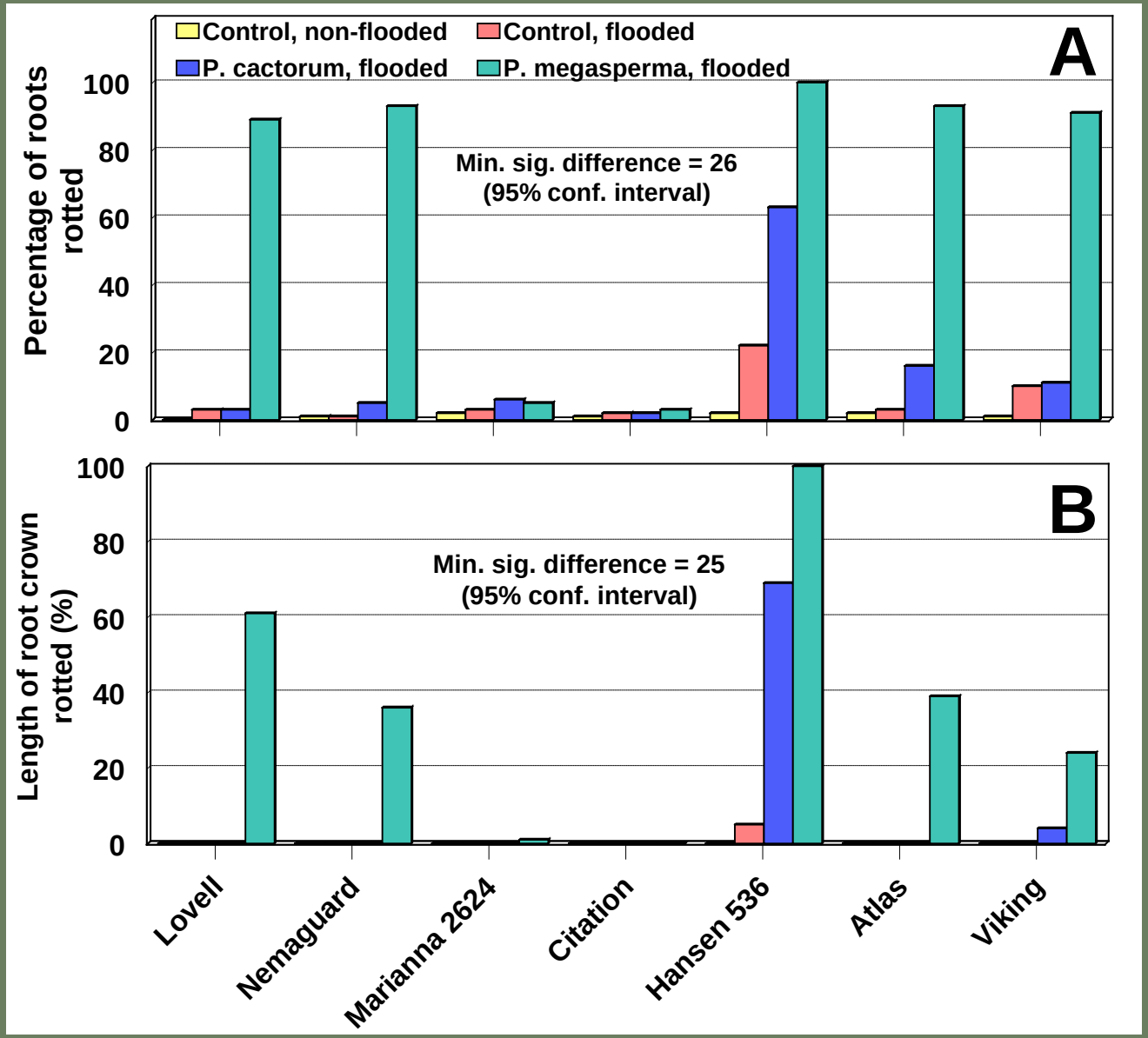
Thoughts on management of *Phytophthora*

Select your rootstock carefully, its complicated !! keep in mind its degree of *Phytophthora* susceptibility

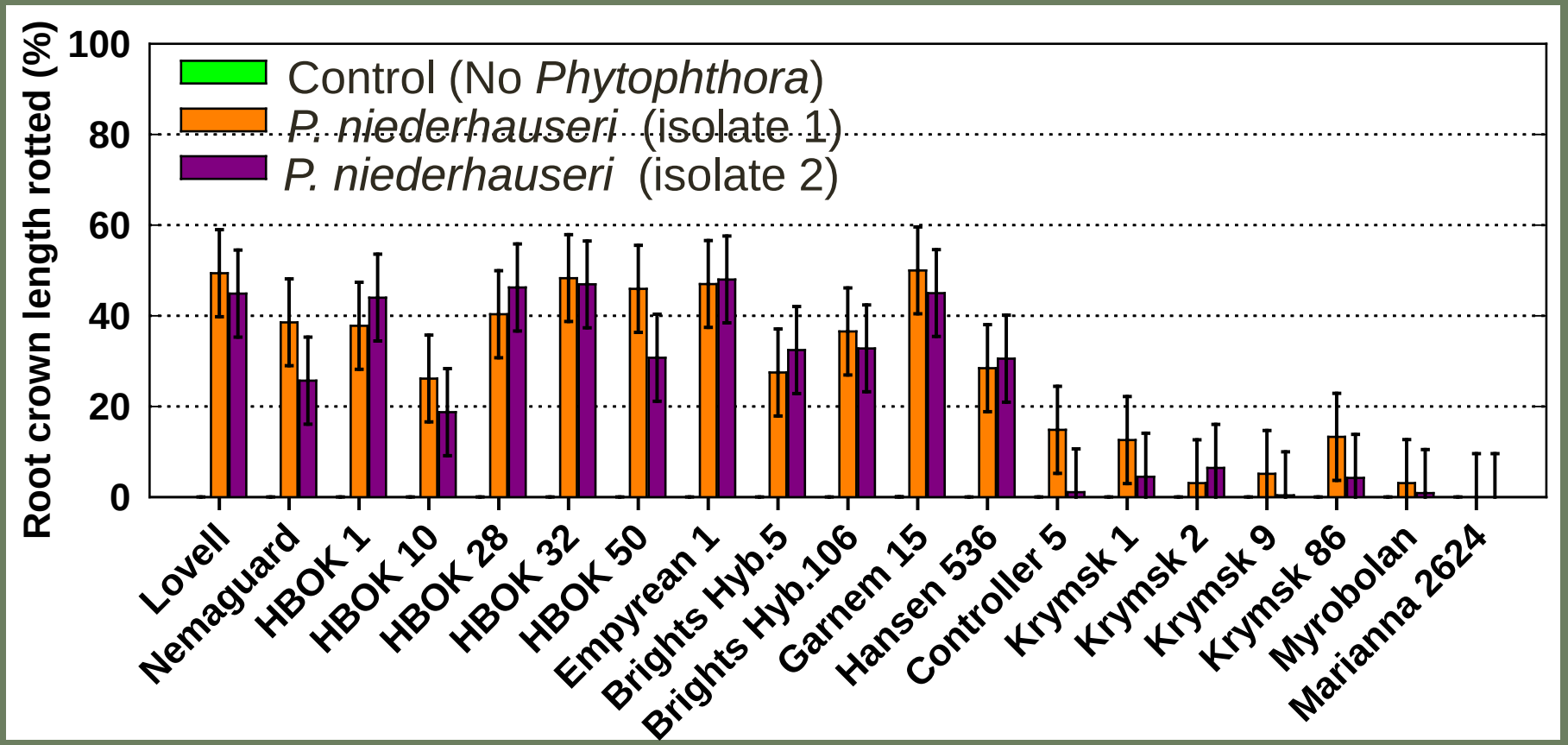
Trait	Lovell (peach)	Nemaguard (peach)	Atlas IS[1] Hybrid	Viking IS[1] Hybrid	Hansen 536 P/A[2] Hybrid	Brights P/A[2] Hybrid	Nickels P/A[2] Hybrid	Krymsk 86	M-40 (plum)	M2624 (plum)	Ishtara (plum)
Wet Soil Tolerant	++	+	++?	++?	+	+	++	?	+++	+++[3]	+++
Anchorage	+++?	++	++++	++++	++++	++++	++++	+++?	+++?	+++	++
Vigor	++	+++	+++	+++	++++	++++	++++	++	+	+	+
Phytophthora Resistance	++	++	++?	++?	+	+	+	+++	+++	+++	+++
Bacterial Canker Resistance	++	++	++	++	+?	+	++?	?	++?	+	?
Crown Gall Resistance	++	++	++	++	++	++	++	?	?	+++	?
Root Knot Nematode Resistance	+?	+++	+++	+++	+++	+++	+++	?	?	+++	?
Oak Root Fungus Resistance	+	+	+	+	+	+	+	+	?	+++	?
Non-Pareil Compatible	Yes	Yes	Yes	Yes	Yes	Yes	Yes	?	No[4]	No[4]	?
Suckers	None	None	None	None	None	None	None	None	Few	Many	?

