LAUREL WILT: A GLOBAL THREAT TO AVOCADO PRODUCTION

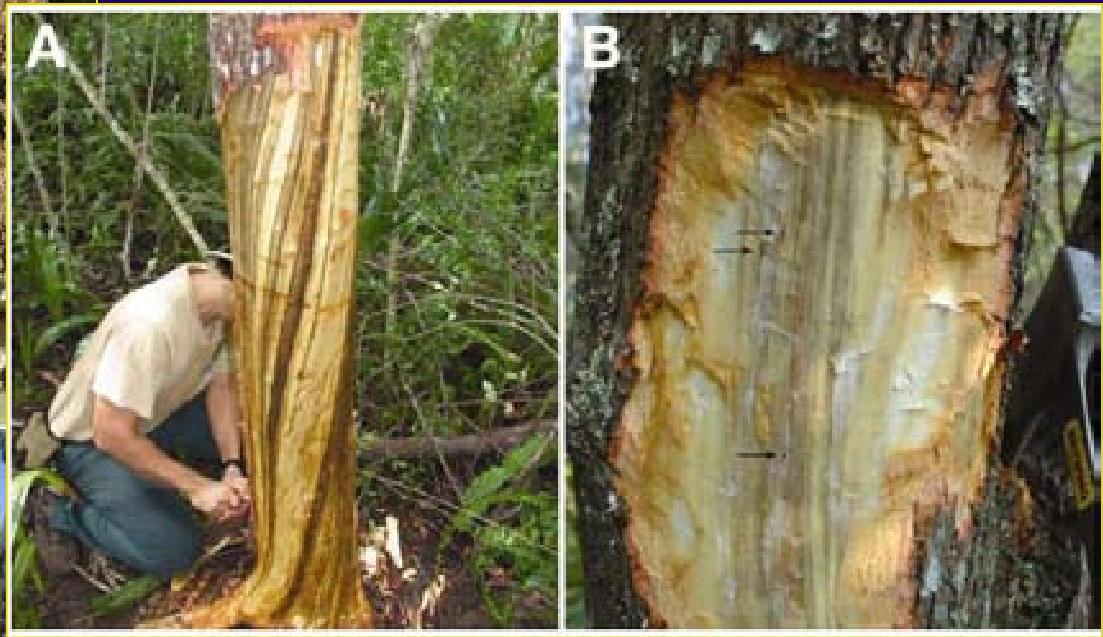
Randy Ploetz
University of Florida
Homestead, FL USA
kelly12@ufl.edu
http://trec.ifas.ufl.edu/personnel_faculty_randy_ploetz.shtml

4th Australian and New Zealand Avocado Grower's Conference, Cairns, 21-24 July 2009

Chronology

An exotic ambrosia beetle, ***Xyleborus glabratus***, detected in Port Wentworth, 2002

Shortly thereafter, dying red bay (***Persea borbonia***) trees noted in surrounding area; they are affected by a new disease, laurel wilt

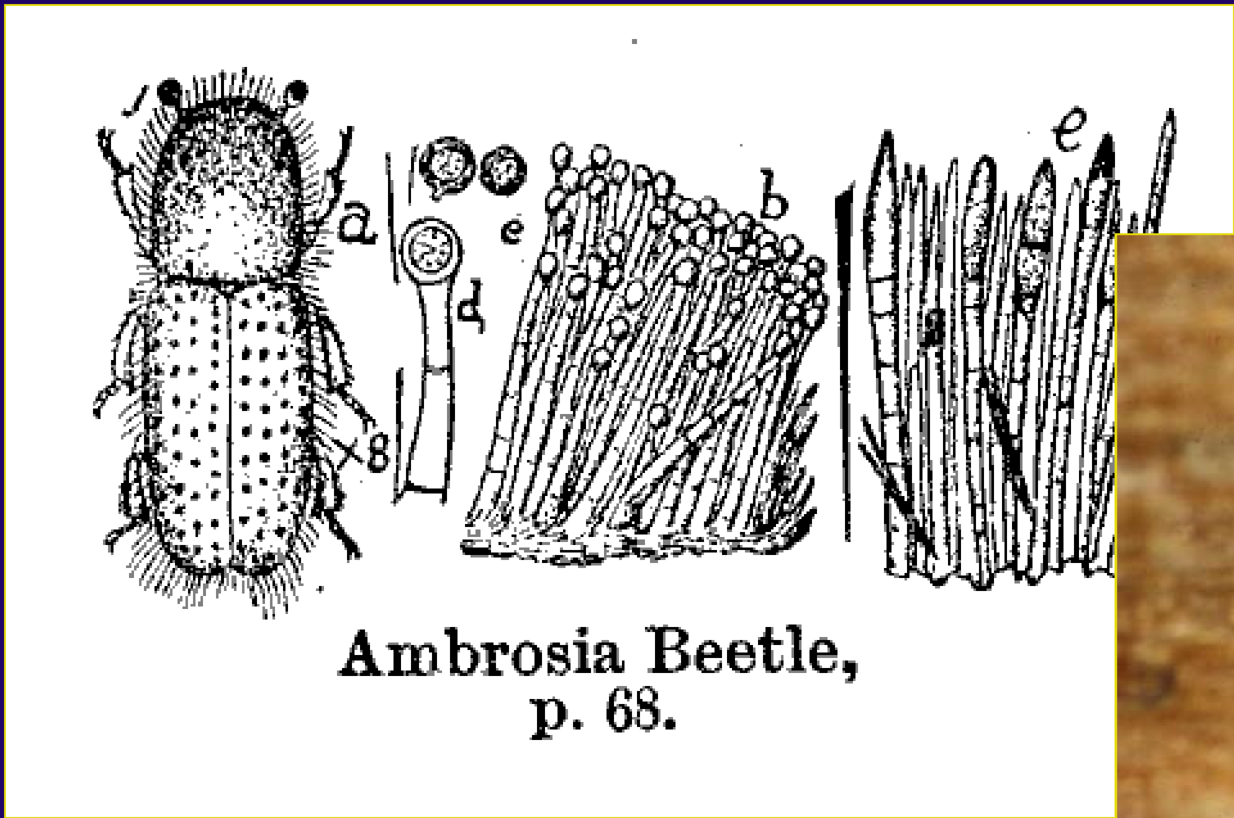


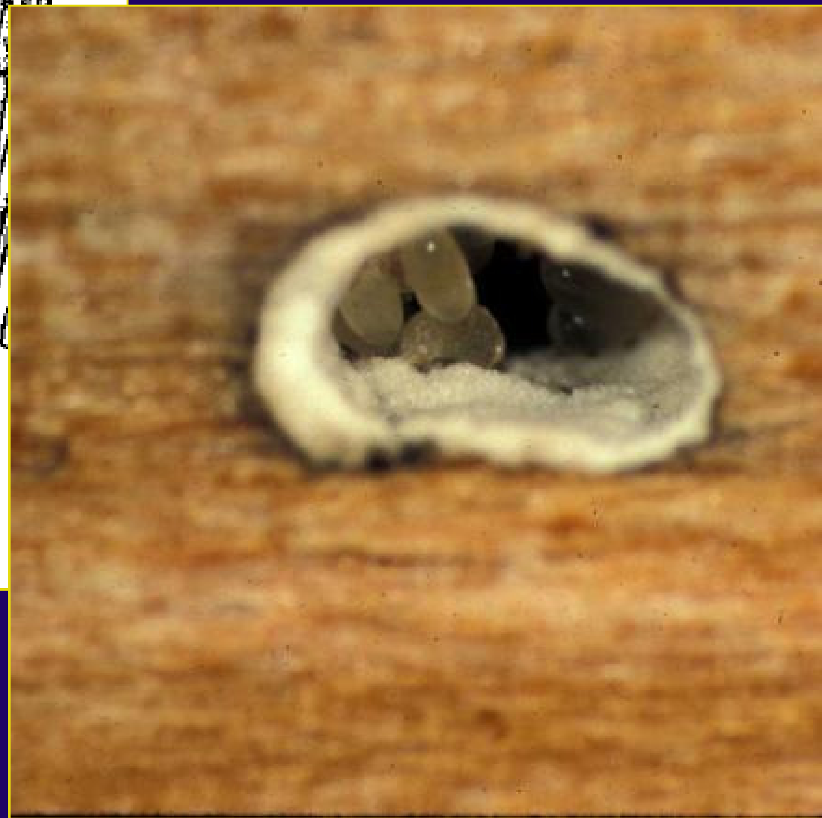
Fraedrich et al. 2008

In controlled studies in 2006, a new fungus, ***Raffaellea*** sp., causes laurel wilt on redbay

Xyleborus glabratus is shown to vector the pathogen in 2007

Ambrosia beetles are fungus farmers.



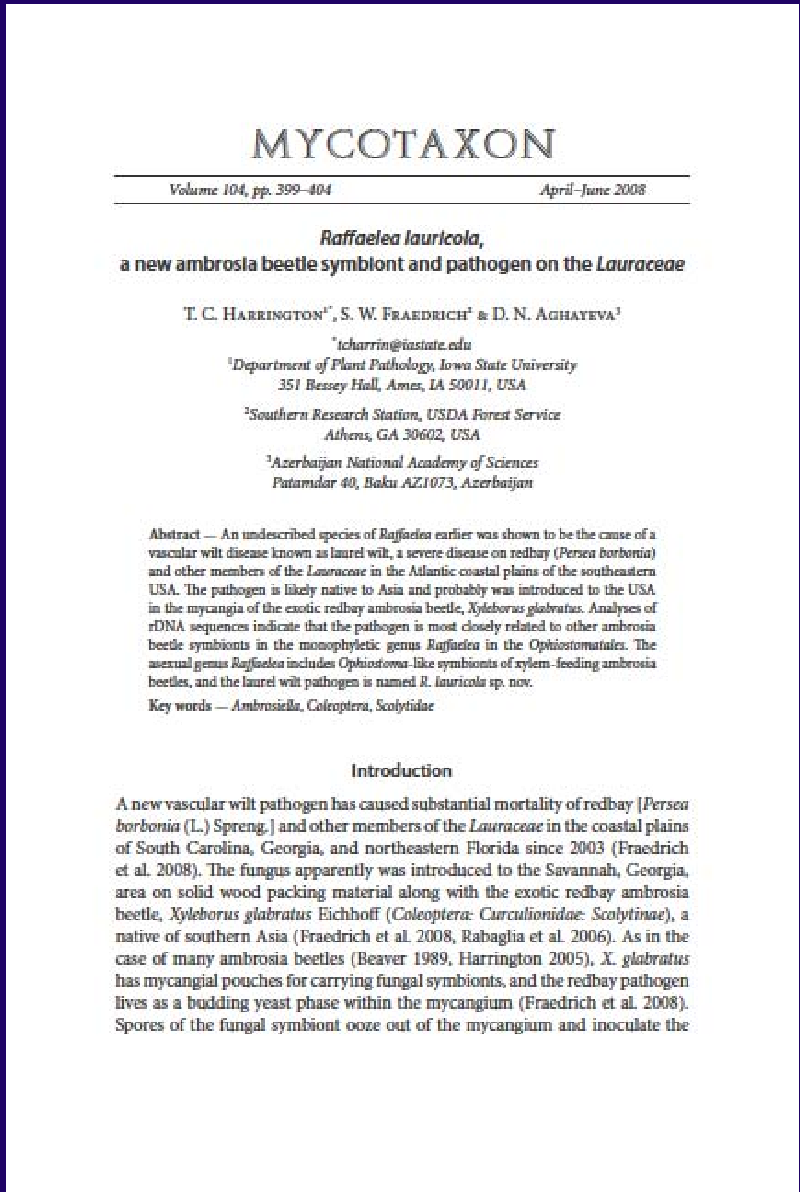


Ambrosia beetle gallery
Robert Rabaglia

In controlled studies in 2006, a new fungus, ***Raffaellea*** sp., causes laurel wilt on redbay

