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Recommendations for Ambrosia Beetle and Laurel Wilt Pathogen Control

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Since the research on the management of the laurel wilt pathogen and several ambrosia beetle vectors is on-going recommendations for mitigation and control periodically change. Currently, the industry has implemented a detection and suppression program with the goal of depressing the ambrosia beetle population and 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) for more information.

Current early detection

Frequent scouting of groves is necessary to locate LW affected avocado trees. LW may be detected by grove owners, managers, and their staff, as well as, through periodic helicopter surveys implemented by the Avocado Administrative Committee.

Early symptoms of LW are green wilted canopies which 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 and do 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 beetles 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 cause of the tree decline and provide growers/operators some guidance in ascertaining whether their tree or trees are infected with LW. If in doubt, take a LW sample.

If you find a tree you suspect has LW

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 should be taken for laboratory analysis and disease confirmation (please reference the "Sampling for Laurel Wilt" handout).

After LW in one or more avocado trees in a grove has been verified, 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.**

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 thy have LW. Rapid tree removal 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 can be contaminated with and spread the fungus to more trees and groves. In addition, leaving intact LW affected trees allows the fungus to spread to nearby trees through root grafting. 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. **Removing the entire tree immediately upon detection may reduce root-graft movement of the laurel wilt pathogen to adjacent trees. If removal is delayed, the disease may move to adjacent trees.**
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 and the pathogen survives in the intact stump; 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 severely char all sides of the wood to at least a 2" to 3" depth.

3. Treating the tree stump (or stumps) with insecticides does not prevent 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 a chemical insecticide (e.g., Malathion, Danitol or Hero), plus adjuvant (i.e., NuFilm, Vapor Gard or Pentrabark). Some biopesticides (e.g., BotaniGard) have also shown promise as detrimental to ambrosia beetles. 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 bringing in large numbers of additional ambrosia beetles to 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. Ambrosia beetles are attracted to trees declining from disease and harsh environmental conditions (e.g., lightning strike, flooding, drought, freeze-damage, etc.) (Table 1). Grove owners and managers should consider removing any severely declining tree and chipping or burning dead wood from their groves using the techniques described above. This will reduce ambrosia beetle habitat and potentially limit ambrosia beetle population build up.

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 outside of the tree stumps and wood, applications of contact insecticides and/or biopesticides are recommended to help control or prevent further beetle movement in the grove. Two foliar applications at a 10-15 day interval should be made. These applications should be directed to the trunk and medium to large wood and not the foliage. In order to reduce the chances of beetle resistance, Malathion and Danitol insecticides (Table 2) should be rotated. Use an adjuvant such as NuFilm to prolong the efficacy of the insecticide. We do not recommend using Vapor Gard and Pentrabark for foliar applications because of potential phytotoxicity.

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 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 investigations are underway to determine if this method is as efficacious as infusion under some circumstances.

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) use 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. Additional research is underway to test new fungicides and alternative application methods and strategies.

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 (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).

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 the seedling rootstocks used.

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. If a recent grant proposal is funded monitoring these groves over the next two years may provide further insights into the efficacy of Tilt® injections for control of LW.

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 (*Raffealea 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.

Camera (spectral) and canine early detection

Spectral early detection of laurel wilt: The research into detection of laurel wilt affected trees before visual symptoms, such as, wilting or desiccated leaves appear using cameras outfitted with specific light-filtering lenses (i.e., multi-spectral cameras) looks promising, but is not currently ready for commercial application.

Canine detection: The canine detection of avocado trees non-symptomatic for LW looks very promising in those groves where avocado tree chips have been removed or burned but may not be ready for commercial application. Groves where avocado trees have recently been chipped tend to overwhelm the sensory perception of the canines. Therefore, growers who desire canine detection of non-symptomatic but laurel wilt affected trees, should either remove the chips present in the grove (perhaps by burning) or remove and/or burn any further wood chip production so as not to interfere with the canine's ability to detect non-symptomatic LW affected trees.

Current helicopter surveys

The helicopter survey implemented by the Avocado Administrative Committee has proved important to alerting the industry and growers to new areas of potential LW infestation and provided the industry, researchers and regulatory people the overview needed to document the extent of this insect-disease complex. Without this background information, regulatory, legislative and researchers do not have the information needed to base potential action on county, state, or federal regulatory assistance (e.g., cost-share programs, ag-exemption status, etc.) and legislative action to fund industry assistance programs (e.g., cost-share programs, tree removal and replanting, etc.) and research.

Table 1. Environmental conditions and symptom descriptions for trees infected with the pathogens causing laurel wilt and phytophthora root rot or affected by lightning, flooding, and freezing weather conditions.

