Soilborne Disease Challenges:
I. Phytophthora (and Other!!) Crown and Root Rots -- Where are We?

Tehama County Walnut Day

20 January 2012

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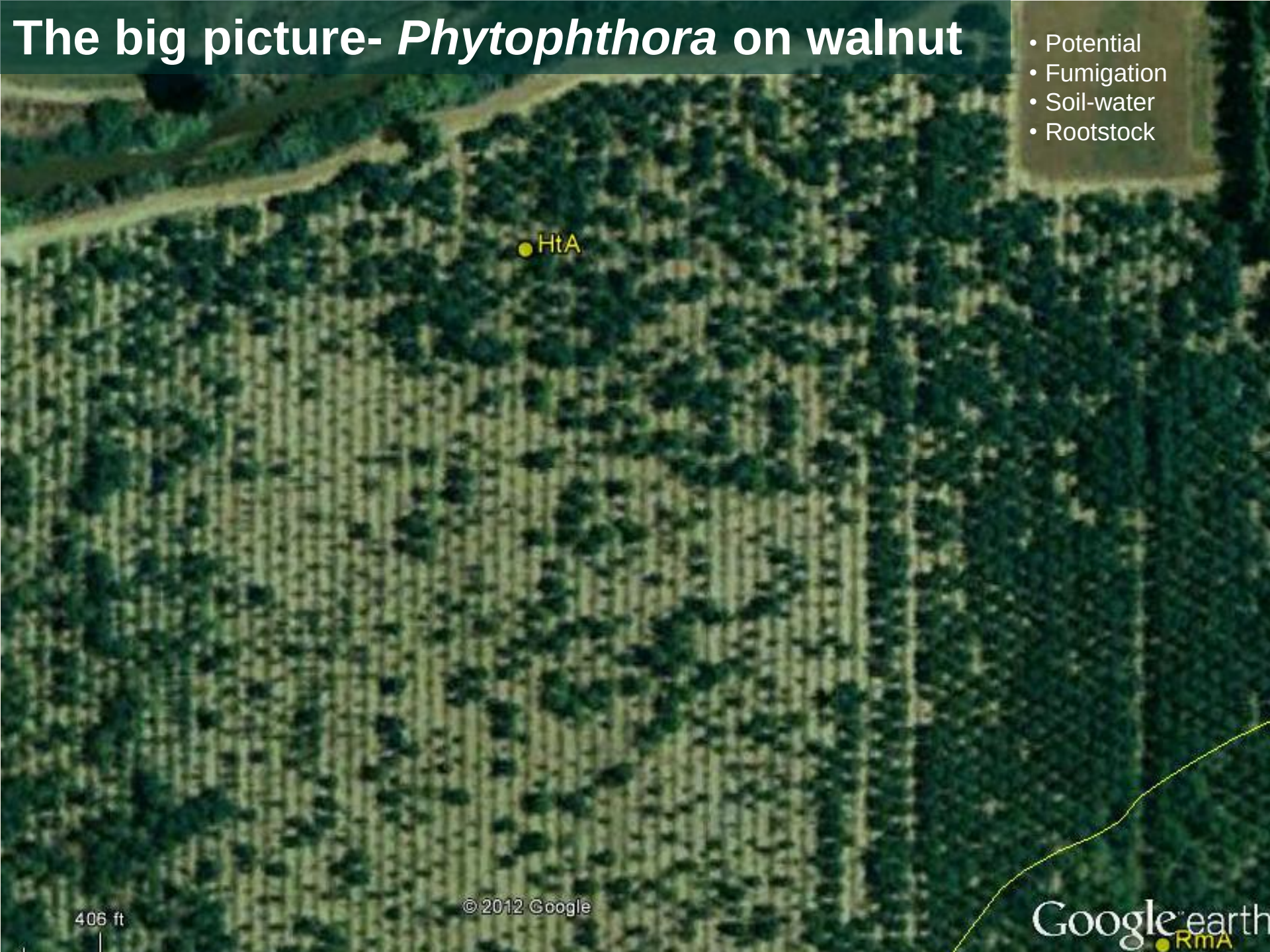
and UCCE Farm Advisors

USDA ARS

The big picture- *Phytophthora* on walnut

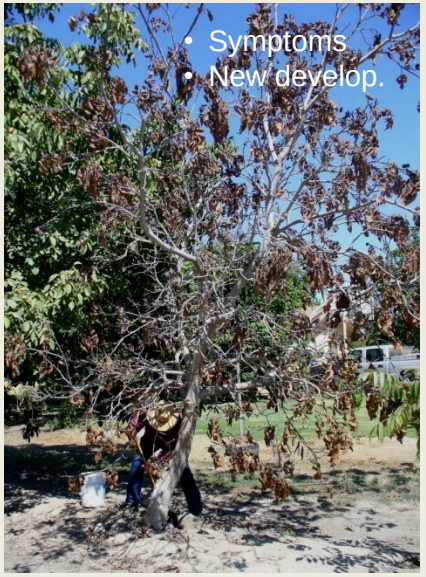
- Potential
- Fumigation
- Soil-water
- Rootstock



Typical symptoms*, *Phytophthora crown and root rots

More symptoms, *Phytophthora cankers*

More symptoms, but not apparently caused by Phytophthora

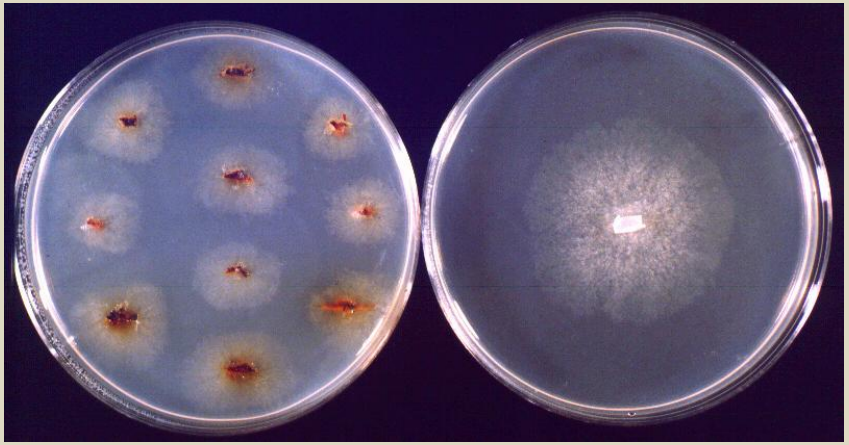


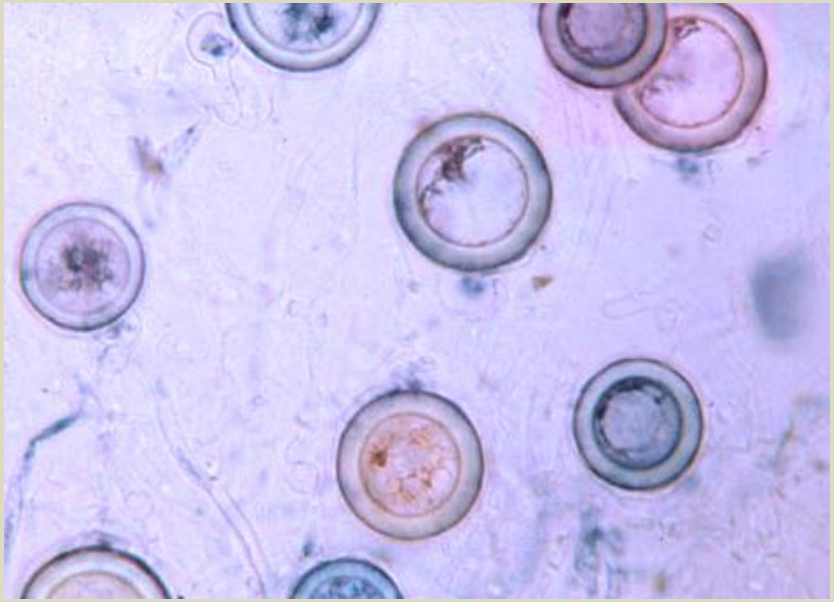
Orchard affected by the oak root fungus, Armillaria