In subsequent work, American species in the Lauraceae are most susceptible

First avocado killed experimentally by laurel wilt, 2007



MYCOTAXON

Volume 104, pp. 399–404 April–June 2008

Raffaelea lauricola, a new ambrosia beetle symbiont and pathogen on the *Lauraceae*

T. C. Harrington[1*], S. W. Fraedrich[2] & D. N. Aghayeva[3]

[*]tcharrin@iastate.edu

[1]Department of Plant Pathology, Iowa State University
351 Bessey Hall, Ames, IA 50011, USA

[2]Southern Research Station, USDA Forest Service
Athens, GA 30602, USA

[3]Azerbaijan National Academy of Sciences
Patamdar 40, Baku AZ1073, Azerbaijan

Abstract — An undescribed species of *Raffaelea* earlier was shown to be the cause of a vascular wilt disease known as laurel wilt, a severe disease on redbay (*Persea borbonia*) and other members of the *Lauraceae* in the Atlantic coastal plains of the southeastern USA. The pathogen is likely native to Asia and probably was introduced to the USA in the mycangia of the exotic redbay ambrosia beetle, *Xyleborus glabratus*. Analyses of rDNA sequences indicate that the pathogen is most closely related to other ambrosia beetle symbionts in the monophyletic genus *Raffaelea* in the *Ophiostomatales*. The asexual genus *Raffaelea* includes *Ophiostoma*-like symbionts of xylem-feeding ambrosia beetles, and the laurel wilt pathogen is named *R. lauricola* sp. nov.

Key words — *Ambrosiella, Coleoptera, Scolytidae*

Introduction

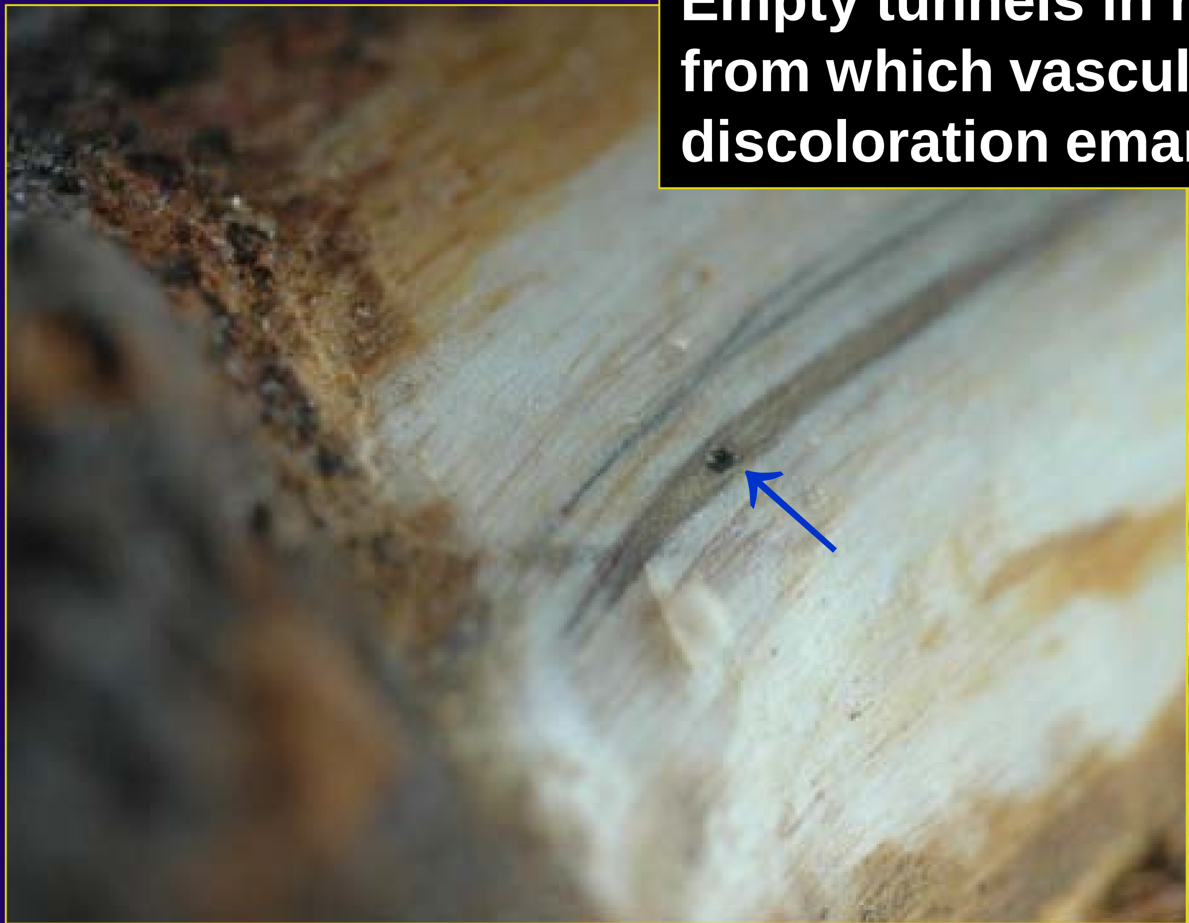
A new vascular wilt pathogen has caused substantial mortality of redbay [*Persea borbonia* (L.) Spreng.] and other members of the *Lauraceae* in the coastal plains of South Carolina, Georgia, and northeastern Florida since 2003 (Fraedrich et al. 2008). The fungus apparently was introduced to the Savannah, Georgia, area on solid wood packing material along with the exotic redbay ambrosia beetle, *Xyleborus glabratus* Eichhoff (*Coleoptera: Curculionidae: Scolytinae*), a native of southern Asia (Fraedrich et al. 2008, Rabaglia et al. 2006). As in the case of many ambrosia beetles (Beaver 1989, Harrington 2005), *X. glabratus* has mycangial pouches for carrying fungal symbionts, and the redbay pathogen lives as a budding yeast phase within the mycangium (Fraedrich et al. 2008). Spores of the fungal symbiont ooze out of the mycangium and inoculate the

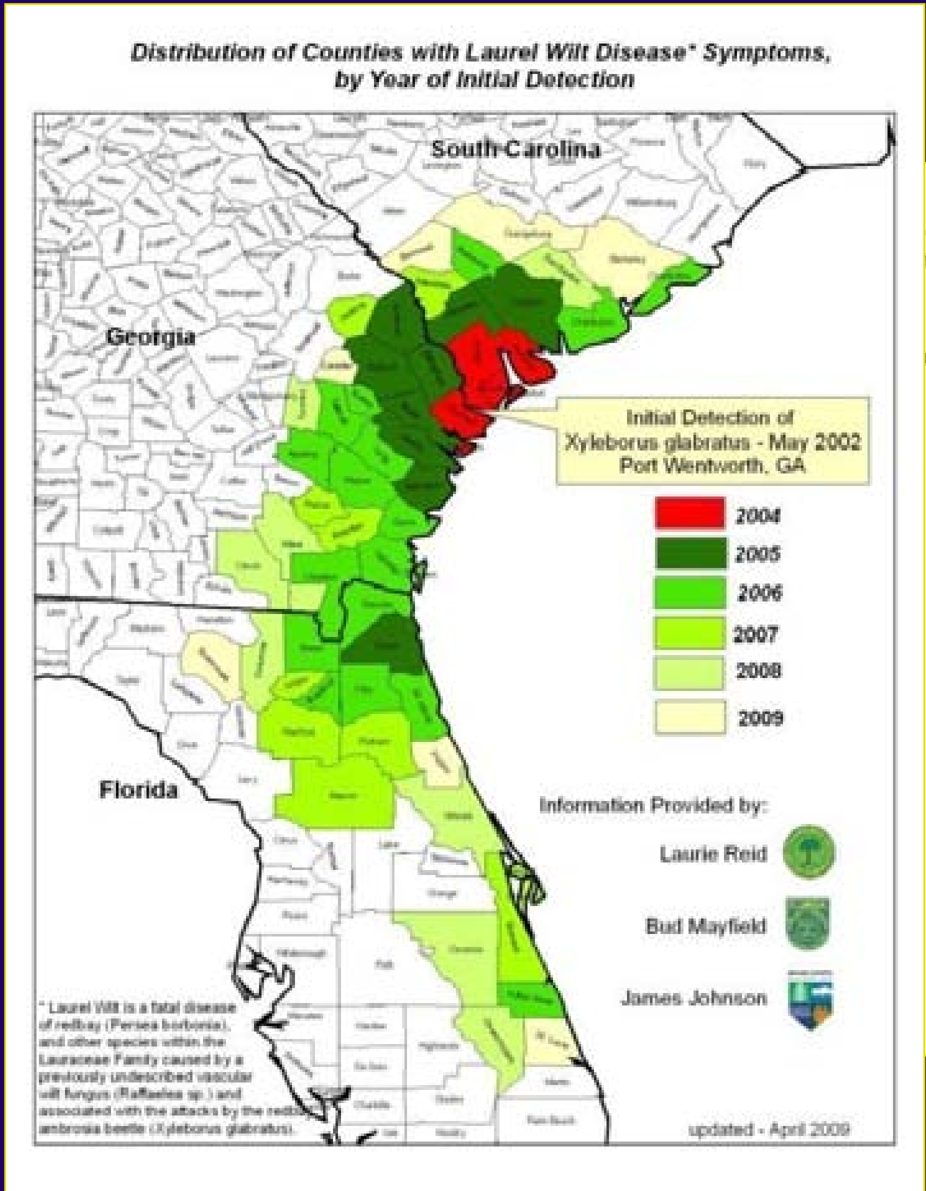
- Pathogen described as ***Raffaellea lauricola*** in 2008.
- It is related to other ambrosial symbionts, which are all saprophytes.
- They are related to plant pathogens in the genus ***Ophiostoma***.

