



Tropical Research and Education Center  
18905 SW 280 St.  
Homestead, FL 33031  
Tel: 305-246-7001  
Website: <http://trec.ifas.ufl.edu>



Miami-Dade County Extension  
18710 SW 288 St.  
Homestead, FL 33030  
Tel: 305-248-3311  
Website: <http://miami-dade.ifas.ufl.edu/>

## Recommendations for Ambrosia Beetle and Laurel Wilt Pathogen Control in Commercial Groves

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Jonathan H. Crane, Tropical Fruit Crop Specialist<sup>1</sup>, Daniel Carrillo, Entomologist – Tropical Fruits<sup>1</sup>, Randy C. Ploetz, Plant Pathologist – Tropical Fruits<sup>1</sup>, Edward A. Evans, Agricultural Economist<sup>1</sup>, and Jeff Wasielewski, Commercial Tropical Fruit Crops Extension Agent<sup>2</sup>; <sup>1</sup>UF/IFAS, TREC, Homestead, FL and <sup>2</sup>Miami-Dade County Extension-UF/IFAS, Homestead, FL

The research on the management of the laurel wilt pathogen and several ambrosia beetle vectors is on-going, therefore, recommendations for mitigation and control may periodically change. Currently, the industry has implemented a detection and suppression program with the goal of depressing the ambrosia beetle population and limiting the incidence of laurel wilt in commercial groves.

In order to manage laurel wilt (LW), suppression of the LW pathogen (the fungus *Raffaelea lauricola*) and the ambrosia beetle vectors is necessary. This document describes the current recommendations and options to control ambrosia beetles and prevent of the spread of the laurel wilt pathogen among avocado trees.

If you have trees symptomatic for laurel wilt please contact Don Pybas, LW Coordinator, (305-247-0848) or Jeff Wasielewski, Commercial Tropical Fruit Crops Agent, (305-248-3311, ext. 227, [jwasielewski@ufl.edu](mailto:jwasielewski@ufl.edu)) for more information.

### Current early detection

A helicopter survey implemented by the Avocado Administrative Committee has proved important in alerting the industry and growers to new areas of potential LW infestation. However, frequent ground scouting of groves is also necessary to locate LW affected avocado trees.

In groves in which LW has not been previously diagnosed or where a new suspect tree is many rows from a previously affected tree or area, a sample of the sapwood may be taken for laboratory analysis and disease confirmation (please reference the “Sampling for Laurel Wilt” handout).

In groves where LW has been verified in one or more avocado trees, further sampling of LW symptomatic trees may be unnecessary (i.e., it may be assumed they have LW). **Trees in severe decline, regardless of the cause, should be removed and destroyed immediately to halt**

## **reproduction of ambrosia beetles in the wood and to remove a likely source of future ambrosia beetle reproduction.**

### **Disease symptoms of laurel wilt**

Early symptoms of LW are green wilted leaves in sections of the canopy. These symptoms are particularly suspect if the symptomatic tree is located next to or near a completely desiccated, declining or dead tree. LW symptoms also include brown, desiccated (dead) leaves that cling to the tree stems and may not drop for up to 12 months. Subsequent symptoms include stem and limb dieback and underneath the bark, the sapwood may have dark blueish-black streaks. Trunks and/or limbs may have numerous small diameter holes with sawdust tubes (toothpick-like protrusions from the bark), and/or sawdust clinging to the bark which is evidence of ambrosia beetle activity (i.e., boring into the tree).

Some visual symptoms of laurel wilt are similar to trees affected by phytophthora root rot, flooding, lightning strike, and freeze damage (Table 1). However, some pre-existing or existing environmental factors (e.g., flooding and freezing) may help separate the weather related tree decline from LW tree decline. If in doubt, take a LW sample.

## **Specific recommendations for groves with laurel wilt affected trees**

### **Sanitation: rapid tree removal and its importance**

A major component of LW control is to remove and destroy LW affected and ambrosia beetle infested trees as soon as it is apparent that they have LW. Do not hesitate to remove and destroy a wilted tree – waiting to see if more of the tree canopy develops symptoms or turns brown allows time for the pathogen to spread to adjacent trees through their connected root systems. This in turn reduces the chances that infusion or injection of adjacent healthy trees with fungicide and/or trenching to sever roots among trees will be successful in stopping the spread of the disease.