High water table and flooding damage, *Paradox and NCB rootstocks*

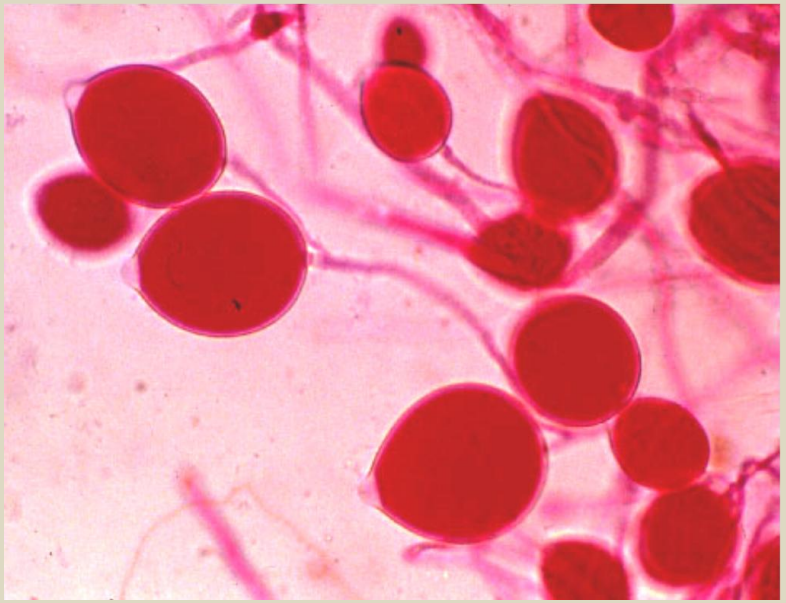
High water table and flooding damage, *Paradox and NCB rootstocks*

Phytophthora,
"Plant Destroyer"





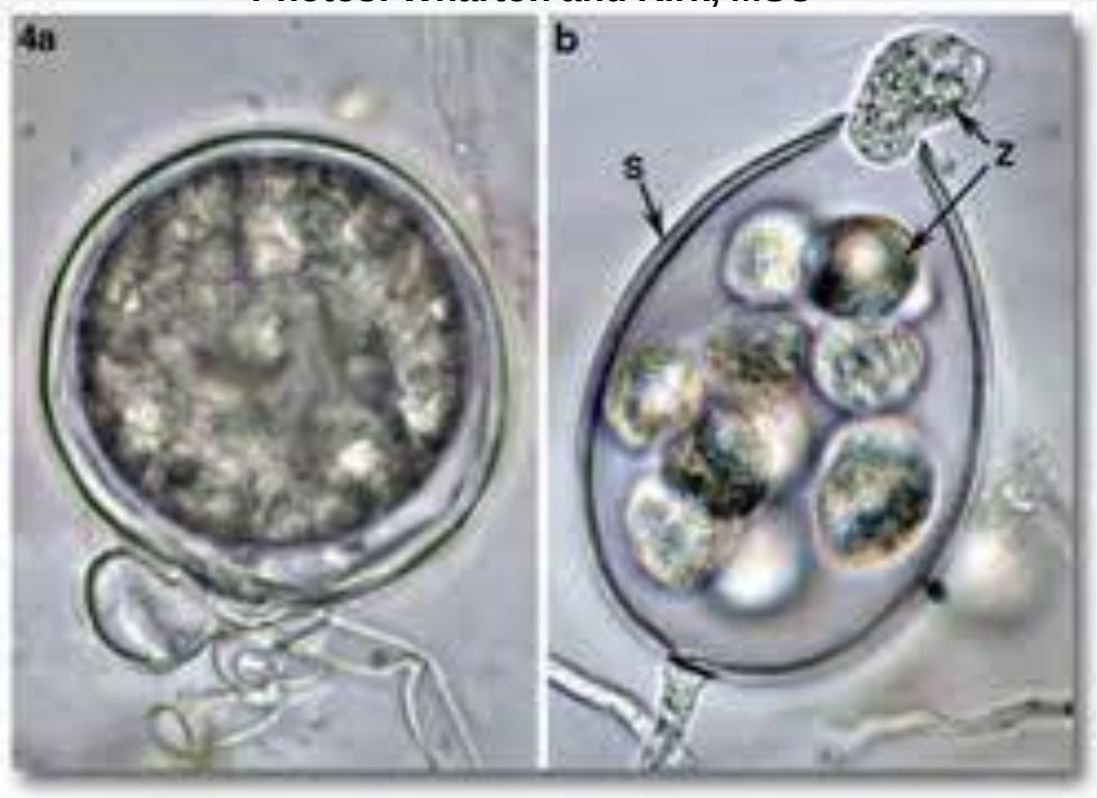
Oospores
(long-term persistence,
sexual reproduction)



Sporangia
(rapid spread, asexual
reproduction)

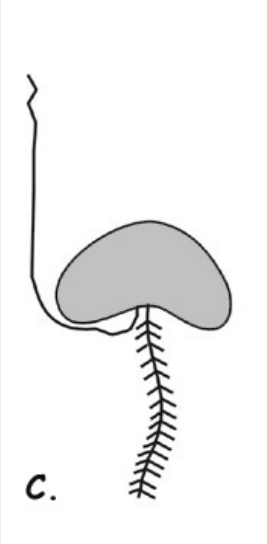
More pictures, Phytophthora

Photos: Wharton and Kirk, MSU



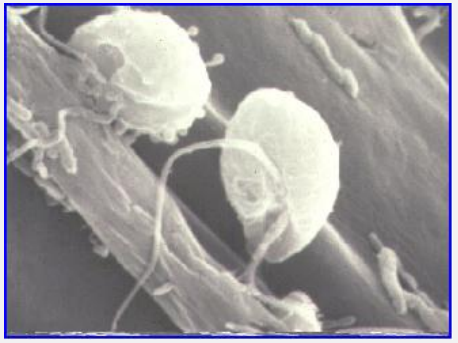
Oospore, note thick wall

Sporangium,
note zoospores,
(one swimming out)