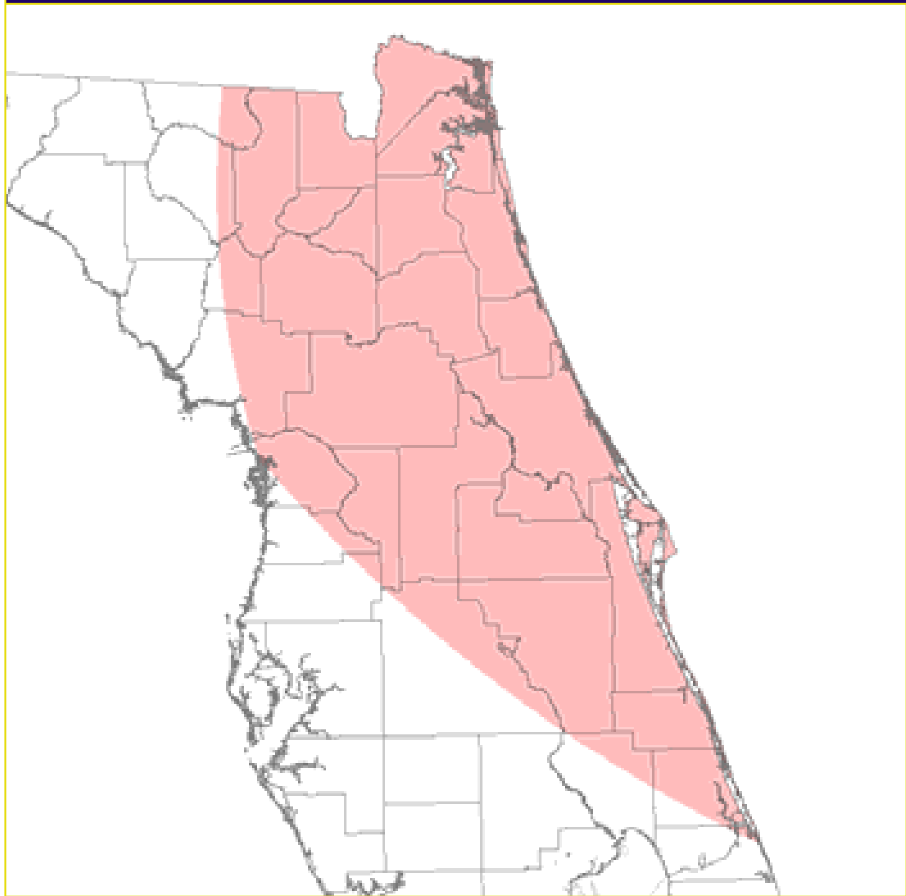
Laurel wilt is only disease caused by an ambrosial symbiont

Initial infections result from aborted tunnels by ***Xyleborus glabratus*** in healthy trees

