Laurel Wilt: A Lethal Disease on Avocado and other Lauraceous Hosts

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Abstract

Laurel wilt is a new disease in the southeastern US. First recognized on Hilton Head Island in 2002, the disease has since spread to over 33 counties in Florida, Georgia and South Carolina (Fig. 1). By mid-2007, the disease had been found as far south as the Ft. Pierce area. It is only a matter of time until laurel wilt reaches southern Florida.

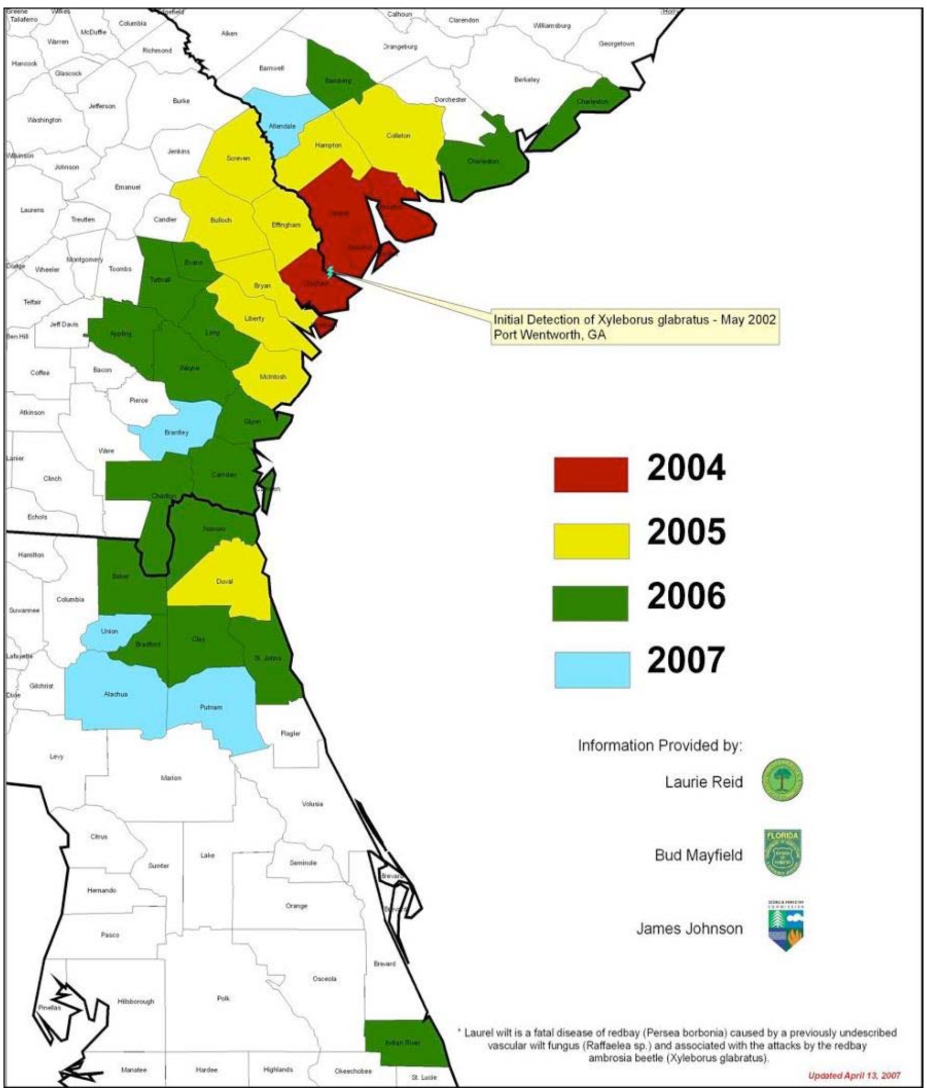

Figure 1. Distribution of laurel wilt, as of 13 April 2007. Note the disjunct distribution in Florida, due probably to the movement of infested red bay wood.