Zoospore
drawing,
note flagella

Photo: Sullivan, NC State

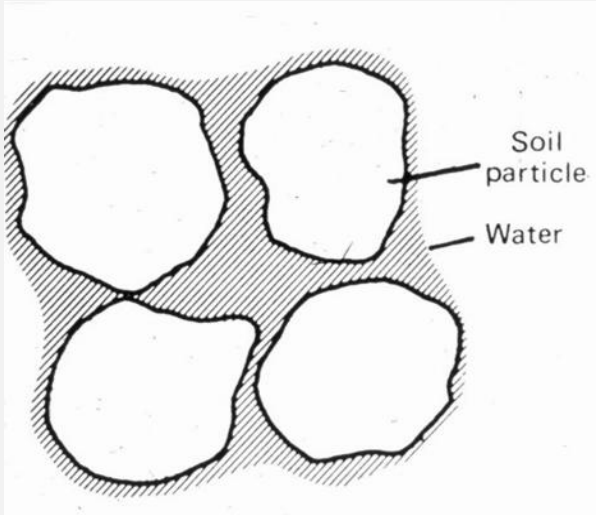


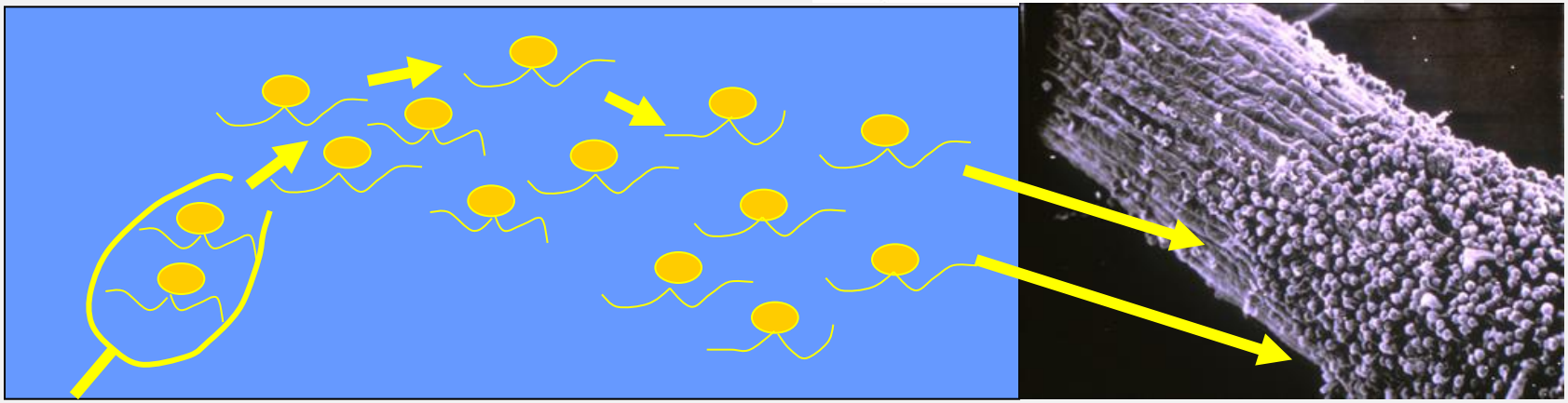
Zoospores on root

Role of free water in root and crown infection by Phytophthora

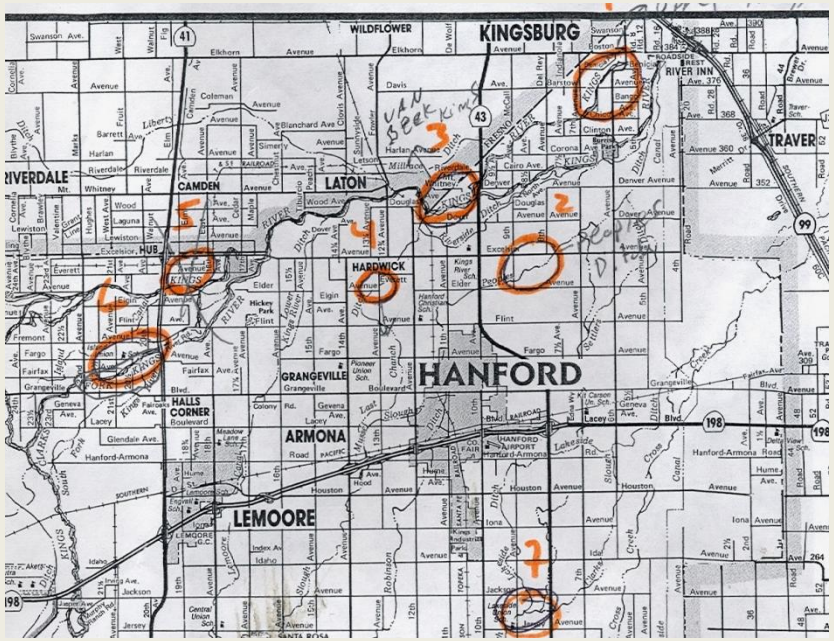
(Soil) water saturation favors:

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

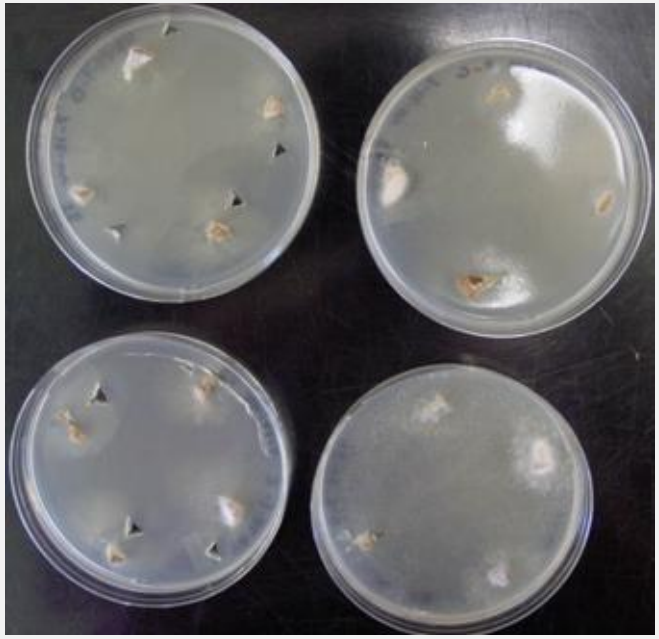


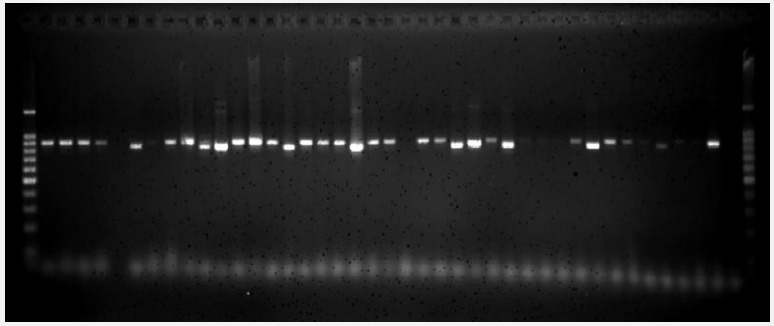


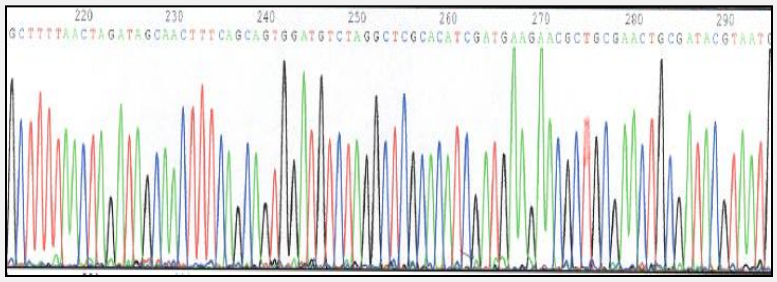
Role of "surface water" in long-distance spread of Phytophthora



Isolation and rDNA-based id. of Phytophthora spp. in Surface Sources of Irrigation Water in Kings County







Detected:

- ***Phytophthora citricola***
- ***P. citrophthora***
- ***P. cryptogea***
- ***P. gonapodyides***
- ***Phytophthora* sp. (unid.)**
- **Several *Pythium* spp.**

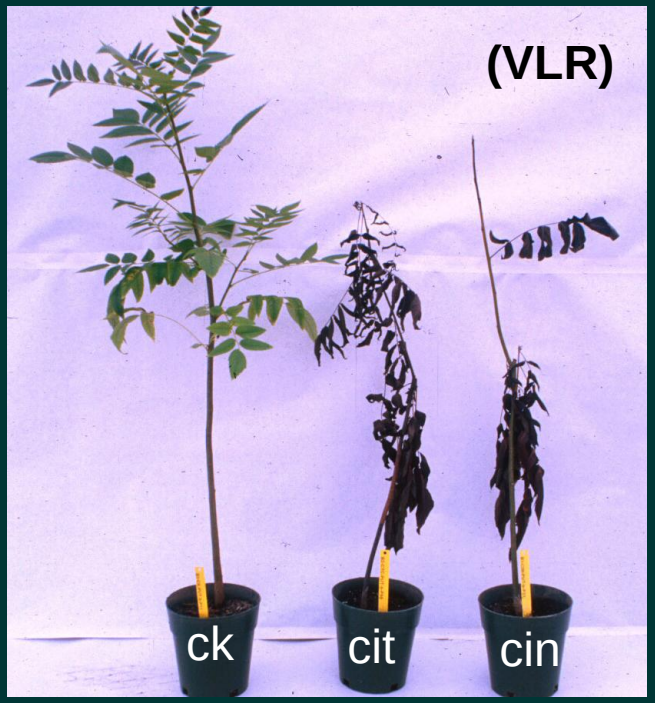
***Infested soil* can transport *Phytophthora* onto trees & between orchards**

Photo-Bruce Lampinen

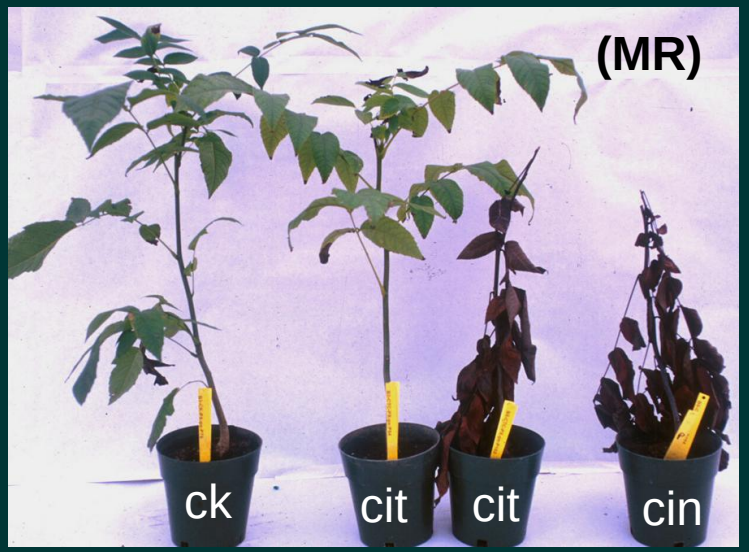
How to prevent and manage??