Empty tunnels in redbay from which vascular discoloration emanates

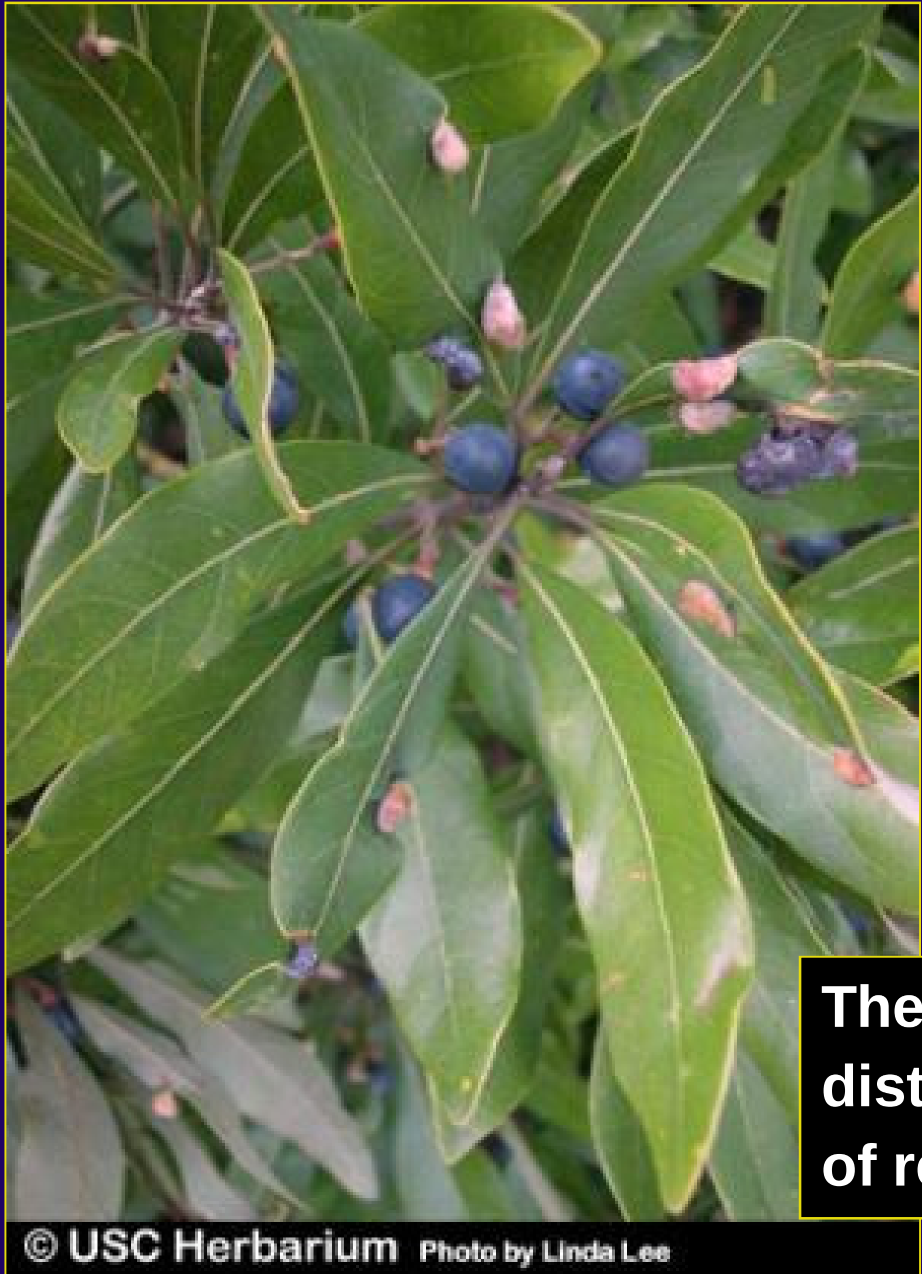


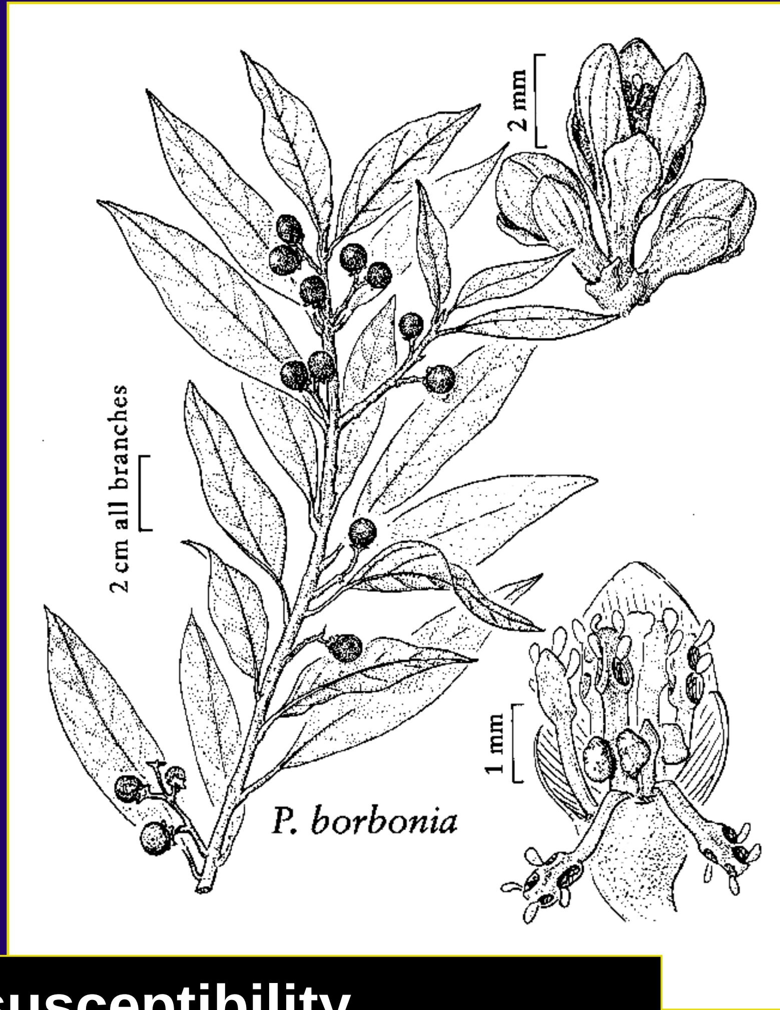




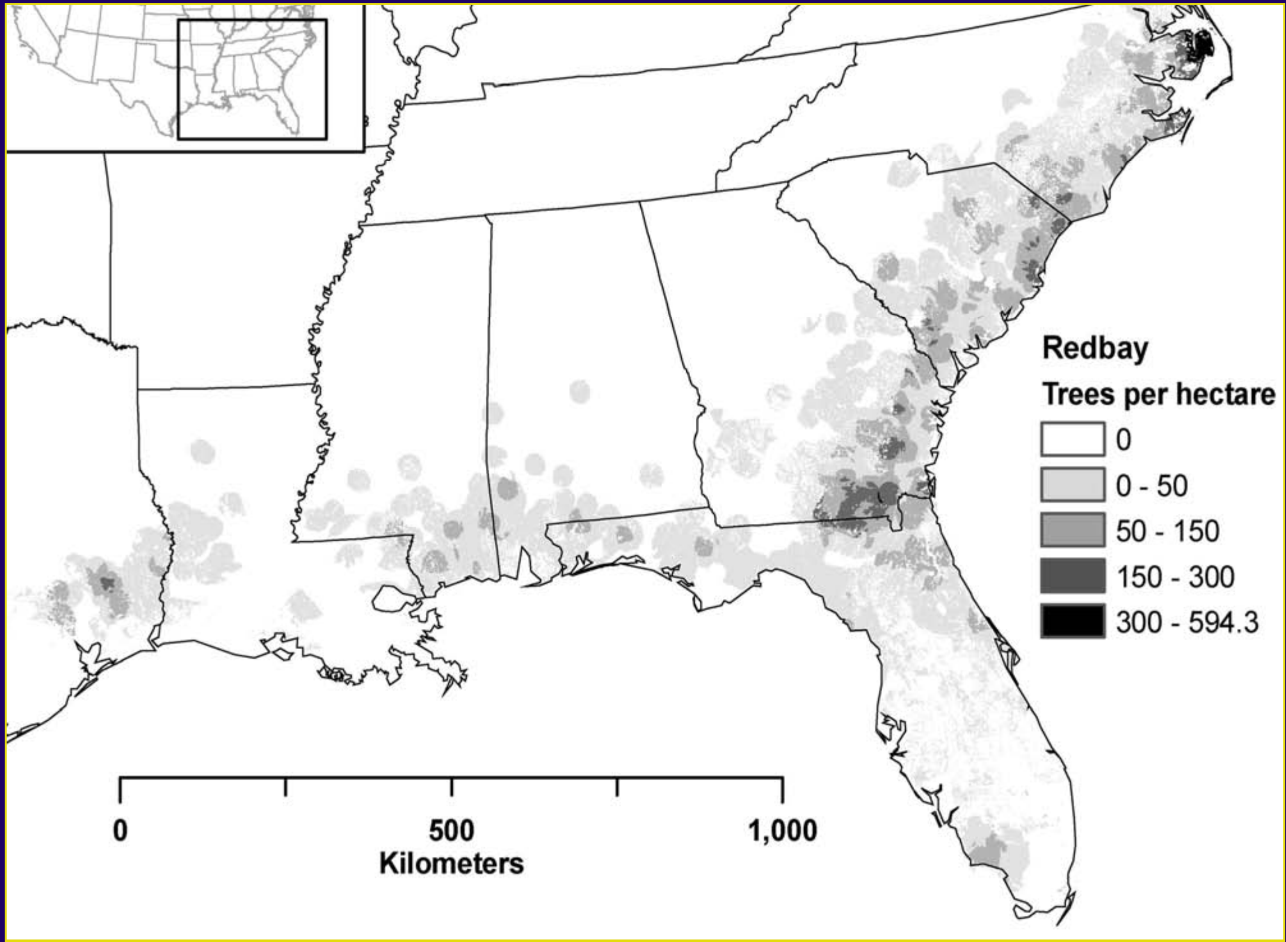
Laurel wilt moves rapidly in eastern US

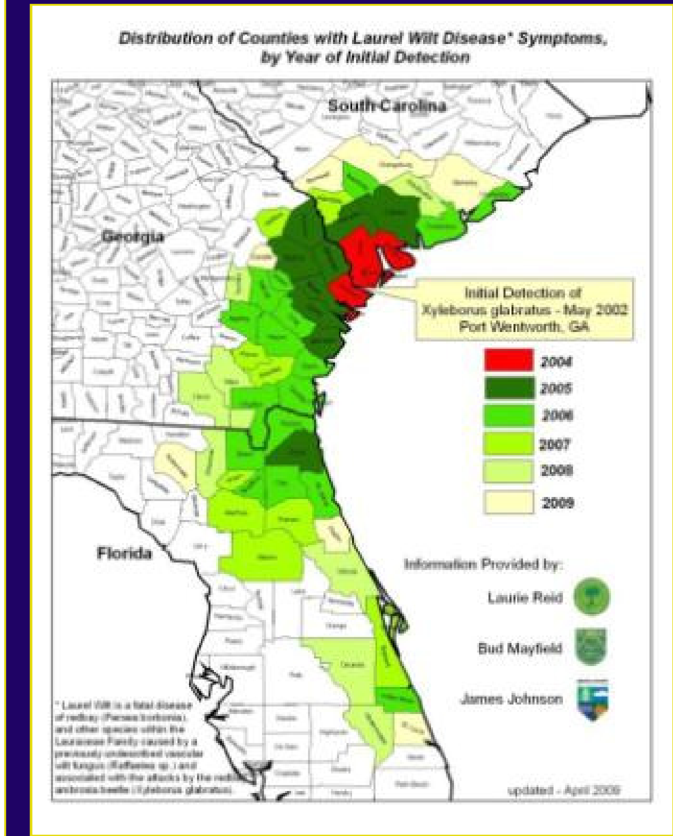
Distribution and movement



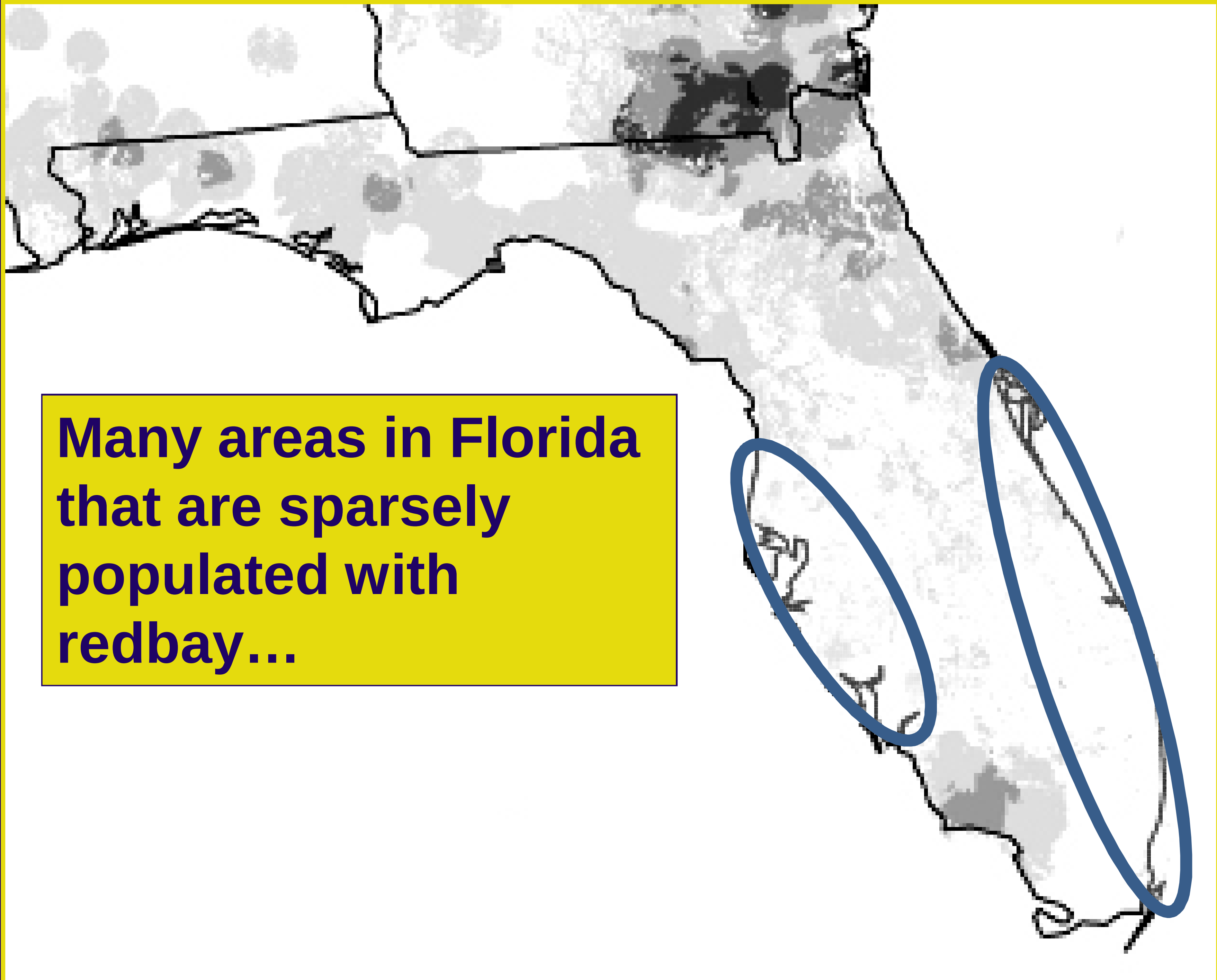


The susceptibility, distribution and prevalence of redbay…

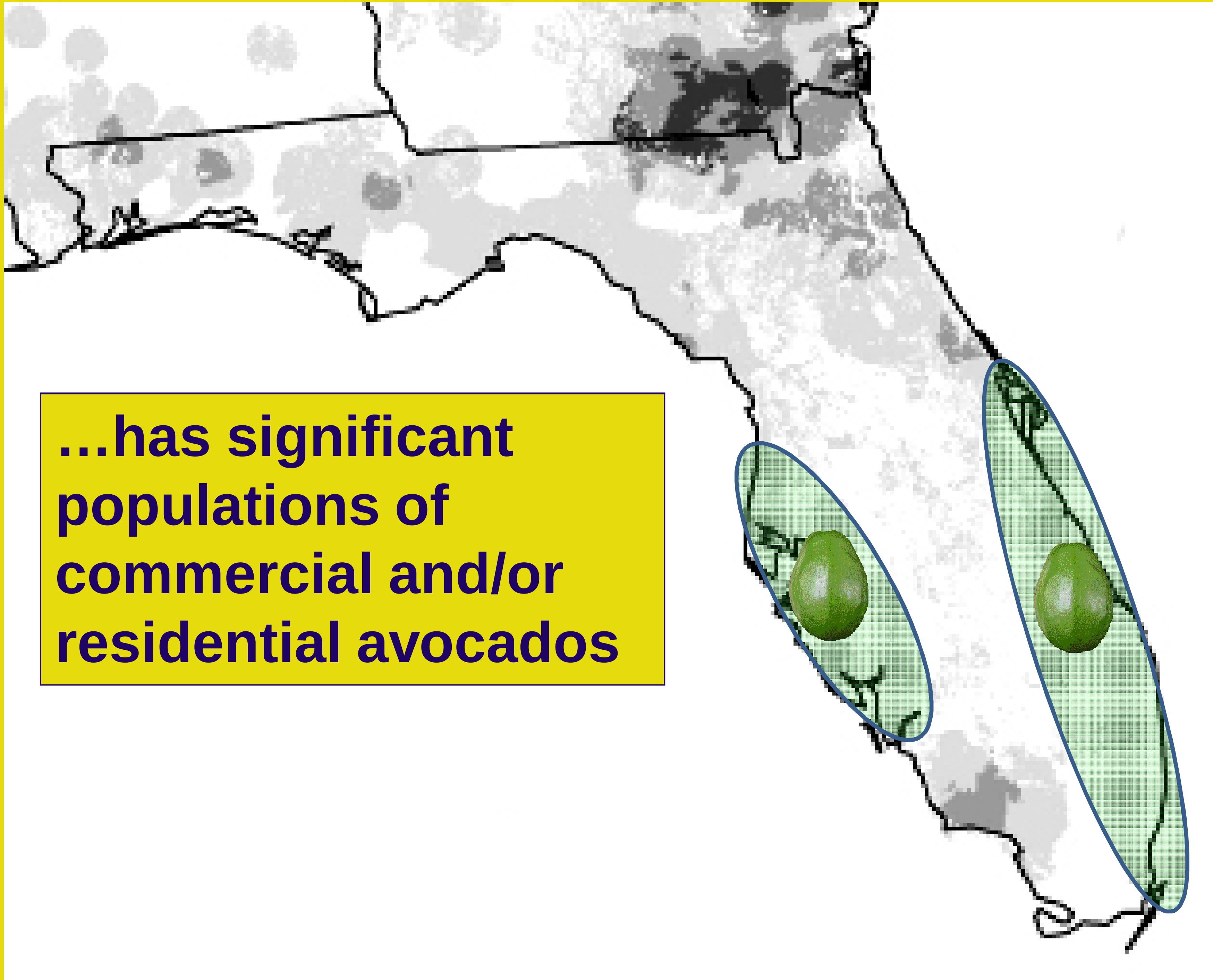




…is responsible for the rapid movement of laurel wilt in the SE USA



Many areas in Florida that are sparsely populated with redbay…



…has significant populations of commercial and/or residential avocados

The role played by avocado in the spread of laurel wilt is incompletely understood

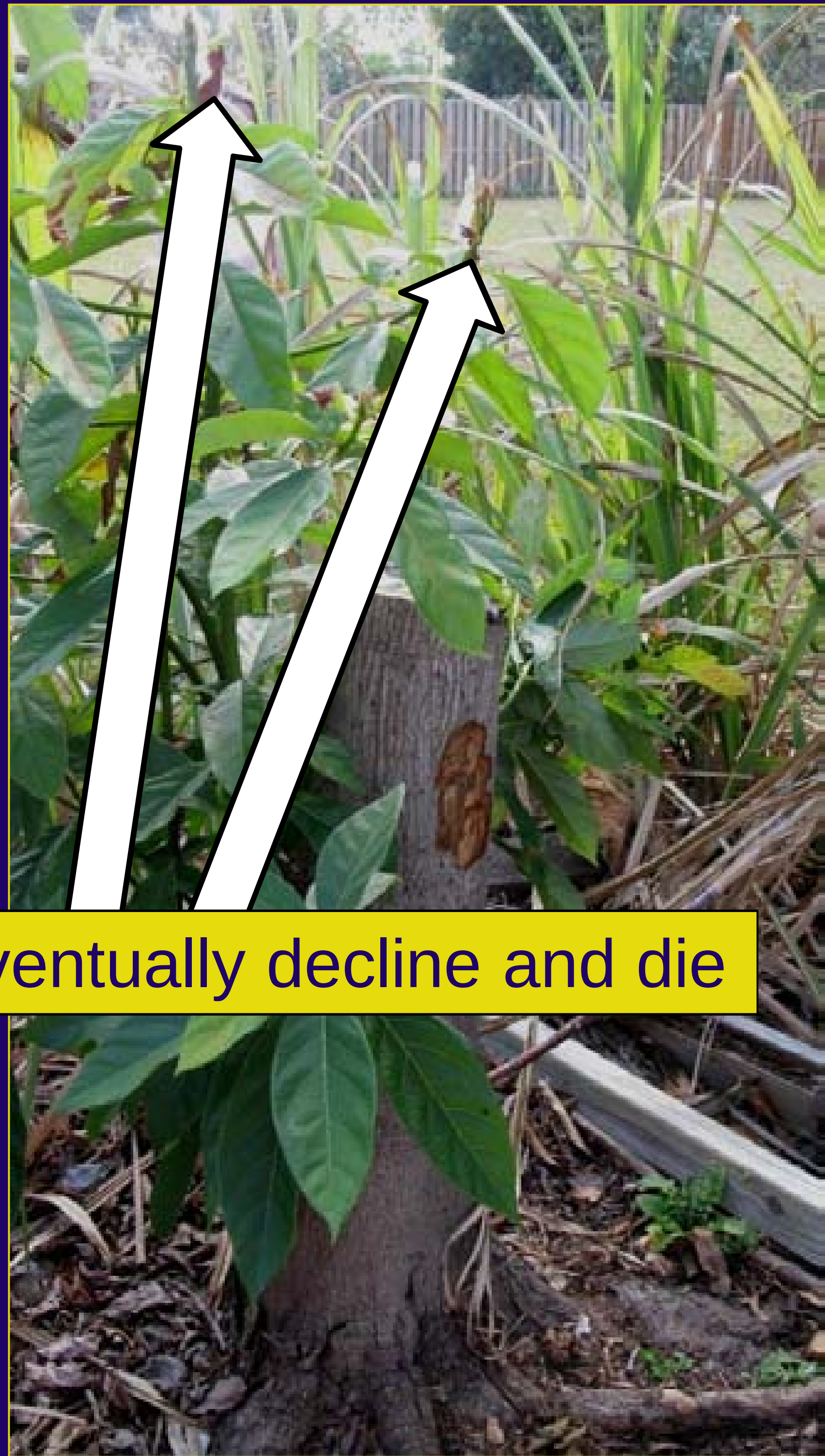
Symptoms

- Retention of wilted leaves
- Sectoral development (in only some traces)

Conspicuous vascular discoloration

…that is eventually associated with evidence of vector activity

Affected trees can re-sprout …



…but eventually decline and die