(Table after F. Niederholzer)

Relative resistance of some roostocks for almond and peach to *Phytophthora* spp., greenhouse



Susceptibility to *Phytophthora*, greenhouse



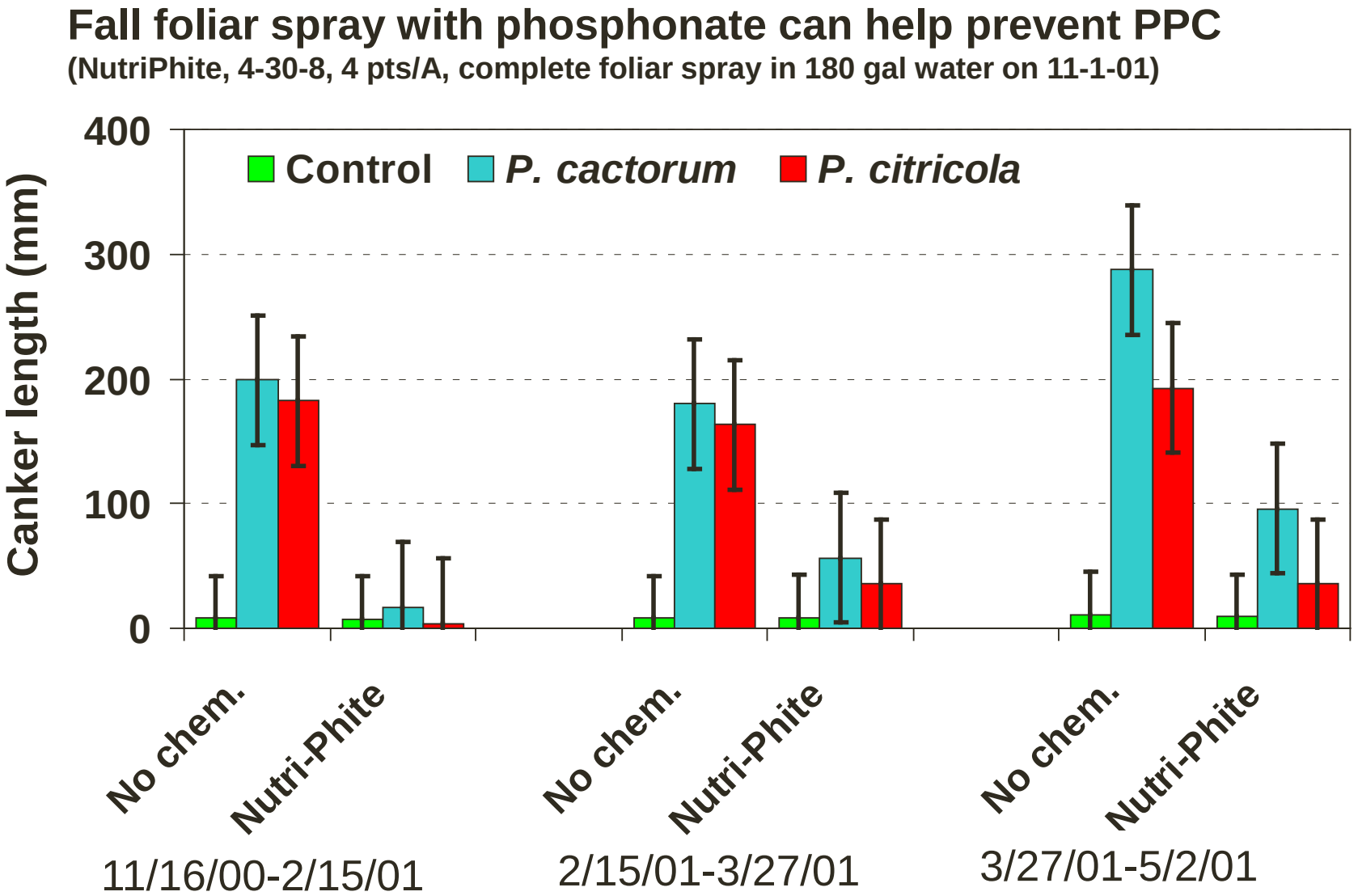
Berms are great, but don’t bury the graft union

Train to avoid scaffold crotch pockets, which are susceptible to infection by *Phytophthora*