Approaches to control, Phytophthora

1. Find and use rootstocks with genetic resistance



Northern California black
(*Juglans hindsii*)
and **English** (*J. regia*)



Paradox hybrid
(*J. hindsii, and others, x regia*)

Chinese wingnut
(*Pterocarya stenoptera*)

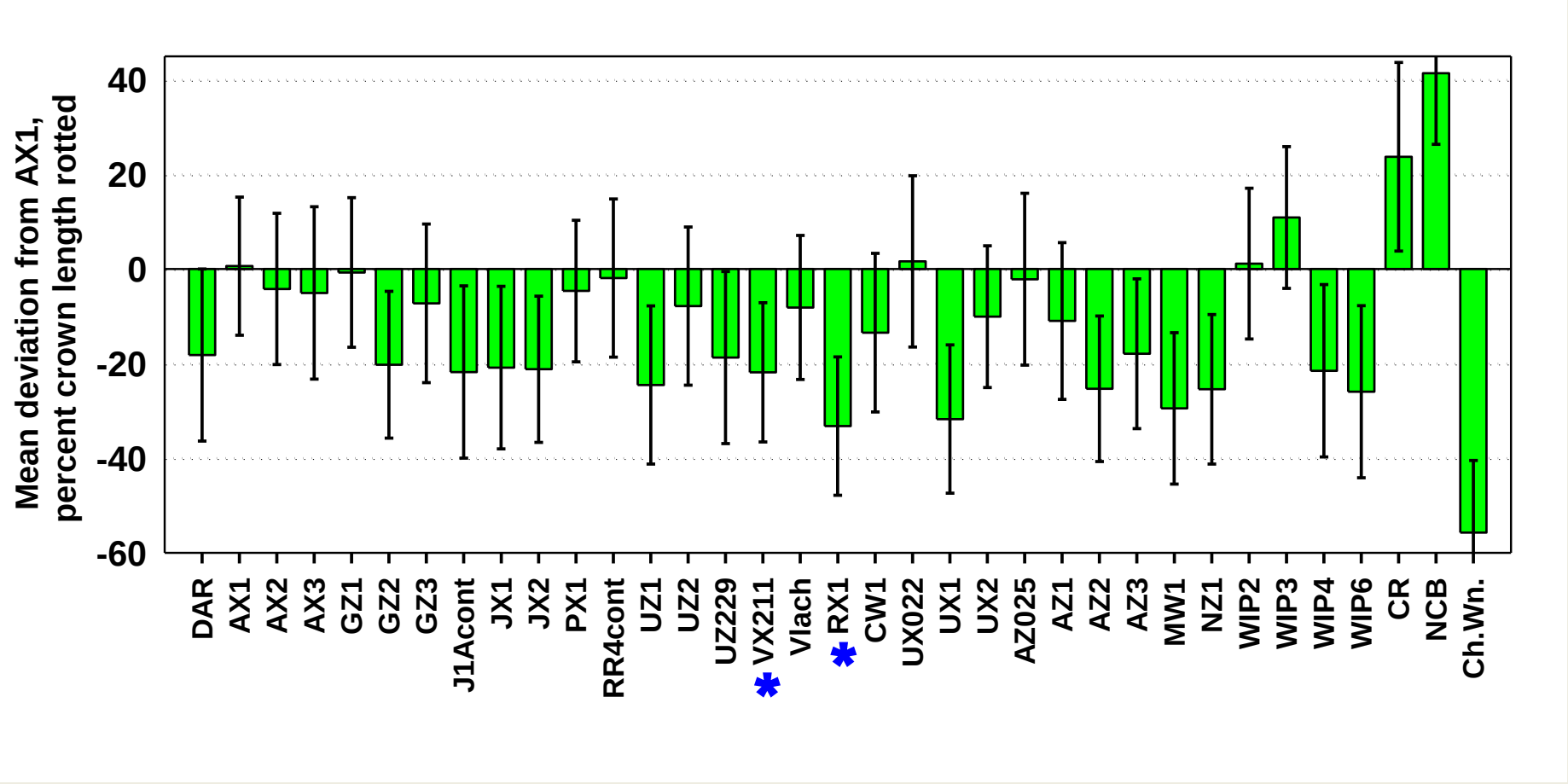
Seedling evaluation program, resistance to Phytophthora, 1997-99

Overview
Clonal evaluations of resistance, 2001-10:

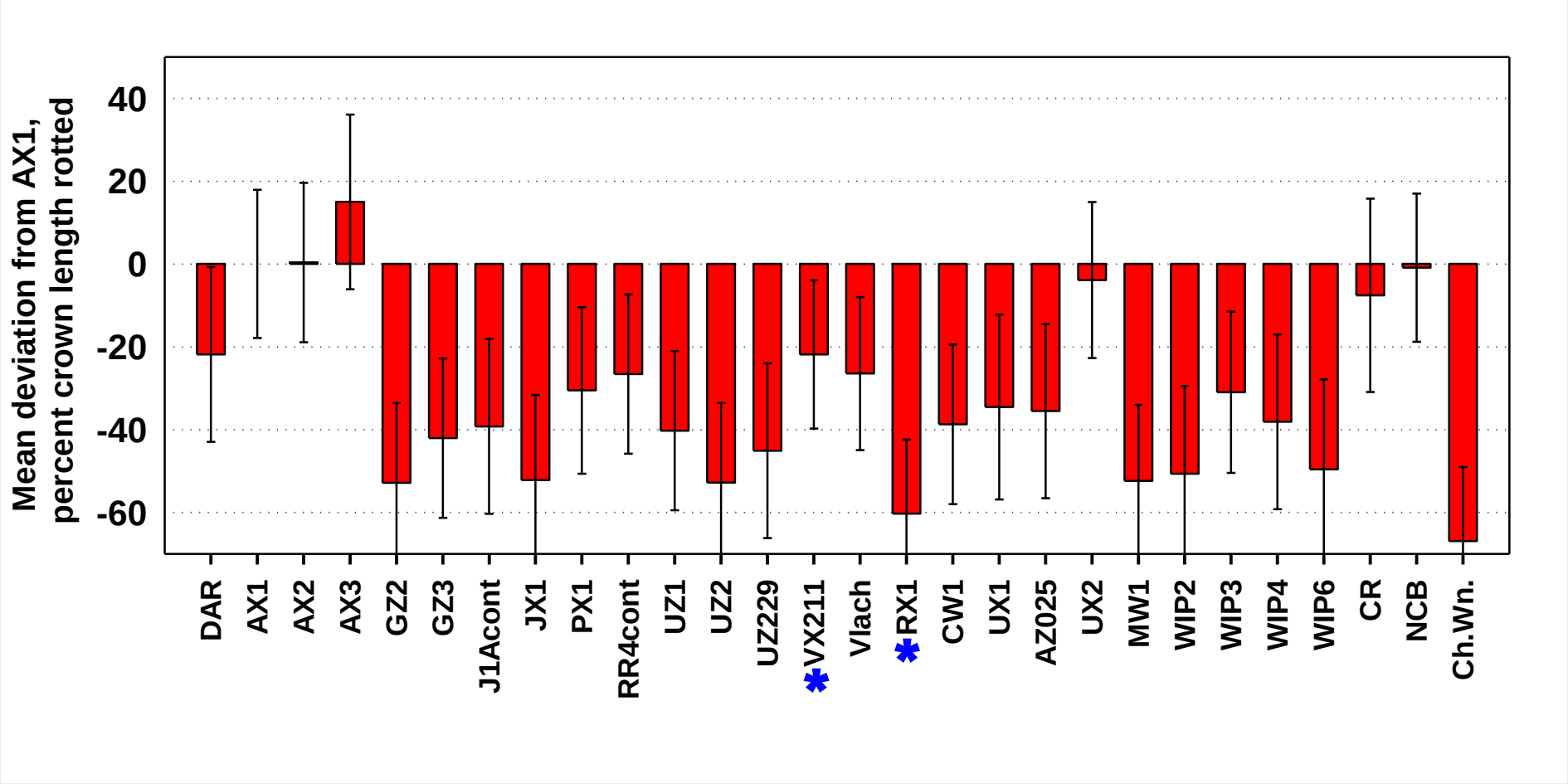
- >40 clonal hybrid selections
- Include elites from seedlings screens with *Phytophthora*, *Agrobacterium*, *Pratylenchus*, CLRV; also controlled crosses
- All hybrids w/ *J. regia* as paternal parent
- All hybrids, simple and complex, w/ black walnut maternal parents
- Standards AX1, NCB, & Chinese WN
- **RX1 is a product**