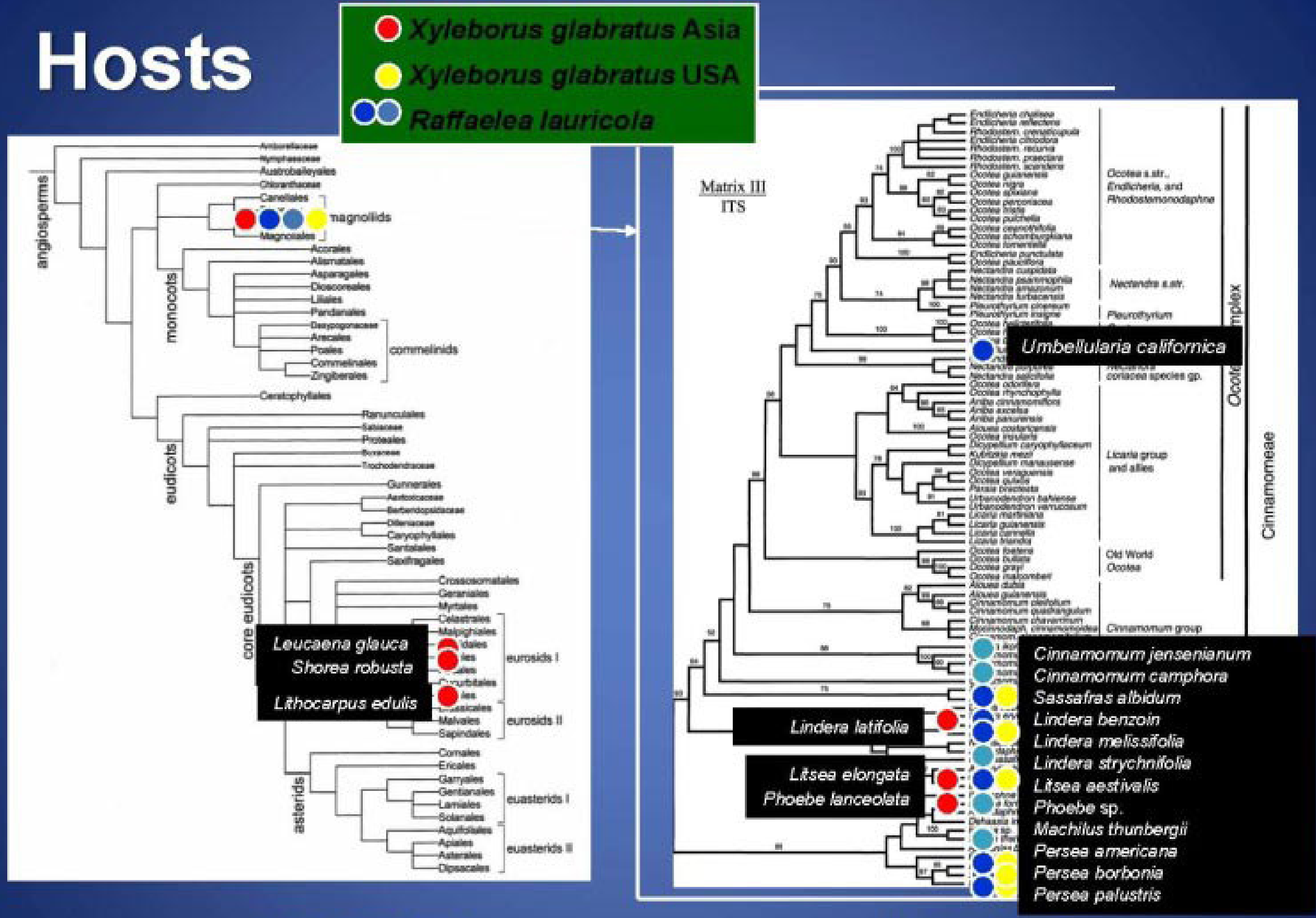
There are <u>many</u> things we do not know about laurel wilt

- Host range?
- Laurel-wilt resistant avocado?
- Identification and development of tolerant genotypes.
- Resistance mechanisms in avocado and other lauraceous hosts?
- Host x insect x fungus interactions?
- Host or other cues that attract insect?
- Conditions that influence insect's colonization of host plants, completion of life cycle, dissemination to healthy and infected trees (it is unlikely that materials infested with ***X. glabratus*** have not been shipped to ports other than Port Wentworth)
- Impact of California bay on development and spread of laurel wilt in California?
- Are other magnoliids in ornamental and landscape trades significant hosts for ***X. glabratus*** and ***R. lauricola***?
- Epidemiology of laurel wilt in agricultural and natural ecosystems?
- Efficacy of existing or proposed control measures?
- Economic impact and cost-effectiveness of control measures?
- How should laurel wilt be regulated, interdicted and managed?