Laurel wilt is caused by a new species of fungus, provisionally named *Raffaelea laurelensis*, that is vectored by a nonnative ambrosia beetle, *Xyleborus glabratus*. The disease poses a serious threat to commercial avocado production in South Florida and valuable germplasm collections in the USDA-ARS national avocado germplasm repository in Miami. Extensive mortality has occurred on four native species in the Lauraceae, and experimentally on avocado, *Persea americana*; the first landscape avocado succumbed to laurel wilt in September, 2007. Over 100 ornamental plants in the Lauraceae that are grown in South Florida may be at risk, as are species that are significant components of Neotropical ecosystems.

Research at TREC focuses on understanding and mitigating the laurel wilt threat to avocado. Commercial cultivars are being screened to identify useful resistance for production in South Florida. Quantitative and qualitative responses of *P. americana* germplasm to the disease are being assessed to better understand the host:pathogen interaction and resistance and susceptibility. And vector behavior and attraction to volatiles that are produced by noninfected and infected host plants will be studied. Understanding these relationships will provide valuable insight into the disease's epidemiology, and could ultimately be most useful in combating the disease.

The Problem

Laurel wilt is caused by an ascomycete fungus, provisionally named *Raffaelea laurelensis* (Fig. 2). This asexual relative of the well-known genus of tree pathogens, *Ophiostoma*, is vectored by a nonnative ambrosia beetle, *Xyleborus glabratus* (Fig. 3). *X. glabratus* was known previously in Bangladesh, India, Japan, Myanmar and Taiwan on Asian members of the Lauraceae, but the fungus is new to science.

Figure 2. Isolates of *Raffaelea laurelensis* recovered from various locations in the southeastern US.

Figure 3. The Asian ambrosia beetle, *Xyleborus glabratus,* which vectors *Raffaelea laurelensis.* Note that the mycangia in which *R. laurelensis* is carried and multiplies are found immediately behind the insect's mandibles.

Significant aspects of the pathogen:vector:host plant interaction are not clear. It is presumed that *R. laurelensis* was introduced with *X. glabratus* when it was moved to the U.S., but there are no reports of laurel wilt in native laureaceous plants that the beetle infests in its Asian homeland. To date, all American members of the Lauraceae have been susceptible. Extensive mortality has occurred on four native species in the family in forest environments in the southeastern US. In particular, red bay, *P. borbonia*, has been decimated in much of its natural range (Fig. 4).

Figure 4. Red bay, *Persea borbonia*, is a significant component of forest ecosystems in the southeastern US. It has been decimated by laurel wilt as it moves through its range.

Whether American members of the Lauraceae are the only suscepts of this disease, the extent to which American and non-American members of this family are susceptible, and how the vector is attracted to healthy and diseased host trees are all unknown. There is an urgent need to answer these questions as laurel wilt spreads in Florida and the Americas.

Ambrosia beetles typically have symbiotic relationships with fungi that they carry in specialized compartments in their bodies, the mycangia. They attack dead and dying trees, their fungal symbionts colonize galleries that they bore in infested trees, and larvae of the beetles graze on lawns of the fungi that develop. The beetles benefit from the breakdown by the fungi of an indigestible food source, lignified cellulose, and the fungi benefit by being transported by the beetle to new trees/food sources. Healthy trees are not attacked in these interactions and the fungi are saprophytes. Thus, laurel wilt is exceptional in that the ambrosia beetle, *X. glabratus*, attacks healthy trees and the fungal symbiont, *R. laurelensis*, is an aggressive plant pathogen.

Prior to 2006, laurel wilt research focused on the disease's impact in native ecosystems in the southeastern US. During this work, the susceptibility of a commercial crop in the Lauraceae, avocado (*Persea americana*), was revealed. Subsequent work has shown that *X. glabratus* is attracted, and effectively vectors *R. laurelensis*, to healthy 'Donnie' avocado in the field, and 'Simmonds' and 'Monroe' in the greenhouse. In addition, plant size, isolate of *R. laurelensis*, and avocado genotype affect disease development in the greenhouse; after artificial inoculation, 'Brogdon' was highly, 'Simmonds' moderately, and 'Reed' slightly susceptible (Fig. 5). In September 2007, the first landscape avocado plant succumbed to the disease in Jacksonville (Fig. 6).