Maternal parent	Rstk. Clone	*P. citricola*										*P. cinnamomi*				
		2001	2004a	2004b	2006	2007a	2007b	2008a	2008b	2009	2010	2007a	2008a	2008b	2009	2010
Juglans ailantifolia	DAR									+	+				+	+
J. californica	AX1	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
J. californica	AX2	+				+		+	+			+	+	+		
J. californica	AX3							+	+				+	+		
J. hindsii	GZ1		+	+	+		+									
J. hindsii	GZ2				+	+	+	+	+			+	+	+		
J. hindsii	GZ3					+		+	+			+	+	+		
J. hindsii	JX1							+	+	+			+	+	+	
J. hindsii	JX2	+	+	+	+		+									
J. hindsii	J1Acont									+	+				+	+
J. hindsii	J21cont									+					+	
J. hindsii	JJ1Dcont							+					+			
J. hindsii	PX1		+	+	+	+	+			+	+	+			+	+
J. hindsii	RR1cont					+						+				
J. hindsii	RR4cont					+				+	+	+			+	+
J. hindsii	bur					+						+				
J. hindsii	UZ1							+	+	+			+	+	+	
J. hindsii	UZ2							+	+	+			+	+	+	
J. hindsii	UZ229									+	+				+	+
J. hindsii	VX211		+	+	+	+	+	+	+	+	+	+	+	+	+	+
J. hindsii	XZ1							+					+			
J. hindsii	Vlach				+	+	+	+	+		+	+	+	+		+
J. hindsii	84-121	+														
J. microcarpa	RX1	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
J. nigra	RW2					+						+				
J. nigra	CW1					+		+	+			+	+	+		
J. californica x J. nigra	UX1	+			+	+	+			+		+			+	
J. californica x J. nigra	UX2	+			+	+	+	+	+	+		+	+	+	+	
J. californica x J. nigra	UX022				+		+									
(J.major x J.hindsii) x J.nigra	AZ1	+			+		+									
(J.major x J.hindsii) x J.nigra	AZ2	+	+	+	+		+									
(J.major x J.hindsii) x J.nigra	AZ3		+	+	+		+									
(J.major x J.hindsii) x J.nigra	AZ025					+		+				+	+			
(J.major x J.hindsii) x J.nigra	MW1					+		+	+	+		+	+	+	+	
(J.major x J.hindsii) x J.nigra	NZ1		+	+	+		+									
(J. hindsii x J. regia)	WIP2				+		+			+	+				+	+
(J. hindsii x J. regia)	WIP3		+	+	+	+	+			+	+	+			+	+
(J. hindsii x J. regia)	WIP4									+	+				+	+
(J. hindsii x J. regia)	WIP6									+	+				+	+
*Pterocarya stenoptera**	Ch. Wn.					+	+	+	+	+	+	+	+	+	+	+
*J. hindsii **	NCB				+	+	+	+	+	+	+	+	+	+	+	+
*J. regia**	CR					+					+	+				+
*J. regia**	Tulare										+					+
*J. regia**	Howard										+					+

2001-2010 summary, large-plant evaluations, crown rot variable, *P. citricola*



2001-2010 summary, large-plant evaluations, crown rot variable, *P. cinnamomi*

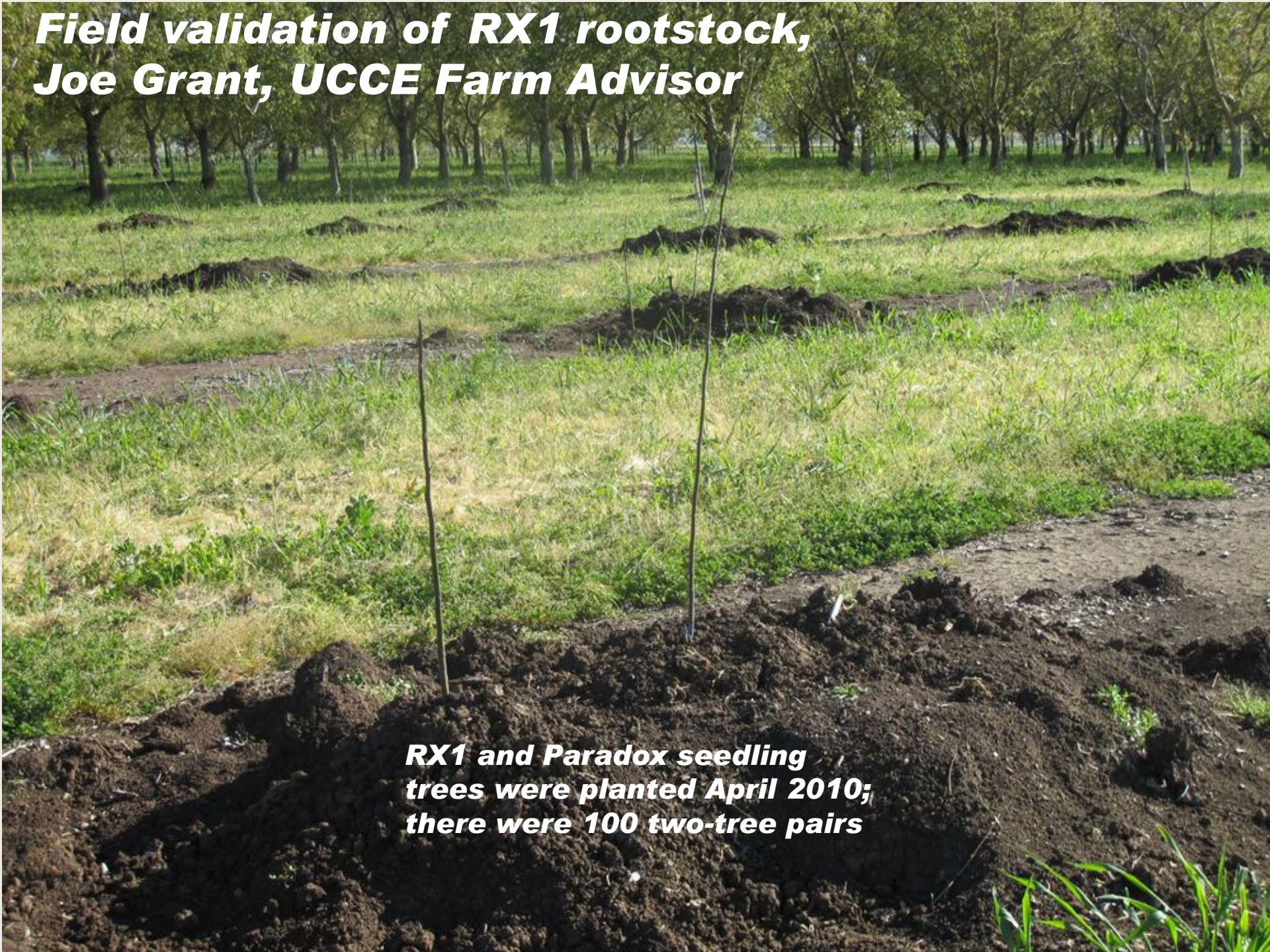


Field testing of RX1 rootstock,
Joe Grant, UCCE Farm Advisor

7-15-2003

9-16-2011

Orchard area infested with *Phytophthora cinnamomi*


Field validation of RX1 rootstock,
Joe Grant, UCCE Farm Advisor
RX1 and Paradox seedling
trees were planted April 2010;
there were 100 two-tree pairs