There are <u>many</u> things we do not know about laurel wilt

- Host range?
- Laurel-wilt resistant avocado?
- Identification and development of tolerant genotypes.
- Resistance mechanisms in avocado and other lauraceous hosts?
- Host x insect x fungus interactions?
- Host or other cues that attract insect?
- Conditions that influence insect's colonization of host plants, completion of life cycle, dissemination to healthy and infected trees (it is unlikely that materials infested with ***X. glabratus*** have not been shipped to ports other than Port Wentworth)
- Impact of California bay on development and spread of laurel wilt in California?
- Are other magnoliids in ornamental and landscape trades significant hosts for ***X. glabratus*** and ***R. lauricola***?
- Epidemiology of laurel wilt in agricultural and natural ecosystems?
- Efficacy of existing or proposed control measures?
- Economic impact and cost-effectiveness of control measures?
- How should laurel wilt be regulated, interdicted and managed?

Hosts



Angiosperms

(http://www.life.uiuc.edu/ib/335/APGII.jpg)

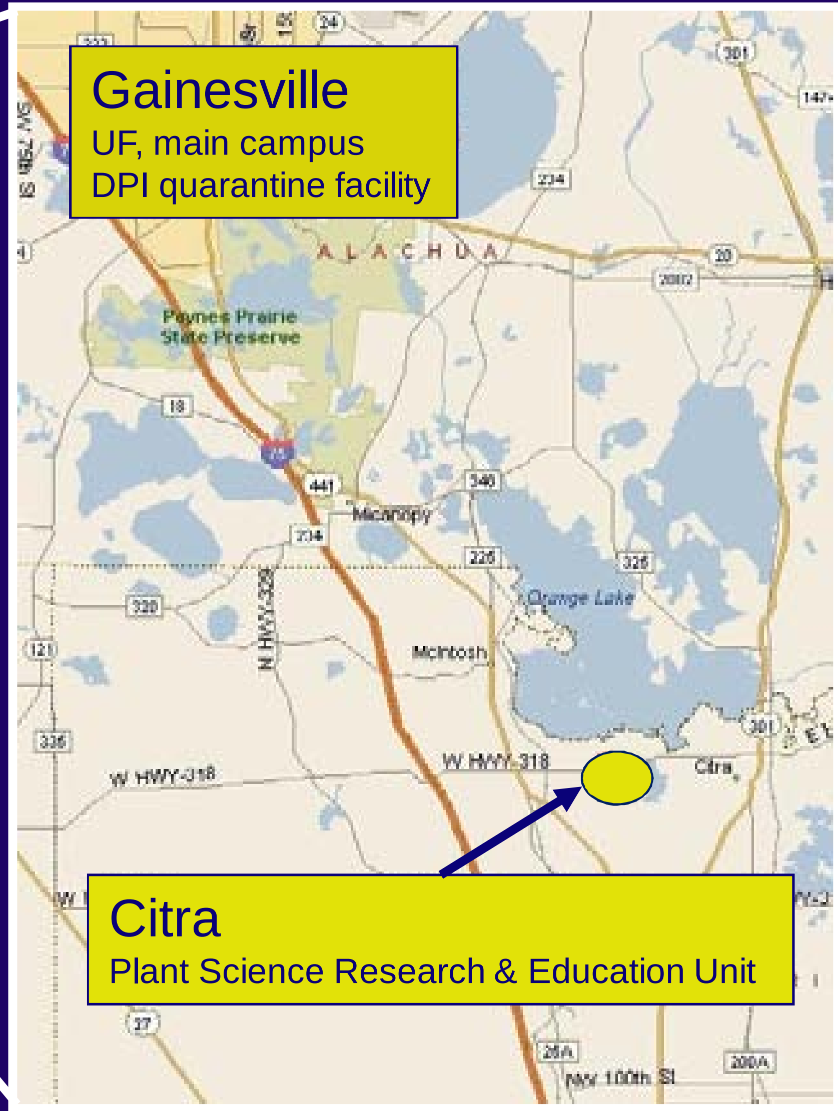
Lauraceae

(Chanderali *et al.*, 2001)

There are <u>many</u> things we do not know about laurel wilt

- Host range?
- Laurel-wilt resistant avocado?
- Identification and development of tolerant genotypes.
- Resistance mechanisms in avocado and other lauraceous hosts?
- Host x insect x fungus interactions?
- Host or other cues that attract insect?
- Conditions that influence insect's colonization of host plants, completion of life cycle, dissemination to healthy and infected trees (it is unlikely that materials infested with ***X. glabratus*** have not been shipped to ports other than Port Wentworth)
- Impact of California bay on development and spread of laurel wilt in California?
- Are other magnoliids in ornamental and landscape trades significant hosts for ***X. glabratus*** and ***R. lauricola***?
- Epidemiology of laurel wilt in agricultural and natural ecosystems?
- Efficacy of existing or proposed control measures?
- Economic impact and cost-effectiveness of control measures?
- How should laurel wilt be regulated, interdicted and managed?

Disease studies



Citra

300 trees moved overnight from Homestead in two 28’ moving vans, 17 and 18 May 2009