Rapid tree removal and destruction including some type of root severing (via trenching or removal of the entire stump) is recommended: 1) because the LW pathogen is capable of moving quickly from an infected avocado tree to adjacent healthy avocado trees through root-grafts; 2) to eliminate infected ambrosia beetles residing in the tree; and 3) because wood and stumps of dead or declining avocado trees are attractive to ambrosia beetles.

Trees affected by LW may harbor the laurel wilt pathogen for many months, and the declining tree attracts hundreds, maybe thousands of ambrosia beetles. If these ambrosia beetles come into contact with the laurel wilt pathogen inside the tree, the beetles and their offspring may be contaminated with and spread the fungus to more trees and groves. Therefore, proper destruction of LW affected trees is an important component for reducing the spread of this disease.

### **Steps for properly removing LW affected trees**

1. Remove the entire tree by pulling or pushing. Pushing trees over before cutting is easier than trying to dig or uproot stumps from the ground.
2. Once the tree has been removed, it should be chipped or burned. Preferably wood too large to chip should be split and then burned. Call FDACS-Div. of Forestry at 305-257-0875 or 954-475-4120 for permission to burn (burn permit). Removing only the top portion of the tree while leaving stumps in-place will not control ambrosia beetles or their reproduction inside the tree and since the pathogen survives in the intact stump pathogen contaminated beetles may be produced; therefore, it is highly recommended that all affected trees and stumps are destroyed (i.e., chipped and/or burned). Wood cut into smaller pieces will burn faster and more completely. The large wood may need to be burned more than one time (restack to expose non-burned wood) in order to be destroyed.

3. Treating the tree stump (or stumps) with insecticides does not prevent the emergence of ambrosia beetles, which are already inside the tree and after a few days does not prevent further ambrosia beetle infestation. Thus, the best method to prevent beetle emergence from this wood and new boring into the wood is to dispose of the wood by chipping and/or burning.
4. Wood chips should be spread out, not mounded, and thoroughly sprayed twice, 7-days apart, with an approved insecticide (e.g., Malathion, Danitol or Hero), plus adjuvant (i.e., NuFilm, Vapor Gard or Pentrabark). Some biopesticides (e.g., BotaniGard) have also been shown to kill ambrosia beetles as well. Avocado groves under organic production should chip and burn all wood (including the chips).
  - **Ambrosia beetles are attracted to avocado wood chips and leaving them untreated or not burned results in increased activity of ambrosia beetles in the grove.**
5. Continue to monitor trees in the grove frequently for LW development; watch for wilting of adjacent trees, which may indicate root-graft movement of the pathogen. Destroying trees as early in the stages of decline as possible will improve suppression of the disease and help stop insect spread.

### **Insecticide applications in the immediate area (1 acre) surrounding LW positive avocado trees**

Ambrosia beetles are most likely to be found in three locations in a grove: (a) inside infested trees, (b) on tree surfaces, or (c) in the air. The largest portion of the ambrosia beetle population is found inside infested trees. Contact insecticides have not been shown to prevent ambrosia beetle emergence from already infested trees or wood and only a few contact insecticides have been found to provide good control of ambrosia beetles on wood surfaces (Table 2).

Chipping and burning wood can eliminate ambrosia beetles inside tree stumps and wood and stop their reproduction. However, to kill ambrosia beetles on tree surfaces, applications of contact insecticides and/or biopesticides to about one acre of trees surrounding the infected tree are recommended to help control or prevent further beetle movement in the grove. After removing LW affected trees, two applications of insecticide directed to the trunk and medium to large wood (not the foliage) should be made at a 10-15-day interval. Malathion, Danitol and Epi-mek are registered for bearing avocado trees. In order to reduce the chances of beetle resistance these products should be rotated (Table 2). Use an adjuvant such as NuFilm to prolong the efficacy of the insecticide. Using Vapor Gard and Pentrabark adjuvants may cause phytotoxicity on leaves. For non-bearing avocado trees, Talstar-S and Hero may be applied (Table 2); use an adjuvant to prolong the efficacy. The biopesticides BotaniGard and Mycotrol are also registered for avocado and have been shown to control some ambrosia beetle species.