Field testing RX1

(trees planted March 2010)

Results to date*:

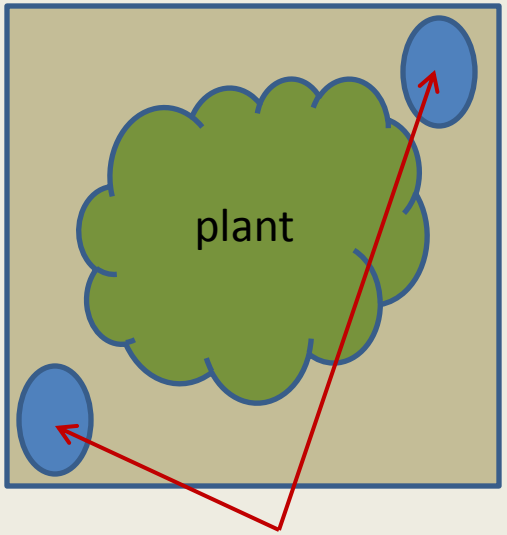
Yr	Rootstock	Mortality (%)**
2010	Pdx sdg.	0
	RX1	0
2011	Pdx. sdg.	17 (+6)
	RX1	0

**P. cinnamomi* isolated from 63% of dead trees and 40% of poorly growing trees.

**Surviving trees grew similarly.

Current status, rootstock work

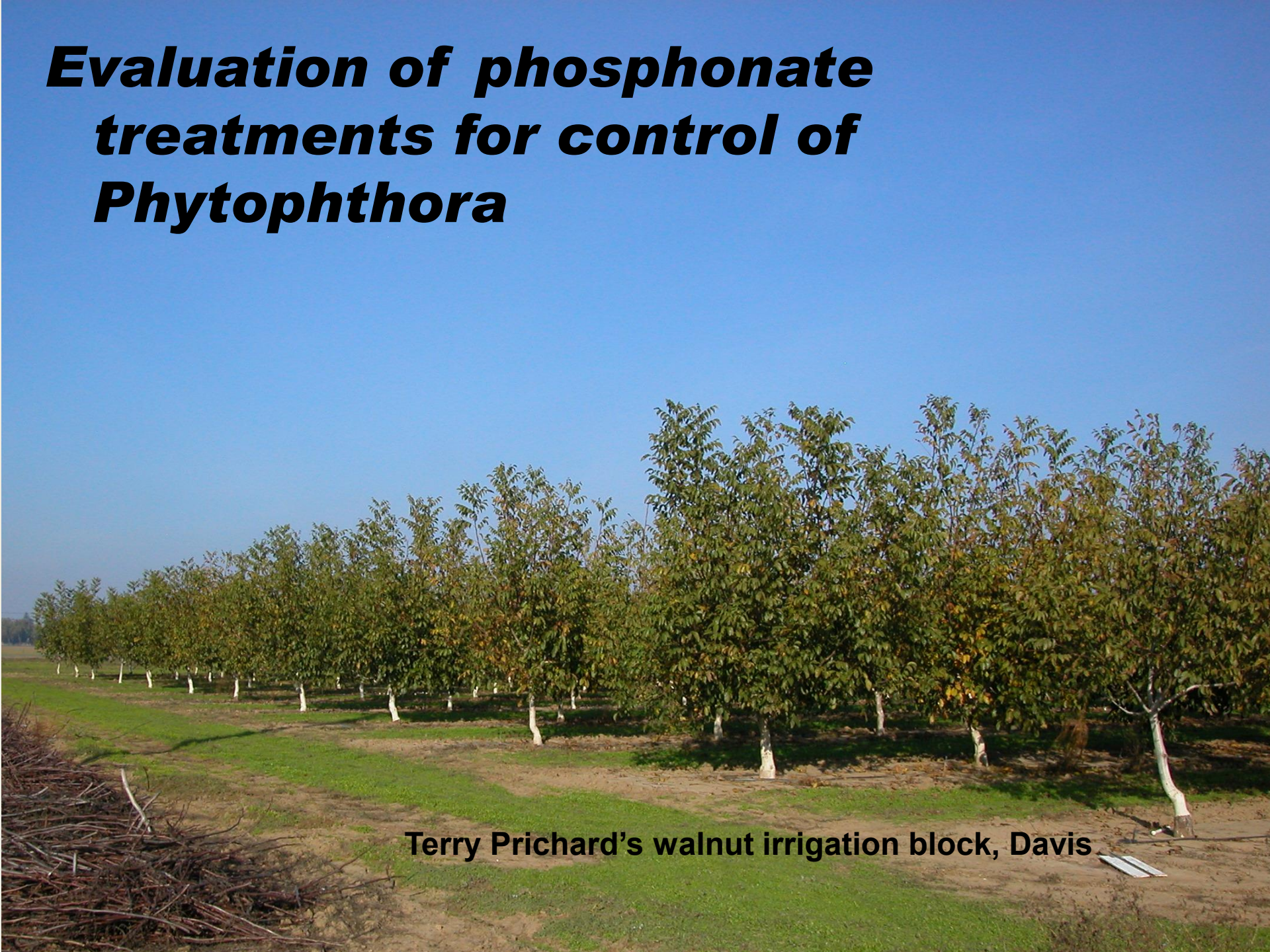
- Promising clonal selections are available
- More field experience is needed with available clones
- Broader explorations are justified and underway



30 ml inoculum

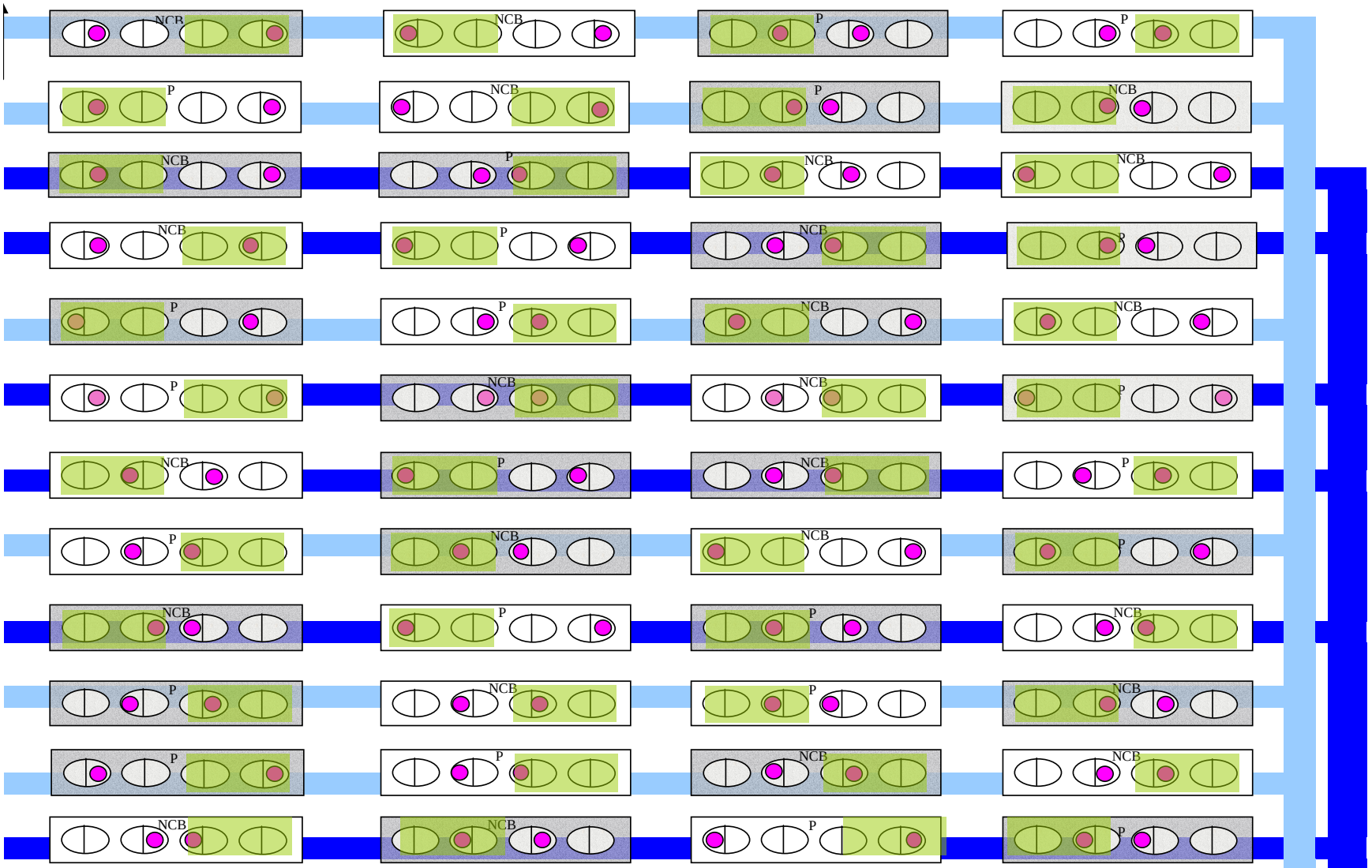
Small-plant assay for resistance to *P. cinnamomi* and *P. citricola*