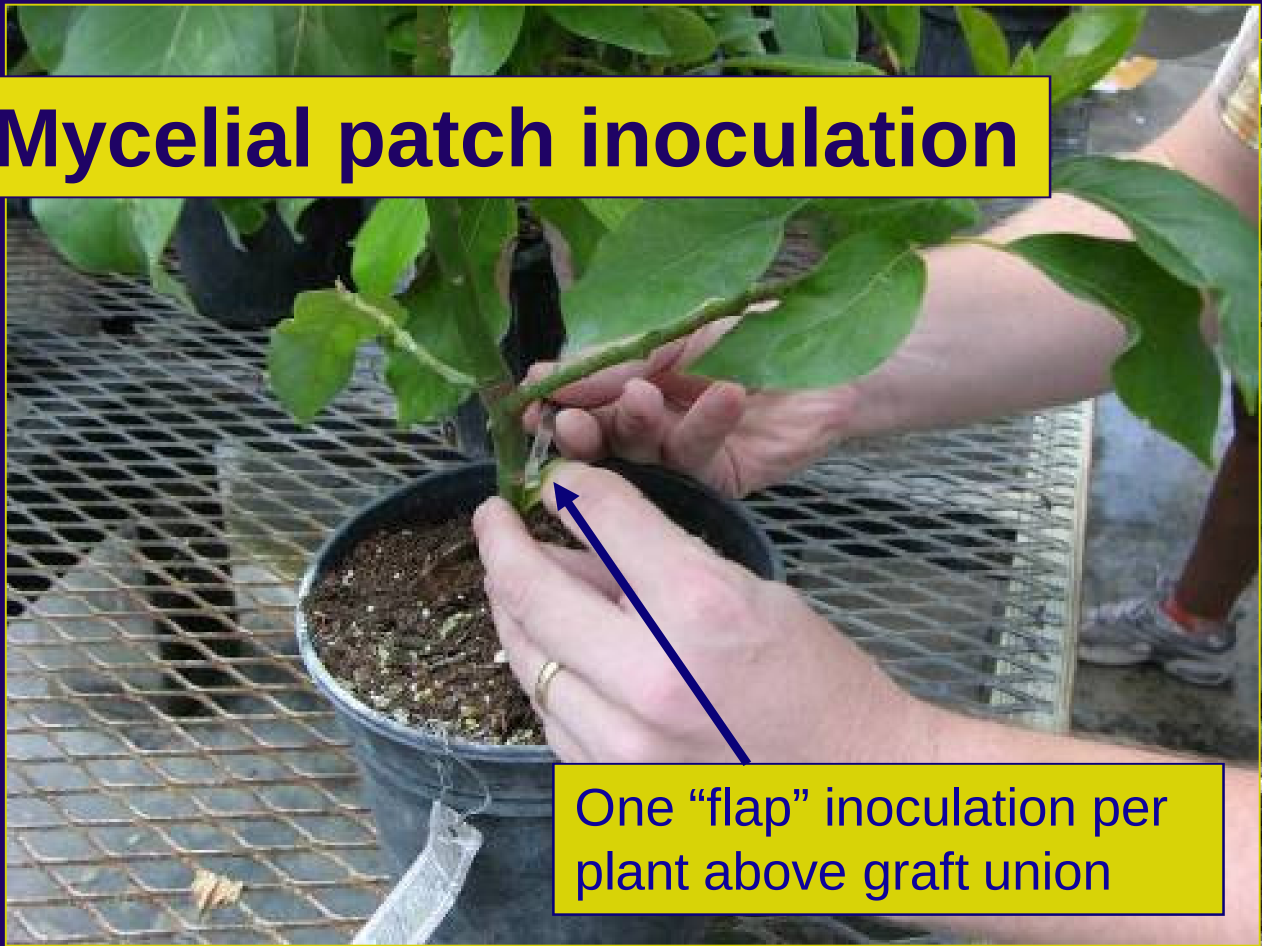
Planted 19 May

Inoculated 20 May

Artificial reproduction of disease

1. Inoculation method

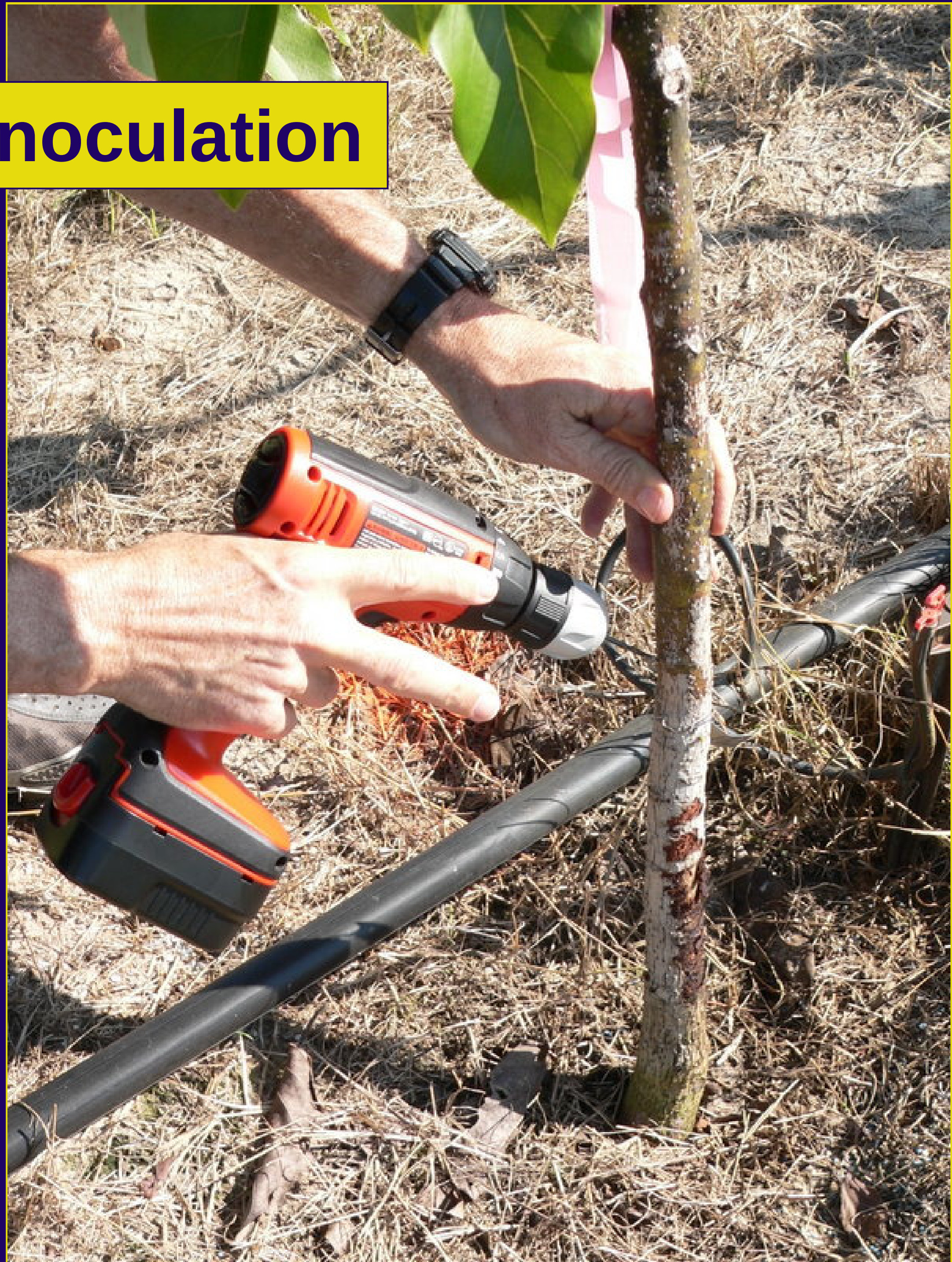
Mycelial patch inoculation



One “flap” inoculation per plant above graft union

…and wrapped with Parafilm

Conidial inoculation

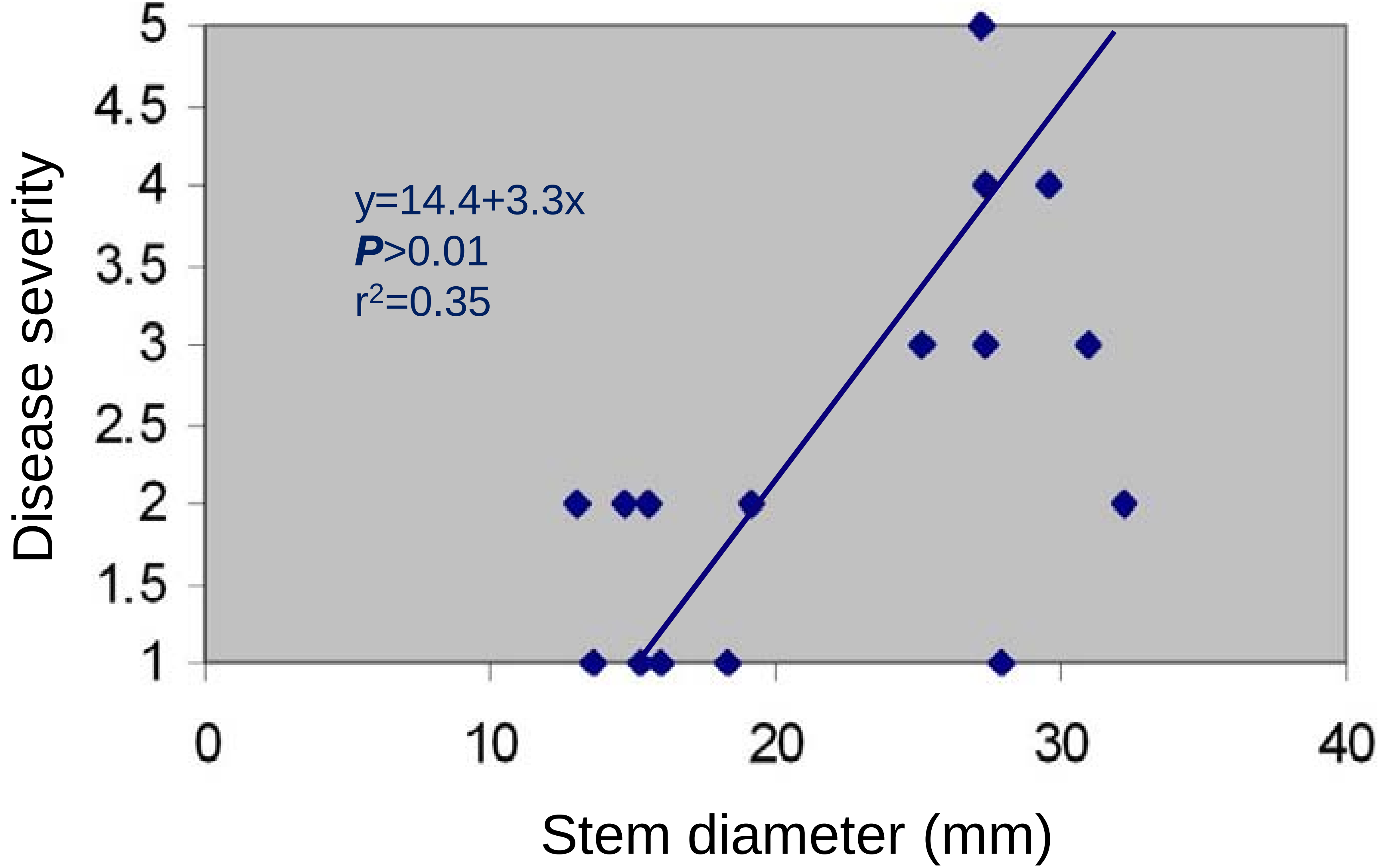


Artificial reproduction of disease

1. Inoculation method
2. Impact of plant size

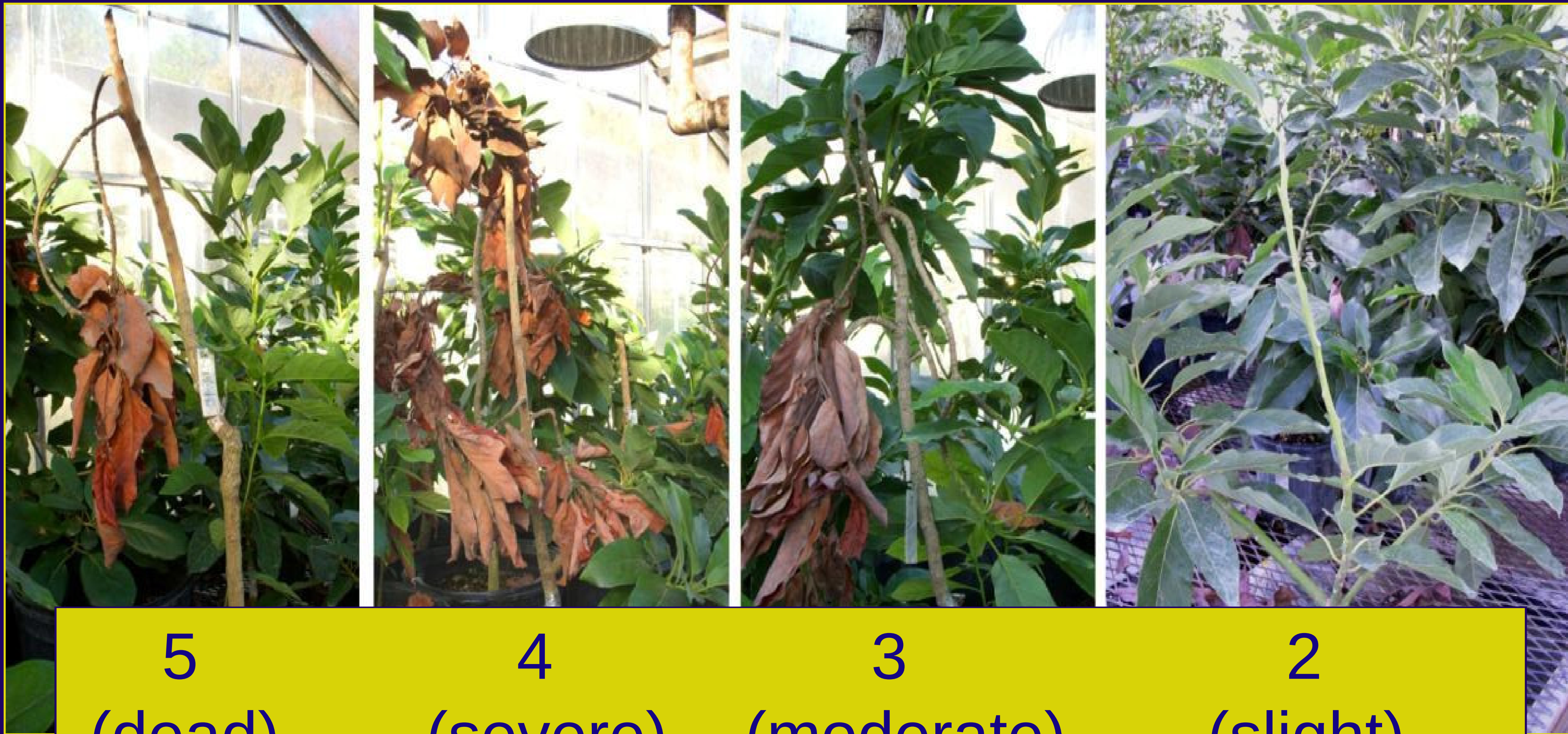
Plant size has great impact on disease development

'Simmonds'
3 gallon sm
3 gallon lg
7 gallon
15 gallon



y=14.4+3.3x
P>0.01
r2=0.35
Disease severity
5
4.5
4
3.5
3
2.5
2
1.5
1
0
10
20
30
40
Stem diameter (mm)

Subjective scale to rate severity



5 (dead) | 4 (severe) | 3 (moderate) | 2 (slight)

A 1-10 scale has been used in 2009

Citra

5 expts established, May 2009

1. Cultivar evaluation (22 cultivars)

Bacon	Day	*Miguel	+*Simmonds
Beta	*Donnie	*Monroe	Tonnage
*Bernecker	Ettinger	Pollack	Trapp
+*Brogdon	*Hall	+Reed	Waldin
*Catalina	*Hass	Russell	Winter Mexican
*Choquette	*Lula		