Design and operate your irrigation system carefully

- Avoid water saturation around root crown
- “24-hr rule”
- Meet ET, not more

Consider phosphonate treatment…

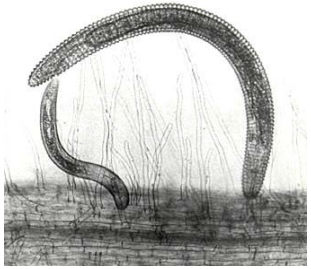


Replant Disease, a real stunter

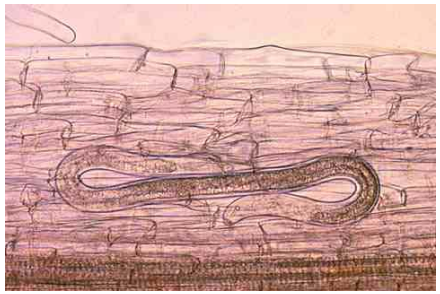
Almond-after-almond, Firebaugh, Madera County

Replant disease, an important replant problem

- Replant disease (RD) **Microbe-induced growth suppression; incidence nearly universal in *Prunus* after *Prunus,* but severity varies greatly**
- Plant-parasitic nematodes **(ring, lesion, root knot), approx. 35% of almond and fresh stone fruit acreage, 60% of cling peach acreage infested (McKenry)**
- Aggressive pathogens, pests **(*Phytophthora*, *Armillaria*, *Verticillium*, Ten-Lined June Beetle) –localized, not managed completely by fumigation**
- Abiotic factors **(physical, chemical conditions related to previous production)**