Evaluation of phosphonate treatments for control of Phytophthora



Terry Prichard's walnut irrigation block, Davis

Design of phosphonate (Fosphite®) trial, Campbell Tract, Prichard irrig. block



Legend:

Foliar spray (1)

Chemigations (3)

Control irrigation

Tree trunk

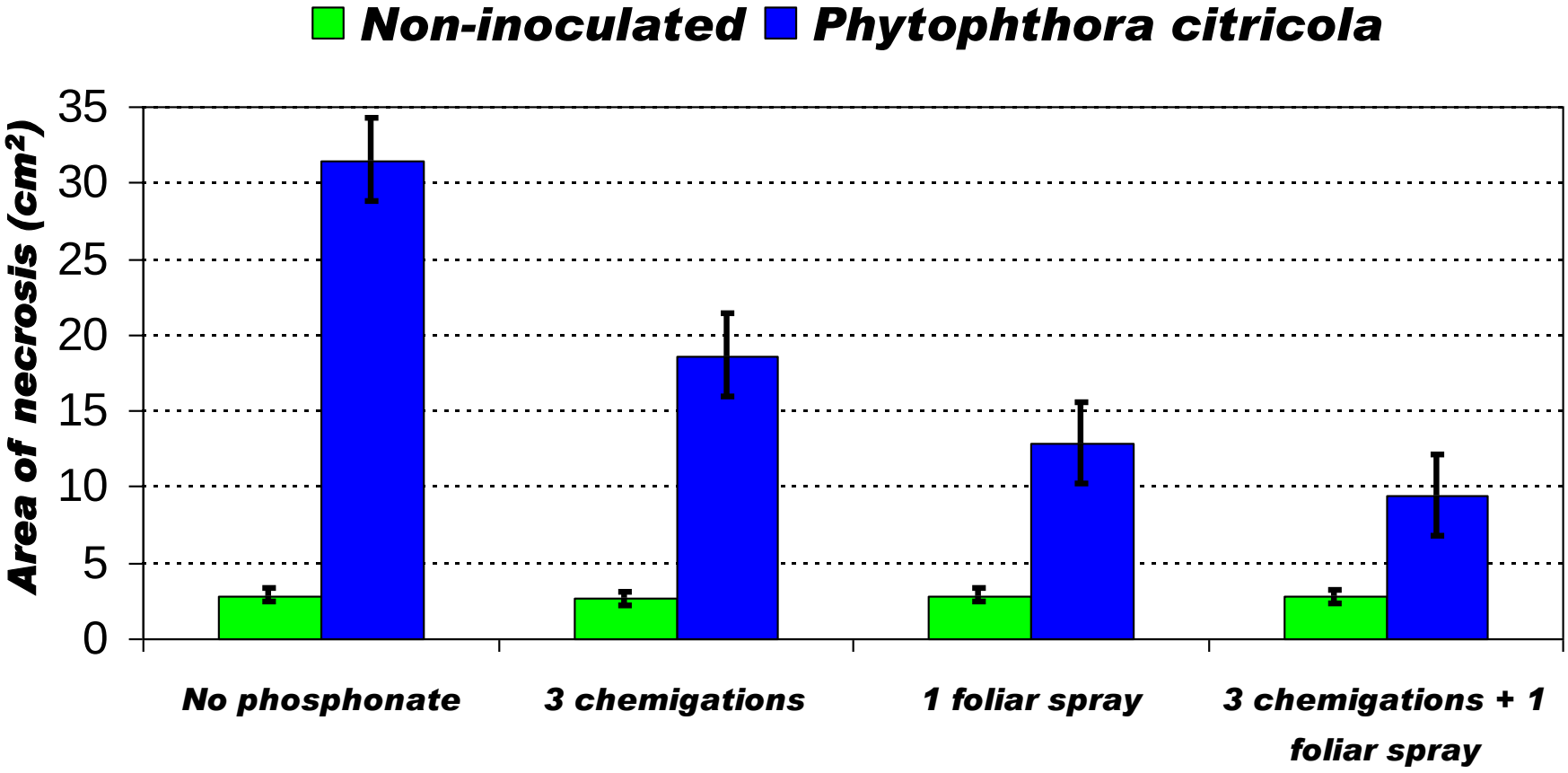
1st *P.citricola* wound inoc.

P.citricola+cinnmomi Infested soil

Efficacy of phosphonate treatments (3 qts./A),

-Trees inoculated 1 month after phosphonate treatments completed

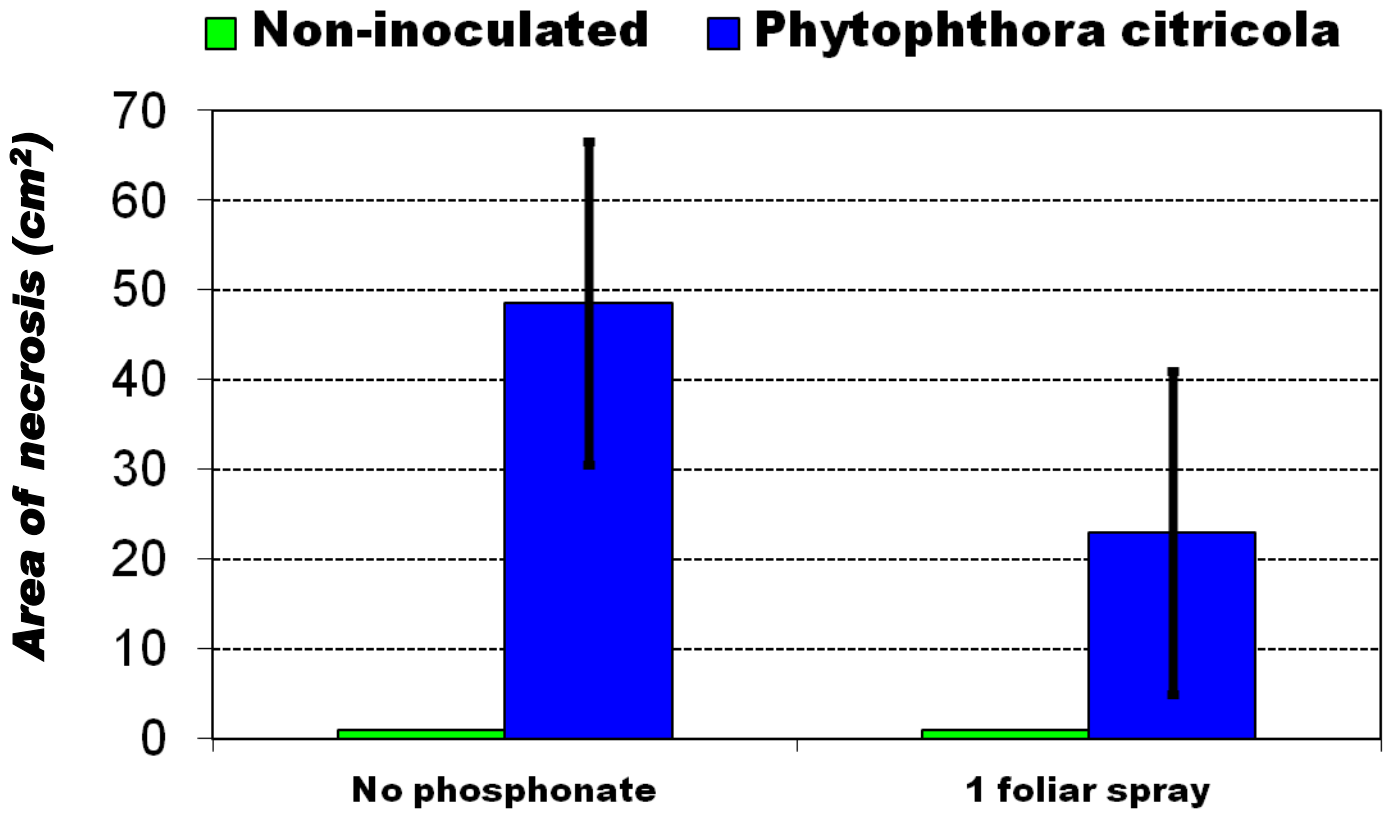
-Cankers measured 3 months after inoculation