### **Options for preventing spread of LW by root grafts among adjacent trees**

#### **Spot treat with systemic fungicide**

At present there are no fungicides that cure LW affected trees. However, the systemic fungicide Tilt® (propiconazole) can be used prophylactically to help prevent LW. In order for the fungicide to protect the tree, it must be inside the tree prior to inoculation with the disease.

Infusion and injection are techniques used to place Tilt® inside trees. Recent research indicates infusion to be a more effective method than injection. However, injection of Tilt® is being used by some producers and it appears the diffusion of fungicide throughout the tree is slow and the re-treatment interval shortened using this method.

There are two options for treating a grove with Tilt®: 1) treat the entire grove prophylactically, before a LW infests any trees in the grove or 2) implement a spot treatment which is to infuse two to three healthy trees that are adjacent to diseased trees (Fig. 1A). The key to the fungicide treatment is

early detection of trees with symptoms of LW, the immediate destruction of any diseased trees, and immediate treatment with Tilt® fungicide to the healthy trees adjacent to the laurel wilt affected tree.

Currently there are two systems for infusing avocado trees with Tilt® (propiconazole) fungicide: passive and pressurized. You must follow the Tilt® label instructions and we suggest you see additional handout information on how to construct and use passive and pressure infusion systems. Infusion with Tilt® has been shown to protect avocado trees from laurel wilt from 8 to 18 months. Currently, Tilt® is the only labeled fungicide approved for laurel wilt control on avocado trees. Tilt® can only be used commercially and is not approved for use by homeowners in their landscapes.

### **Trenching to isolate LW affected trees**

In some groves where spot treatment with fungicides has not been entirely successful, trenching a perimeter between healthy and potentially LW affected trees has been tried. However, like spot treatments with infusion, early detection of LW and implementation of sanitation procedures along with the trenching increase chances for limiting the root-graft spread of LW among adjacent trees.

To isolate the LW affected tree, dig a perimeter trench that surrounds 2 to 3 healthy trees in all directions from the LW affected tree or area (Fig. 1A). In order to sever the roots among avocado trees, the trench must reach the limestone bedrock layer. Generally, a trench 6 to 8 inches deep will sever tree roots between trees in-row and between-row areas of the plow layer but the trench needs to be 18 to 24 inches deep where cross trenches correspond to the row and tree spacing (Fig. 1B). Rooting among trees in irrigation trenches also need to be severed; however, this results in the need for costly irrigation repair.

### **Frequently Asked Questions**

1. How long does it take to infuse a tree with Tilt®? Experience has shown infusion may take between 20 minutes and in excess of 24 hours per tree; however, infusion rates depend primarily upon the transpiration rate (natural water loss rate through plant leaves) of the avocado trees, as well as, current weather conditions, and tree water status.

In general, trees that have recently received substantial water from rainfall and/or irrigation are in a physiological state capable of rapid transpiration and can absorb the fungicide relatively quickly. However, trees that have recently experienced drought (within the past few days) or are under drought stress may have a low transpiration rate and take much longer to absorb the fungicide. The potential rate of transpiration generally increases with increasing temperature and decreasing relative humidity. The potential transpiration generally decreases during cool weather and/or high relative humidity. Rootstock can also affect the rate of transpiration and avocado trees in Florida are commonly grafted onto seedling rootstocks; therefore, there is a potential for trees to transpire at different rates due to differences in genetics and water conducting anatomy among seedling rootstocks.

2. Does injecting, rather than infusing, trees with Tilt® protect avocado trees? There is evidence infusion is superior to injecting trees with Tilt®, however, a number of groves injected with Tilt® prior to and after LW infestation have remained LW free. It also appears diffusion of Tilt® fungicide throughout the tree is slow and the re-treatment interval shortened using injection.

3. When is a tree positive for LW? A tree is positive for LW when a proper xylem wood sample has been taken and submitted to either UF/IFAS TREC Diagnostic Lab (Homestead) or FDACS-Division of Plant Industry Lab (Gainesville) and determined through laboratory testing to be positive for the pathogen (*Raffaelea lauricola*) that causes LW. Local growers may want to use the Diagnostic Lab located at UF/IFAS TREC in Homestead since it is close by and results are obtained within 10 working days. Note: False negatives may occur because: (a) the amount of LW pathogen in a tree may be very small and unevenly distributed within the tree, (b) the wood sample may be taken improperly, and/or (c) the wood sample may miss the location where the pathogen is present.