Ring nematode



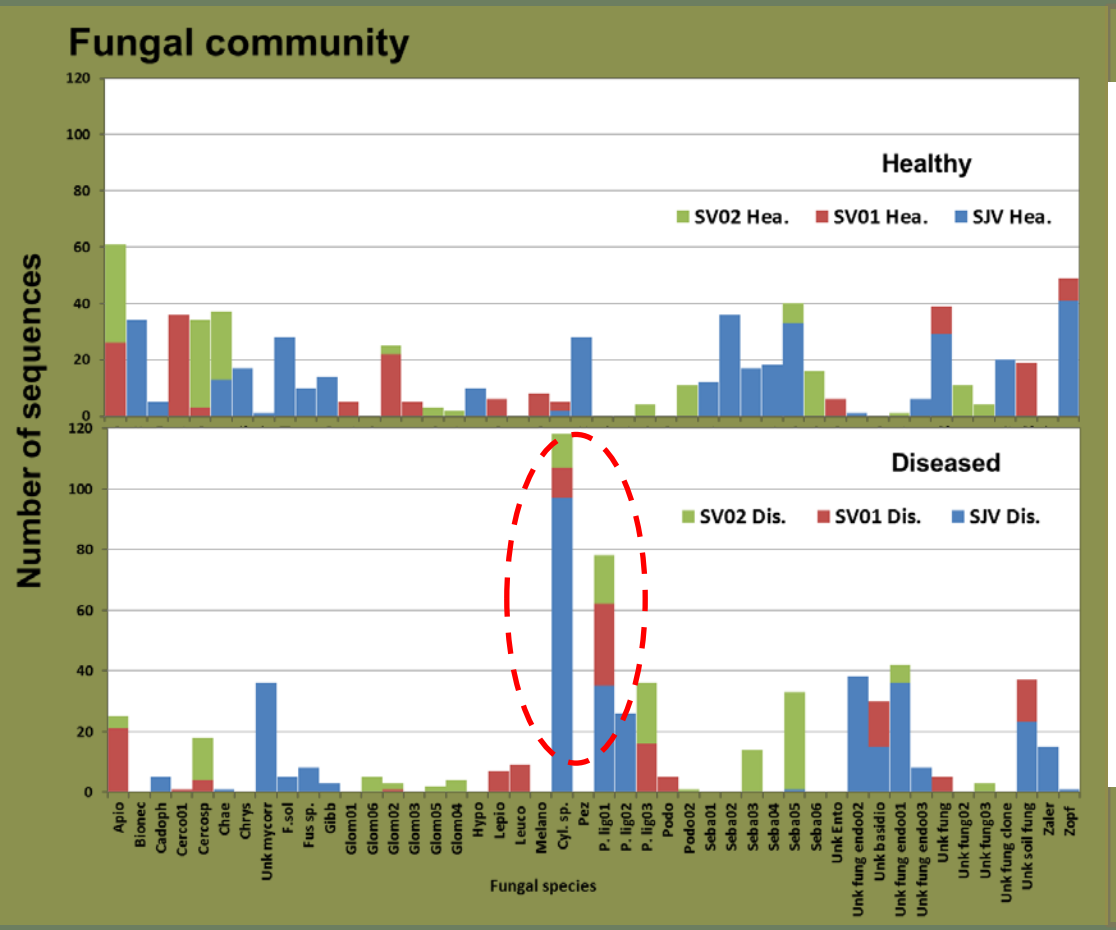
Lesion nematode

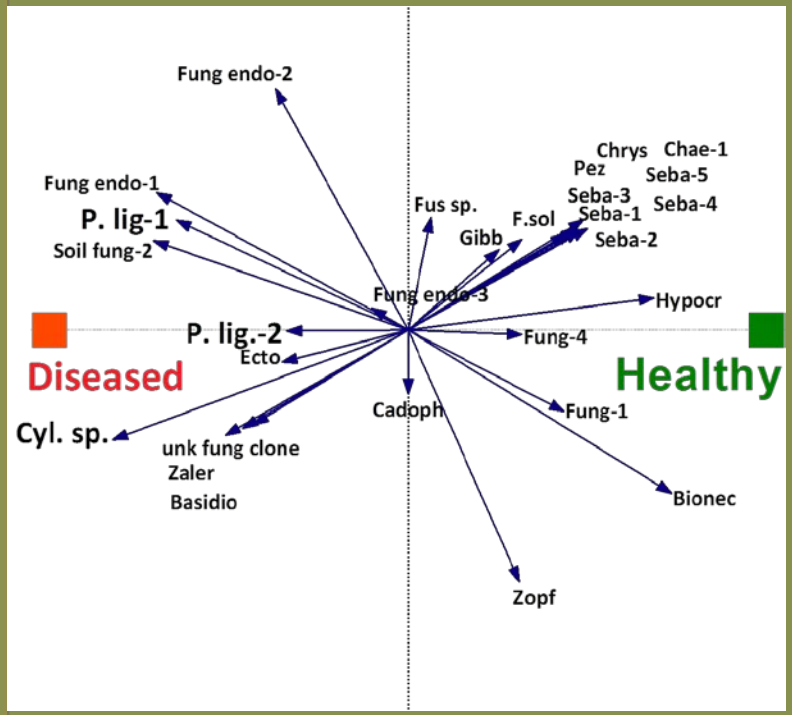
Key nematode parasites on *Prunus*

Healthy tree **RD-affected tree**

Symptoms of replant disease on almond

Replant Disease: Sorting through the haystack of potential causes…





Ordination analysis

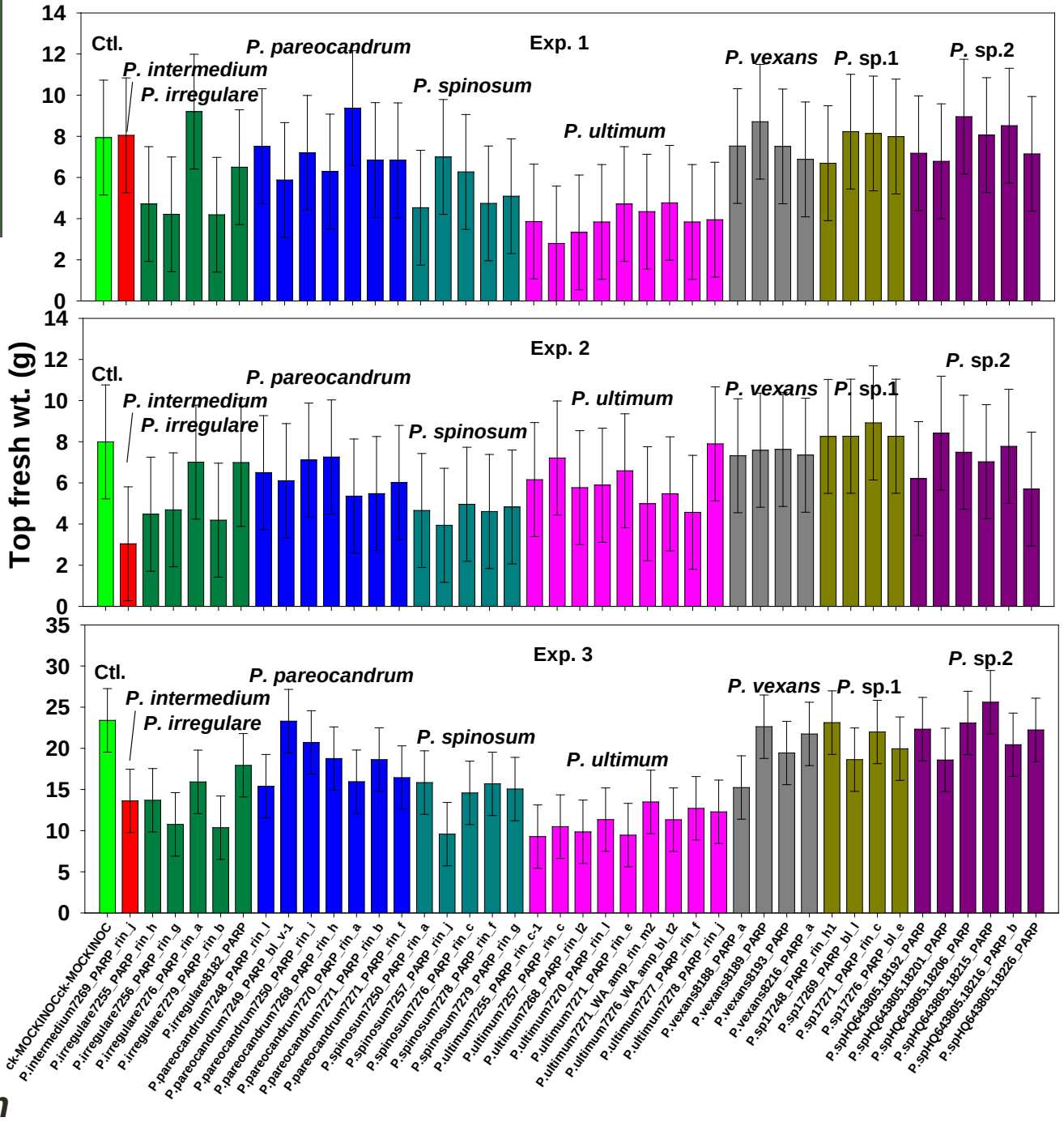
Key findings:

1. *Pythium* and *Cylindrocarpon* spp. contribute to PRD

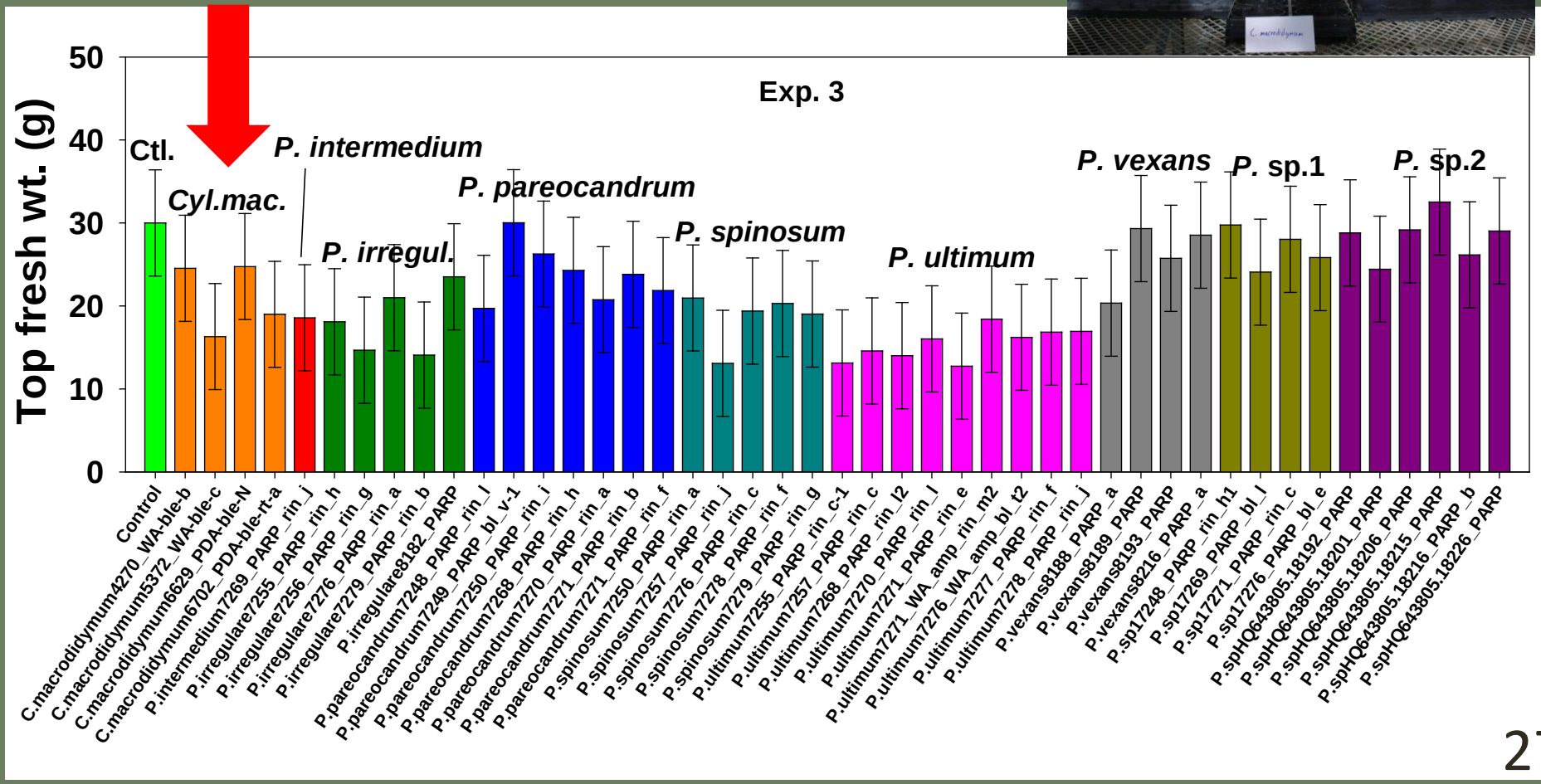
Ck *P. ultimum*

Ck *P. irregulare*

Ck *P. pareocandrum*

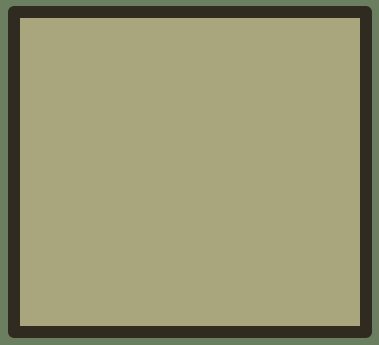


Pathogenicity of *Cylindrocarpon* and *Pythium* species on Nemaguard peach rootstock