Efficacy of phosphonate treatments (3 qts./A),

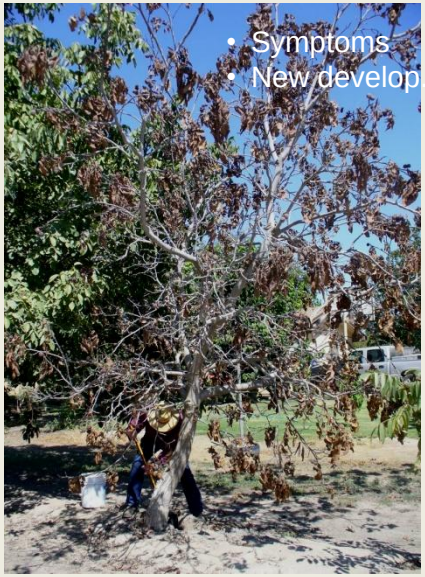
-Trees inoculated 7 months after phosphonate treatments completed

-Cankers measured 3 months after inoculation



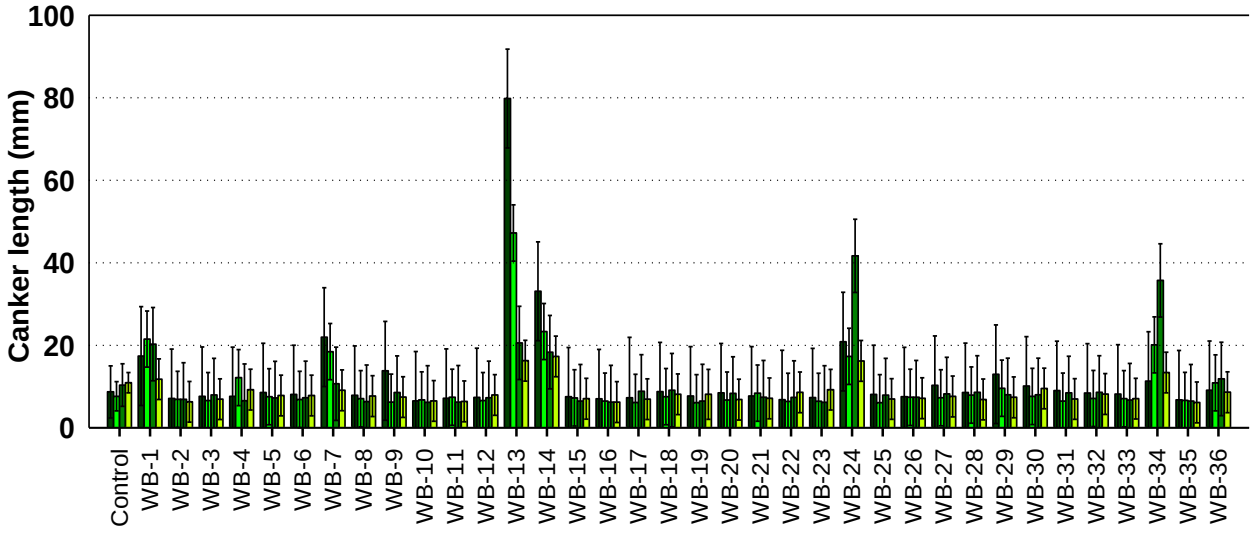
Assessing poorly understood crown and root problems on Paradox

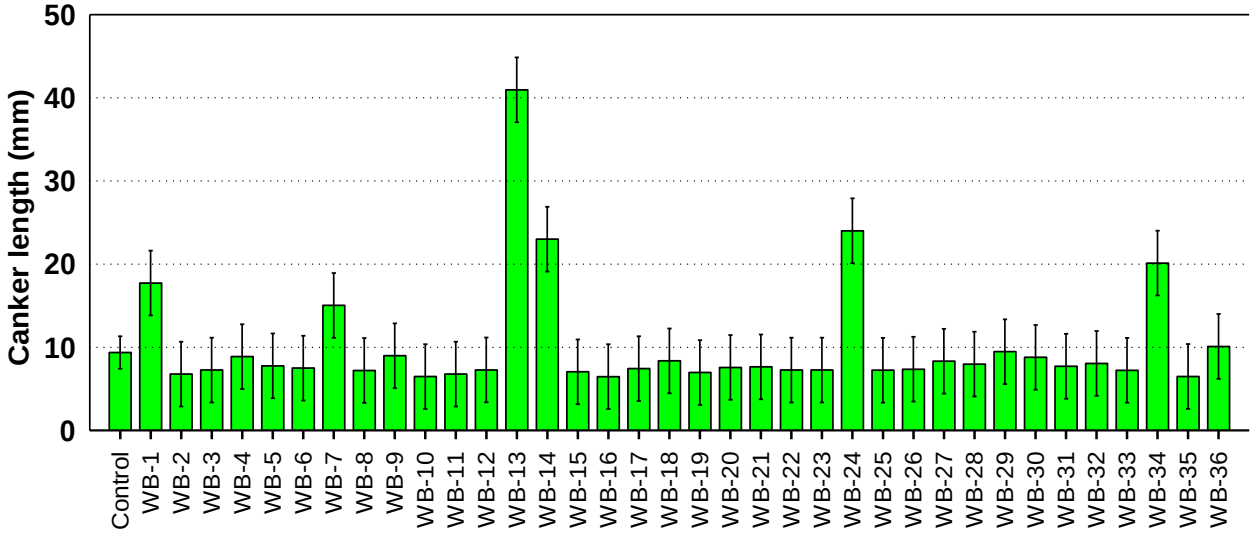
(Our work involves Bob Beede, Janine Hasey, Chuck Leslie, Themis Michailides, others)



More Paradox canker symptoms

Paradox canker: testing pathogenicity of isolates





Results:

6 of 36 isolates, WB-1, WB-7, WB-13, WB-14, WB-24, WB-34 were pathogenic; these isolates all were *Brenaria nigrifluens*

Some key points

Phytophthora typically localized but can be devastating

To minimize losses from Phytophthora:

- Good preparation (site selection, ripping, drainage)
- Irrigate to meet ET, but avoid prolonged water saturation (>>24 hr)
- Consider new rootstock option (RX1)
- Phosphonate sprays can help

There are "new" Paradox problems to watch for.

More field experience needed with Paradox clones.

Thank You!!