4. When is an avocado grove positive for LW? A grove is positive for LW when one or more avocado trees have tested positive for the pathogen causing LW.

5. Does every tree in a grove that shows symptoms of LW have to be laboratory-tested to be assumed positive for LW? No, not every symptomatic tree must be laboratory tested for it to be assumed infected with the LW pathogen. The LW pathogen is capable of moving from a LW infected avocado tree to adjacent avocado trees via root grafting. If one tree in the grove is confirmed as having LW, adjacent or nearby trees showing wilt, leaf desiccation, and tree die-back probably have LW. This is especially true if the grove has little to no history of phytophthora root rot or other pathogen induced decline and has not been recently flooded. We suggest that a newly LW symptomatic tree five or more rows away from a documented LW positive tree may warrant LW testing and documentation.

Table 1. Other potential causes of tree decline. Trees in decline from any cause may attract ambrosia beetles carrying the laurel wilt pathogen.

Potential cause of tree decline	Environmental conditions <sup>z</sup>	Symptoms	Comments
<i>Phytophthora cinamomi</i> (phytophthora root rot)	Flooding or frequent (persistent) soil saturation. Poor soil drainage. Low-lying area prone to wet/saturated soil conditions. Recent tropical storms (i.e., high rainfall).	<ul style="list-style-type: none"> <li>• Leaf wilting (may or may not be sudden)</li> <li>• Leaves may remain on the shoots although in some cases there is rapid leaf drop</li> <li>• Leaf desiccation/browning</li> <li>• Stem dieback</li> <li>• Progressive tree dieback</li> <li>• Necrotic fibrous root system</li> <li>• Tree decline and death</li> </ul>	Some groves have areas within the grove with a known history of Phytophthora root rot problems. May spread to adjacent trees with similar soil conditions. Trees attacked by wood boring beetles.
Lightning	Most common during spring/summer and early fall (i.e., the rainy season)	<ul style="list-style-type: none"> <li>• Leaf wilting</li> <li>• Leaf desiccation/browning</li> <li>• Leaves may remain on the shoots although in some cases there is a sudden pronounced leaf drop.</li> <li>• Sudden stem, limb and/or trunk dieback</li> <li>• Scorching of limbs and/or trunk</li> <li>• Tree decline and death</li> </ul>	Typically trees adjacent to the affected tree have terminal shoots in the tops of the trees that are dead (with desiccated brown leaves). Trees attacked by wood boring beetles.
Freezing	Historically, may occur from mid-Nov. through first week of March	<ul style="list-style-type: none"> <li>• Water soaking of leaves (mottled, dark green color)</li> <li>• Leaf desiccation/ browning</li> <li>• Leaves may remain on the stems but eventually fall off</li> <li>• Sudden stem, limb and/or trunk dieback</li> <li>• Tree decline and death</li> </ul>	Typically, entire areas within the agricultural area are affected similarly although there are micro-climates (e.g., low lying areas, "cold spots") that may experience more frequent or severe cold temperatures than others. Trees may be attacked by wood boring beetles