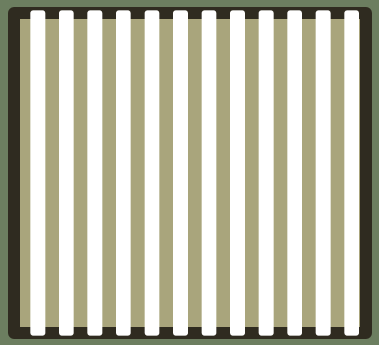


Managing replant disease with fumigants

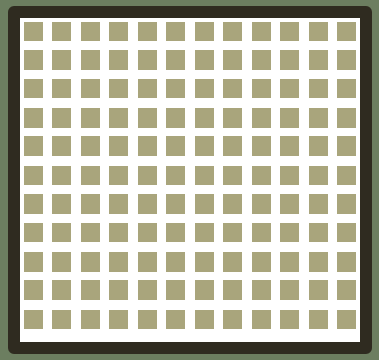
Broadcast
100% coverage

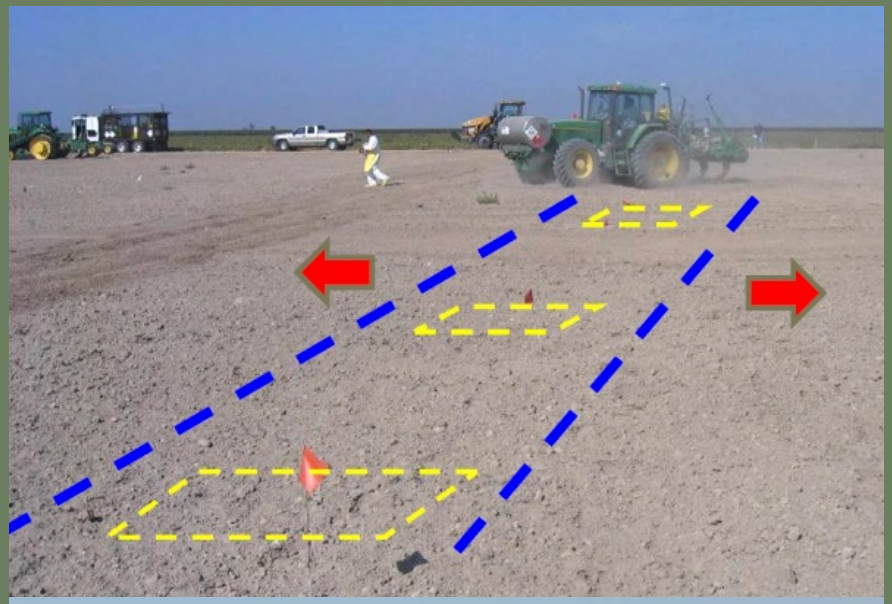


Strip
50% coverage



GPS-Grid
<20% coverage



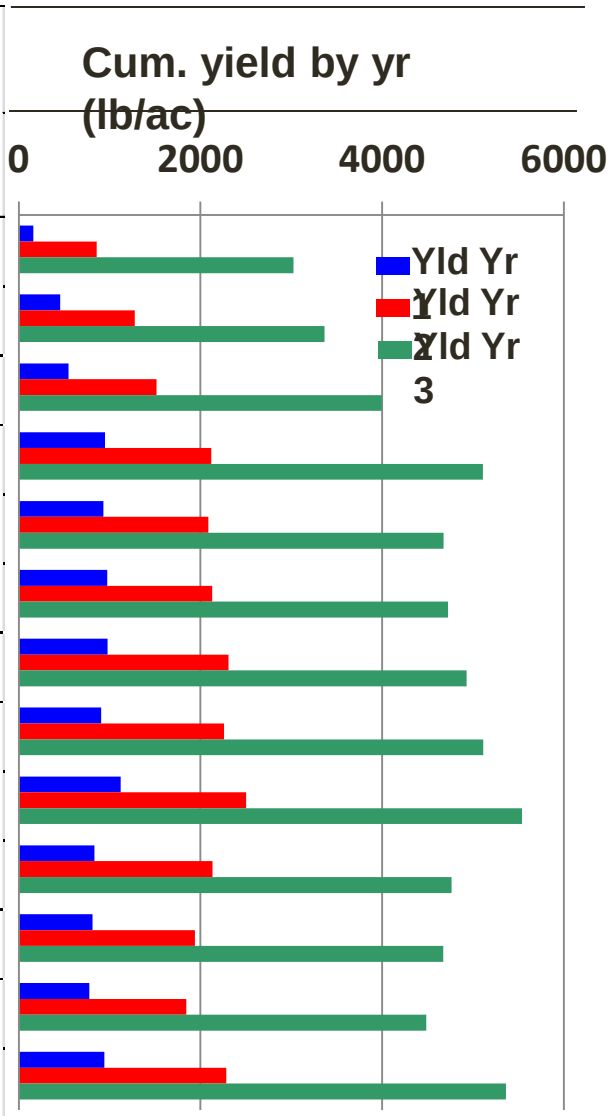


Almond replant trial, Firebaugh, CA

Fumigant	Treated area	Fumigant rate		Cost of trt. ($/ac.)
		lb / trt. ac.	lb / or. ac.	
Control	None	0	0	0
Methyl br.	Row strip (45%)	400	180	1962
Telone II	Row strip (38%)	340	129	393
Midas	Row strip (38%)	0	152	na
Chloropicrin	Row strip (38%)	400	152	871
Chloropicrin	Row strip (38%)	300	114	677
Chloropicrin	Row strip (38%)	200	76	482
Telone C35	Row strip (38%)	550	209	882
Pic-Chlor 60	Row strip (38%)	550	209	829
Pic-Chlor 60	Row strip (38%)	400	152	667
Chloropicrin	Tree spot (17%)	400	68	441
Telone C35	Tree spot (17%)	550	94	447
Telone C35	Full coverage (100%)	550	550	2169

Almond replant trial, Firebaugh, CA

Fumigant	Treated area	Fumigant rate lb / trt. ac.	Fumigant rate lb / or. ac.	Cost of trt. ($/ac.)
Control	None	0	0	0
Methyl br.	Row strip (45%)	400	180	1962
Telone II	Row strip (38%)	340	129	393
Midas	Row strip (38%)	0	152	na
Chloropicrin	Row strip (38%)	400	152	871
Chloropicrin	Row strip (38%)	300	114	677
Chloropicrin	Row strip (38%)	200	76	482
Telone C35	Row strip (38%)	550	209	882
Pic-Chlor 60	Row strip (38%)	550	209	829
Pic-Chlor 60	Row strip (38%)	400	152	667
Chloropicrin	Tree spot (17%)	400	68	441
Telone C35	Tree spot (17%)	550	94	447
Telone C35	Full coverage (100%)	550	550	2169



Almond replant trial; Firebaugh, CA

Fumigant	Treated area	Fumigant rate		Cost of trt. ($/ac.)	Cum. net reven. gain ($/ac.)[a]	
		lb / trt. ac.	lb / or. ac.		Yield Yr. 2	Yield Yr. 3
Control	None	0	0	0	0	0
Methyl br.	Row strip (45%)	400	180	1962	(1,120)	(1,279)
Telone II	Row strip (38%)	340	129	393	929	1,552
Midas	Row strip (38%)	0	152	na	na	na
Chloropicrin	Row strip (38%)	400	152	871	1,593	2,433
Chloropicrin	Row strip (38%)	300	114	677	1,870	2,727
Chloropicrin	Row strip (38%)	200	76	482	2,422	3,328
Telone C35	Row strip (38%)	550	209	882	1,926	3,296
Pic-Chlor 60	Row strip (38%)	550	209	829	2,462	4,202
Pic-Chlor 60	Row strip (38%)	400	152	667	1,885	2,814
Chloropicrin	Tree spot (17%)	400	68	441	1,725	2,857
Telone C35	Tree spot (17%)	550	94	447	1,530	2,473
Telone C35	Full coverage (100%)	550	550	2169	688	2,511

Current Cal-DPR funded work to optimize fumigant use

1. Use a greenhouse-based peach seedling bioassay to increase knowledge available on the need for preplant fumigation

2. Augment bioassay testing results with orchard validations

3. Demonstrate and optimize GPS-controlled spot fumigation in commercial almond orchards

=

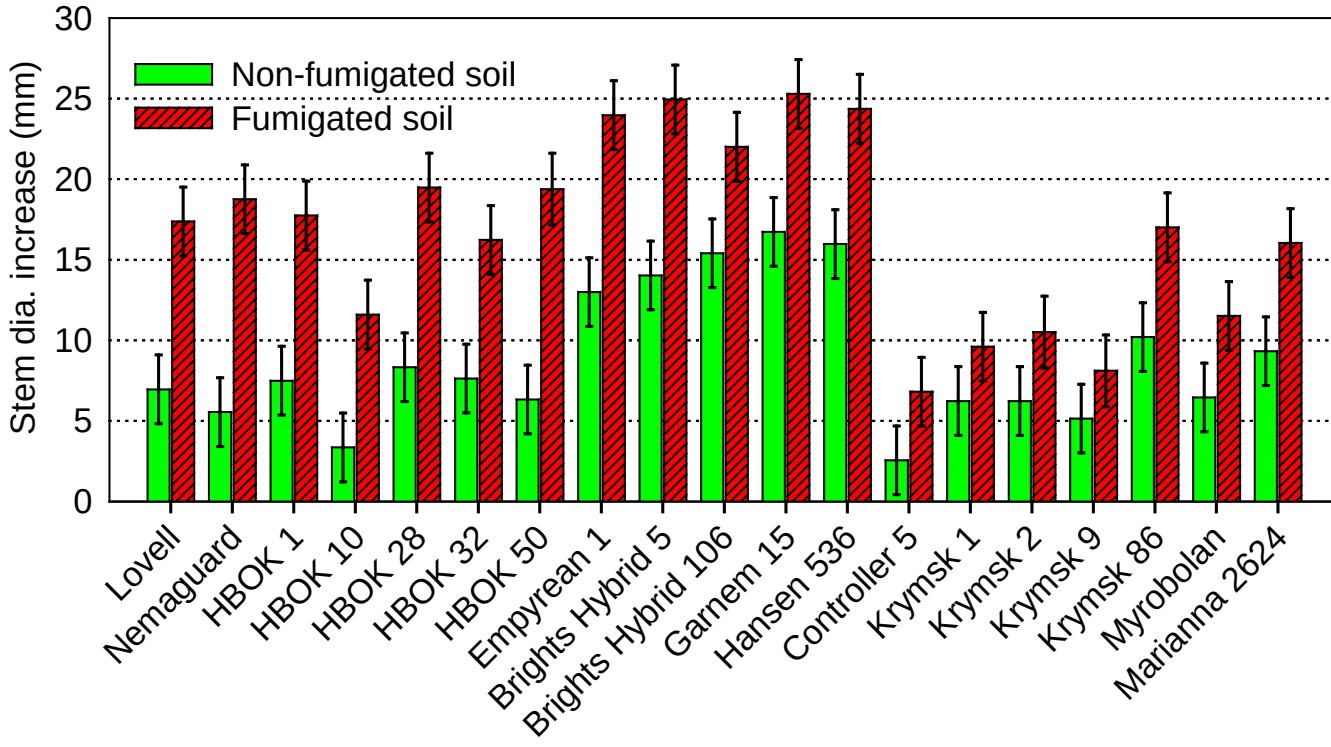
??