Figure 5. On 30 August 2007, avocado cultivars were inoculated with *Raffaelea laurelensis* in the Division of Plant Industry quarantine facility in Gainesville: (left) Patch inoculation, and (right) wilting and branch death in 'Simmonds' plants 20 days after inoculation.

Figure 6. (left) Landscape avocado in Jacksonville affected by laurel wilt, and (right) vascular discoloration associated with the disease (note exit site for the beetle vector).

The epidemiology of laurel wilt is poorly understood. How the beetle vector locates and interacts with host trees is not known. Ambrosia beetles find suitable host trees by orienting to host and fungus volatiles, as well as aggregation pheromones. Volatiles from diverse taxa of *Persea* have been identified, but we are not aware of work with healthy and diseased *Persea.* Work is needed to determine whether there are qualitative differences among the volatiles that are produced by diseased and healthy trees, as these might be useful in managing laurel wilt.

Results on red bay, *P. borbonia*, suggest that a single feeding/probing event by a contaminated *X. glabratus* female is sufficient for infection to occur; however, this may not be the case in avocado. During recent work, single patch inoculations healed without apparent impact on some plants, and some plants that were challenged with presumably infested *X. glabratus* were also not affected. To what extent these responses resulted from low levels of the pathogen in ininoculated and infested plants is not clear. Since ambrosia beetles are attracted more to infested/diseased trees than to healthy trees, it is probable that avocado would be exposed to increasing numbers of *X. glabratus* and, thus, levels of *R. laurelensis* inoculum during at least the initial history of such an interaction. Understanding this aspect of the pathogen:host interaction is relevant to predicting the performance of different cultivars in the field, as those that resist single inoculations might succumb to repeated attacks by the beetle and fungus.

What is being done

Resistance to laurel wilt. There are three botanical races of *P. americana*, Guatemalan, Mexican and West Indian. Avocado cultivars are pure representatives of the races or hybrids thereof. Although commercial cultivars are genetically diverse (there are well over 200 unique accessions in the USDA-ARS national repository in Miami), the most important clones in South Florida are fairly narrowly defined; most have West Indian pedigrees.

In field studies in northern Florida, we will determine whether useful resistance exists among the major commercial cultivars that are grown in South Florida. Additional work will examine response in a diverse set of *P. americana* germplasm, as it may ultimately be necessary to consider a wider range of genotypes if avocado is to be produced in areas affected by this disease.

Vector behavior and attraction. The behavioral responses of *X. glabratus* to induced host plant volatiles will be investigated in: i) noninfested host plants, ii) *X. glabratus*-infested host plants and iii) host plants infected with *R. laurelensis*. Volatiles from noninfested, *X. glabratus*-infested, and *R. laurelensis*-infected whole plants of *P. borbonia* and *P. americana* will be collected and analyzed by gas chromatography and mass spectroscopy. Collected volatiles will also be analyzed to identify compounds that elicit an antennal electrophysiological response from *X. glabratus*. (i.e., compounds to which the beetle vector is hard-wired to respond).

Compounds that are identified in laboratory assays will be synthesized and tested as attractants for adult *X. glabratus*. Captures will be compared on baited versus nonbaited traps, and the captured adults will be counted and sexed (only female *X. glabratus* are mobile and vector the pathogen). Traps treated with volatile attractants will be assessed for potential monitoring or attract and kill techniques of the beetle in the field.

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WARNING: Red bay has been used as a preferred barbeque fuel, due to its aromatic smoke. DO NOT transport red bay wood for this purpose, as this is an efficient means by which the laurel wilt pathogen and vector are disseminated.