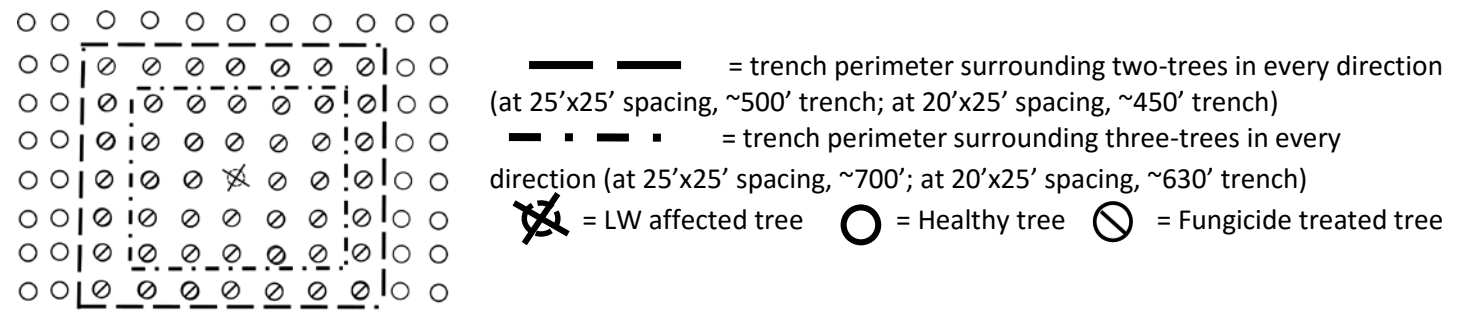
<sup>z</sup> Environmental conditions with respect to south Miami-Dade County.

Table 2. Contact insecticides for ambrosia beetle control. Applications should be directed to the trunk and medium to large wood to about one acre of trees surrounding the infected tree. Rotate pesticides products reduce the potential for insect resistance. Mix the chemical insecticides (Danitol, Malathion and Hero) with an adjuvant (e.g., NuFilm) to prolong its efficacy. The biological control insecticides BotaniGard ES and Mycotrol do not need an adjuvant and should be stored in a cool (<85°F), dry place.

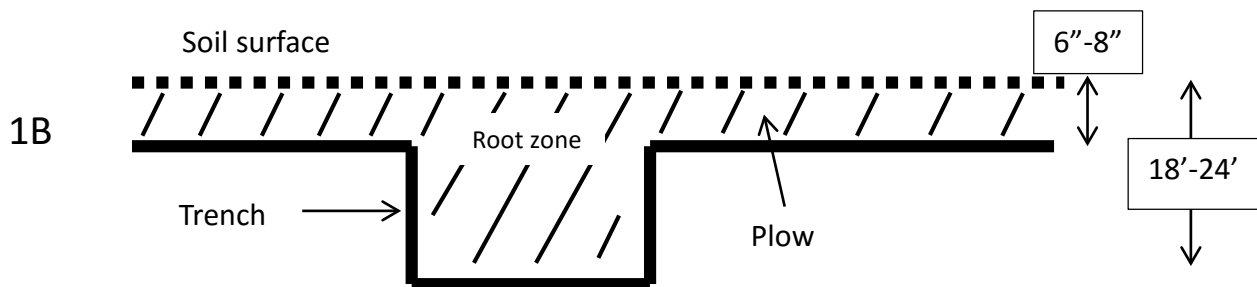
Product	Rate per acre	Spray interval	Potential # of applications allowed per year per acre	Comments – estimated days of efficacy <sup>z</sup>
Danitol 2.4 EC (fenpropathrin)	21.3 oz	14	1	14-21
Malathion 5EC (malathion)	24 oz/100 gallons	7-10	Open	10-14
Hero (liquid) <sup>y</sup> (zeta-cypermethrin+ bifenthrin)	10.3	14	6	14-21 ( <b>non-bearing trees only</b> <sup>xy</sup> )
Epi-mek 0.15EC (abamectin)	20 oz	30	2	Not known
Talstar S (bifenthrin)	40 oz	NA	1	Not known; <b>non-bearing trees only</b> <sup>y</sup> ; may not need adjuvant
BotaniGard ES ( <i>Beauvaria bassiana</i> )	32 oz	7-14	Open	Not known
Mycotrol-O ( <i>Beauvaria bassiana</i> )	32 oz	7-14	Open	Not known; organic production

x, Special Local Need (SLN Section 24C): y, Only for non-bearing trees; do not apply within 1 year of harvest. z, The estimated days of efficacy is influenced by numerous factors including weather conditions (e.g., rainfall, temperature, and UV light intensity).

### Spot Treatment and Trenching



**Fig. 1A.** Two- and three-tree fungicide spot treatment boundaries and/or trenching perimeter for severing tree roots among healthy and laurel wilt affected trees.



**Fig. 1B.** Diagram of root zone between trenches and in the cross trenches where roots must be severed among healthy and laurel wilt affected trees.

(c://tree destruct and LW control recommendations 3-18-16.doc)