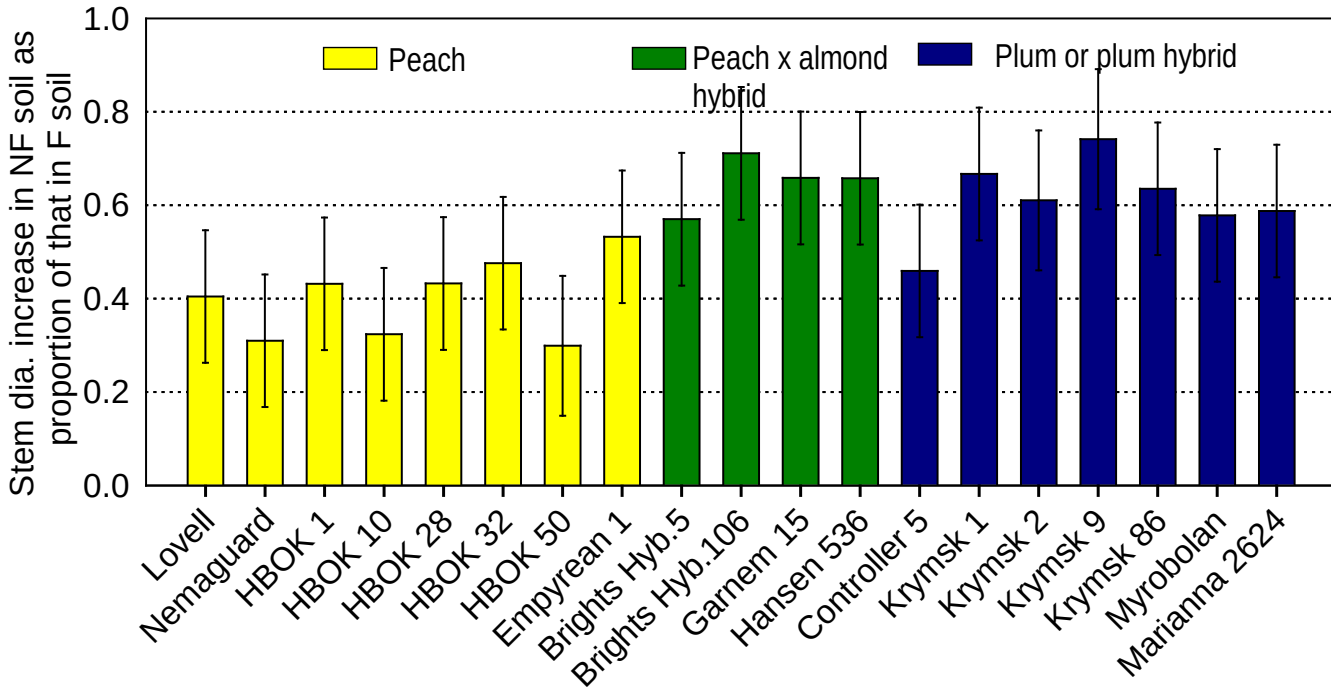
Kerman trial, sandy loam soil, “commercial-scale strip vs. spot test”

Managing replant disease <u>without</u> fumigants

How about rootstock resistance??

2011-12 trial





Key findings:

2. Rootstocks vary significantly in resistance to PRD and *Phytophthora*, but no rootstock best for all RP's. For now, choose carefully…