+ Tested in 2007

* Tested in 2008

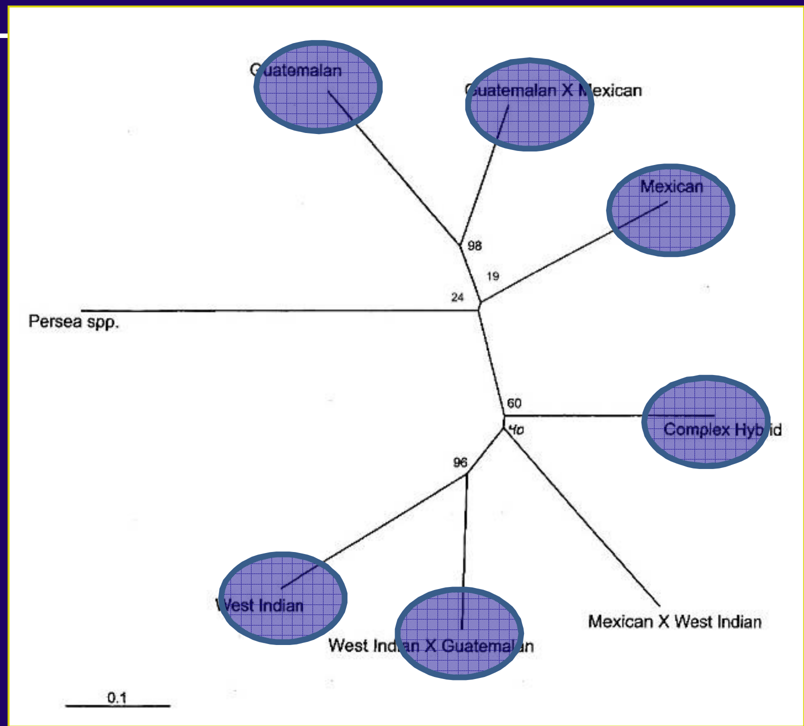


Table 2. Avocado cultivars in 2009 Citra experiments

Cultivars	Mean severity	Genome	Mean genome
Bacon	2.3 cd	M	2.3c
Ettinger	2.7 bcd	GxM	
Hass	4.4 abcd	GxM	3.1abc
Winter Mexican	2.0 d	GxM	
Reed	3.0 bcd	G	3.0bc
Brogdon	4.3 abcd	GxMxWI	4.3a
Choquette	2.8 bcd	GxWI	
Hall	5.0 abc	GxWI	
Lula	3.4 bcd	GxWI	
Miguel	3.7 bcd	GxWI	3.5ab
Beta	3.2 bcd	GxWI	
Monroe	3.2 bcd	GxWI	
Tonnage	3.3 bcd	GxWI	
Bernecker	4.3 abcd	WI	
Catalina	3.5 bcd	WI	
Day	3.2 bcd	WI	
Donnie	4.5 abcd	WI	
Pollack	3.2 bcd	WI	4.4a
Russell	5.0 abc	WI	
Simmonds	6.0 a	WI	
Trapp	4.8 abc	WI	
Waldin	5.2 ab	WI	

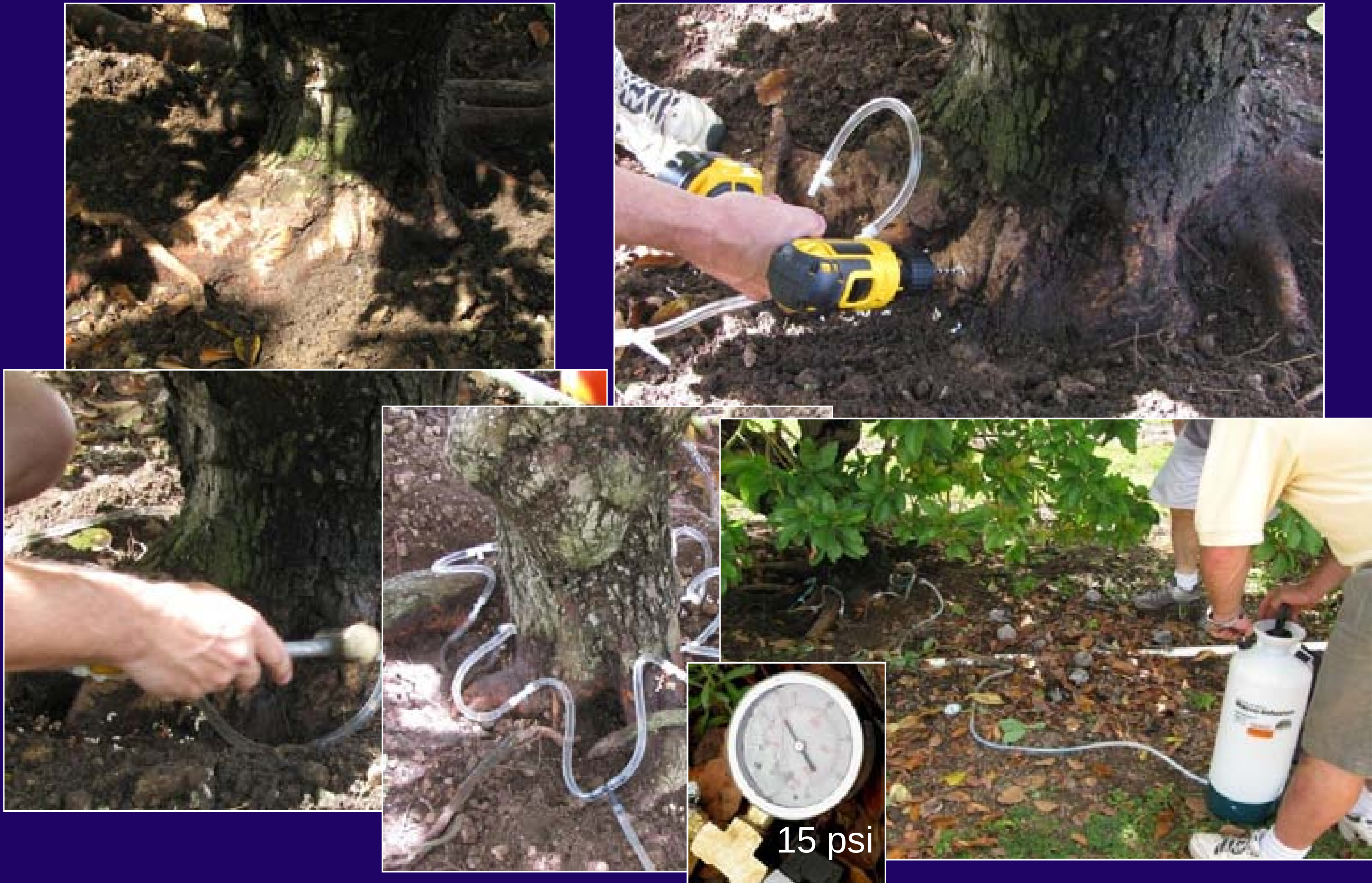
There are <u>many</u> things we do not know about laurel wilt

- Host range?
- Laurel-wilt resistant avocado?
- Identification and development of tolerant genotypes.
- Resistance mechanisms in avocado and other lauraceous hosts?
- Host x insect x fungus interactions?
- Host or other cues that attract insect?
- Conditions that influence insect's colonization of host plants, completion of life cycle, dissemination to healthy and infected trees (it is unlikely that materials infested with ***X. glabratus*** have not been shipped to ports other than Port Wentworth)
- Impact of California bay on development and spread of laurel wilt in California?
- Are other magnoliids in ornamental and landscape trades significant hosts for ***X. glabratus*** and ***R. lauricola***?
- Epidemiology of laurel wilt in agricultural and natural ecosystems?
- Efficacy of existing or proposed control measures?
- Economic impact and cost-effectiveness of control measures?
- How should laurel wilt be regulated, interdicted and managed?

In planta fungicide assays

- Fungicide application methods

Macro-infusion of fungicides



Macro-infusion of fungicides

Soil drench application

Chemjet microinjectors

Considerations

1. Time (15-30 min/tree prep time and 10 min–90 min for macroinfusion)

Considerations

1. Time
2. Tree size

- macroinfusion: only trees with flare roots
- other measures needed for small trees

Considerations

1. Time
2. Tree size
3. Expense – Fungicide and application devices, applicator time

Considerations

1. Time
2. Tree size
3. Expense
4. Efficacy? (work must be done on small trees at Citra)

1.

2.

3.

Arbotect 2/3x rate, 1 wk post-injection

5. Phytotoxicity

Arbotect 1x rate, 6 wks post-macroinfusion

Consideratio

1. Time consumin
2. Tree size
3. Expense
4. Efficacy?
5. Phytotoxicity
6. Fruit residues?

Conclusions

Much remains to be learned about the laurel wilt pathosystem, however…

Conclusions

- A previously unknown fungus, ***Raffaelea lauricola***, causes laurel wilt

Conclusions

- A previously unknown fungus, ***Raffaelea lauricola***, causes laurel wilt
- ***Raffaelea lauricola*** is a symbiont of the ambrosia beetle, ***Xyleborus glabratus***

Conclusions

- A previously unknown fungus, ***Raffaelea lauricola***, causes laurel wilt
- ***Raffaelea lauricola*** is a symbiont of the ambrosia beetle, ***Xyleborus glabratus***
- The laurel wilt pathosystem is unique: symbiont is pathogenic, and beetle attacks healthy trees

Conclusions

- A previously unknown fungus, ***Raffaelea lauricola***, causes laurel wilt
- ***Raffaelea lauricola*** is a symbiont of the ambrosia beetle, ***Xyleborus glabratus***
- The laurel wilt pathosystem is unique: symbiont is pathogenic, and beetle attacks healthy trees
- Host range of ***Raffaelea lauricola*** includes American members of the Lauraceae

Conclusions

- A previously unknown fungus, ***Raffaelea lauricola***, causes laurel wilt
- ***Raffaelea lauricola*** is a symbiont of the ambrosia beetle, ***Xyleborus glabratus***
- The laurel wilt pathosystem is unique: symbiont is pathogenic, and beetle attacks healthy trees
- Host range of ***Raffaelea lauricola*** includes American members of the Lauraceae
- Management: Holistic approach will likely be needed (resistance, fungicides and sanitation)

Thank you

- Avocados Australia and the New Zealand Avocado Growers Association
- The ANZAGC09 meeting organizers

For research support:

- Florida Avocado Committee
- University of Florida, IFAS Vice President
- Pine Island Nursery
- Zill High Performance Plants, Inc.
- USDA, T-STAR Special Grants
- Miami-Dade County Commission
- USDA-APHIS

For slides and information: Steve Fraedrich, Jim Hanula, Bud Mayfield, Jorge Pena, Bob Rabaglia, Jason Smith and Mike Thomas