Nemaguard, C35-fumigated soil

Nemaguard, NF soil

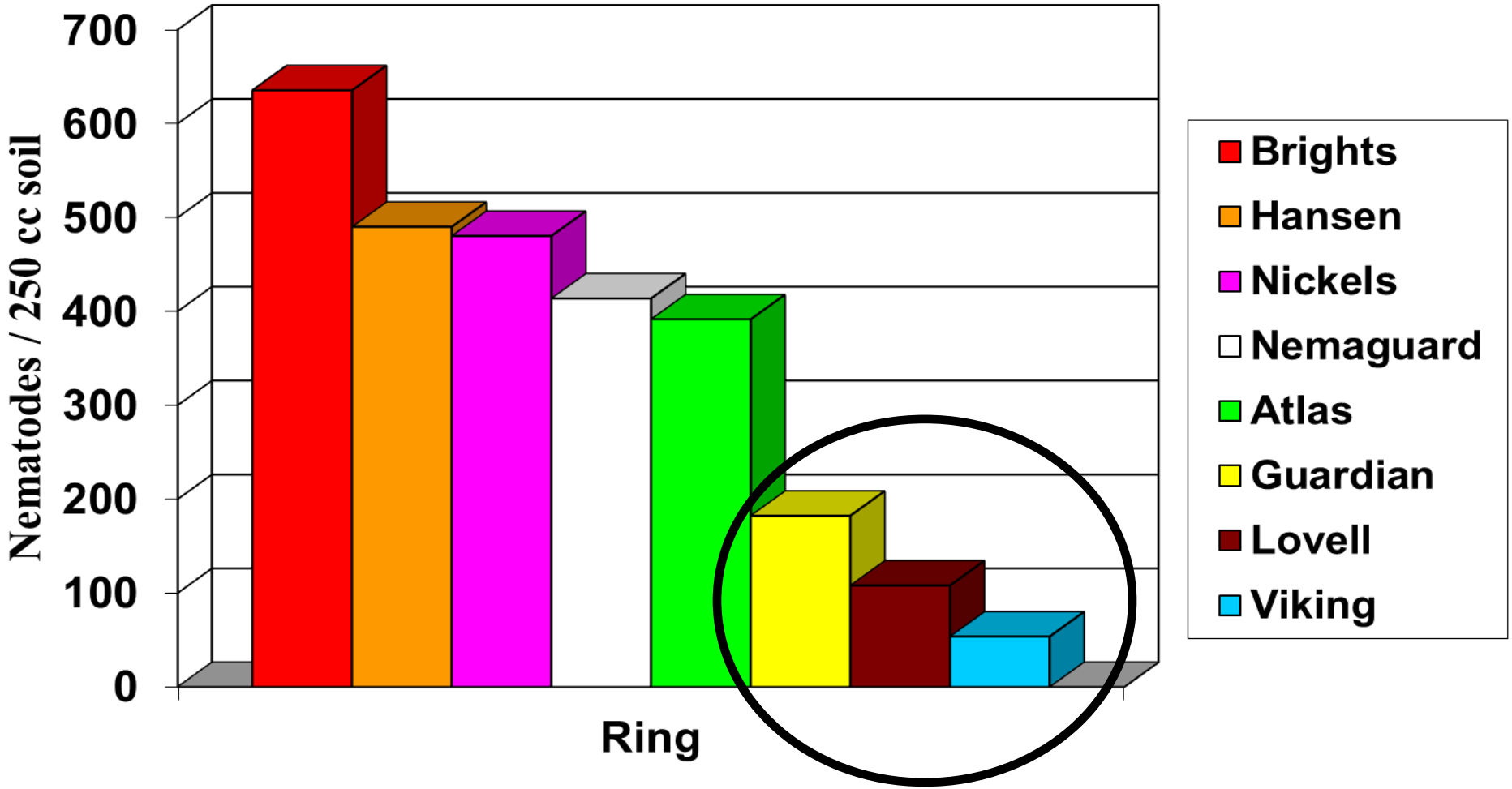
Hansen 536, C35-fumigated soil

Hansen 536, NF soil

Soil Numbers of Pathogenic Nematodes as Influenced by Almond Rootstock

Escalon, CA. January, 2005

DATA OF ROGER DUNCAN, UCCE



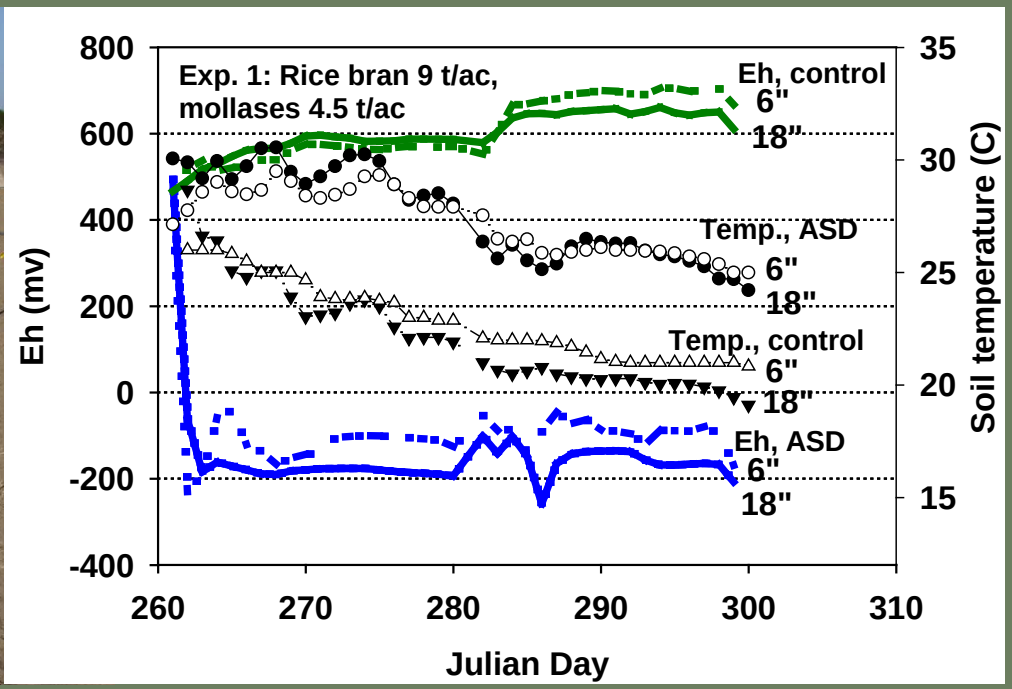
Managing Replant disease without fumigants, Kearney Ag Center Trial, 2013-14

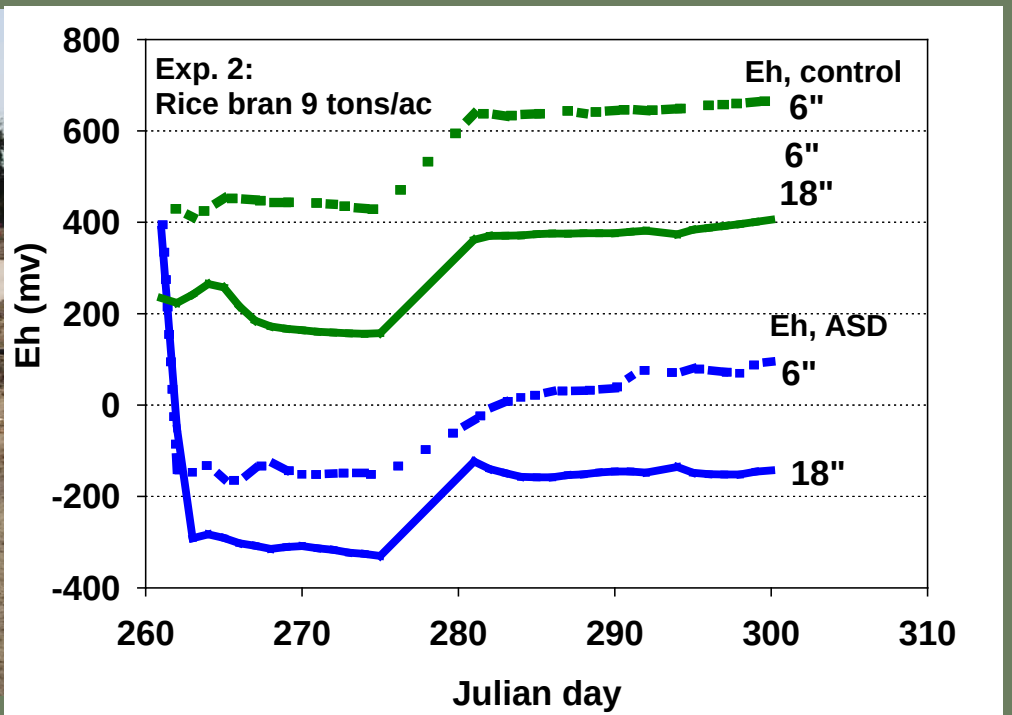
Preplant treatments include combinations of:

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

Preplant NF treatments, KAC trial

ASD treatment





Early results, KAC trials

Pre-plant fumigation and ASD both eradicated bioassay inoculum of *P. ultimum*, whereas the pathogen survived in the non-treated controls (means 3180 to 6383 cfu/g soil).

<u>Left</u>, tree growth representative of ASD and fumigation trts.; <u>right</u>, growth representative of controls


Thank you!
Questions?
Trial interests?
Research details?
gtbrowne@ucdavis.edu