Potential cause of tree decline	Environmental conditions[z]	Symptoms	Comments
Raffaelea lauricola (laurel wilt)	Not known if environmental conditions affect the prevalence of pathogen or rate of progress of LW symptoms. Appears the activity of the ambrosia beetles is affected by environmental conditions.	• Leaf wilting (tends to be sudden) • Leaves may remain on the shoots for up to about 6 months or more • Leaf desiccation/browning (to dark bluish green) • Stem dieback • Progressive tree dieback • Dark brown, black or bluish-black streaks in sapwood • Tree decline and death	From the available data, peak activity of the ambrosia beetles in south Miami-Dade County occurs during the spring/summer. Trees attacked by wood boring beetles.[y]
Phytophthora cinamomi (phytophthora root rot)	Flooding or frequent (continual) soil saturation. Poor soil drainage. Low-lying area prone to wet/saturated soil conditions. Recent tropical storms (i.e., high rainfall).	• Leaf wilting (may or may not be sudden) • Leaves may remain on the shoots although in some cases there is leaf drop • Leaf desiccation/browning • Stem dieback • Progressive tree dieback • Necrotic fibrous root system • Tree decline and death	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)	• Leaf wilting • Leaf desiccation/browning • Leaves may remain on the shoots although in some cases there is a sudden pronounced leaf drop. • Sudden stem, limb and/or trunk dieback • Scorching of limbs and/or trunk • Tree decline and death	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	• Water soaking of leaves (mottled, dark green color) • Leaf desiccation/ browning • Leaves may remain on the stems but eventually fall off • Sudden stem, limb and/or trunk dieback • Tree decline and death	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

y, Recently determined up to nine different ambrosia beetles may be contaminated with laurel wilt spores; two species of ambrosia beetles have been found experimentally capable of transmitting laurel wilt to avocado plants under controlled conditions; appears they can successfully inoculate avocado trees under grove conditions.
z, Environmental conditions with respect to south Miami-Dade County.

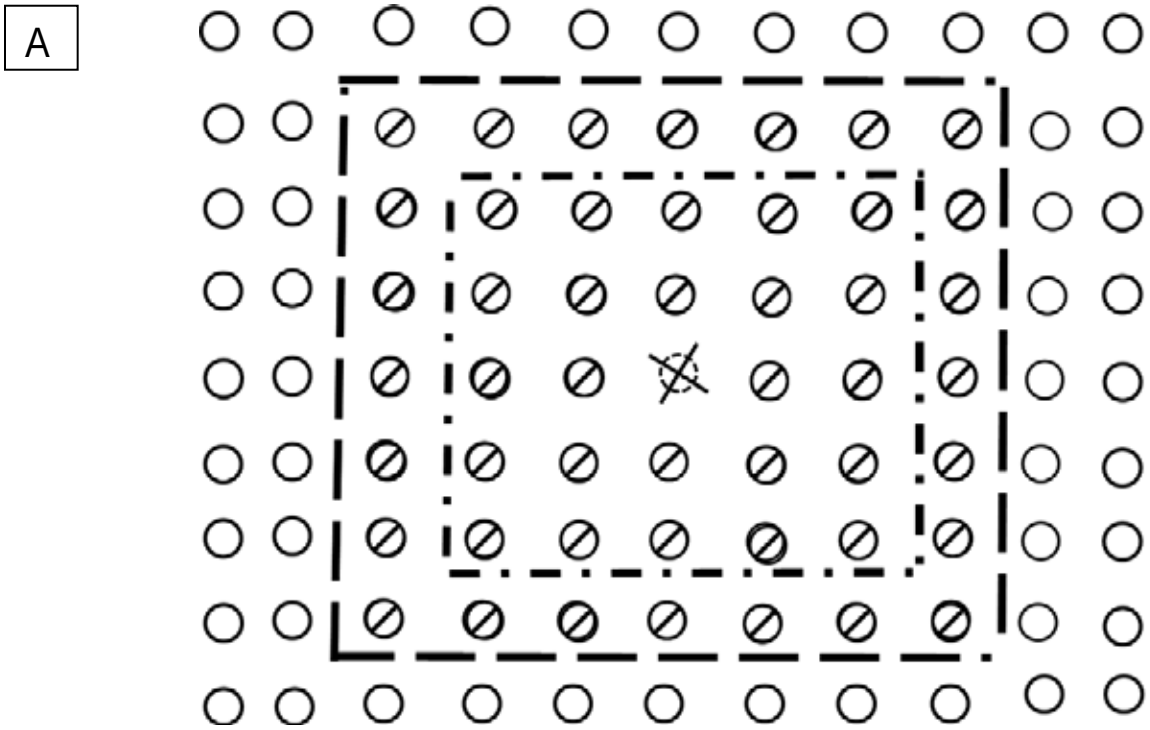
Table 2. Contact insecticides for ambrosia beetle control. Rotate pesticides products reduce the potential for insect resistance. Mix the chemical insecticides (Danitol and Malathion) with an adjuvant (e.g., NuFilm) to prolong its efficacy. Store BotaniGard ES and Mycotrol in a cool (<85°F), dry place.

Product	Rate per acre	Spray interval	Potential # of applications allowed per year per acre	Comments – estimated days of efficacy[z]
Danitol 2.4 EC, foliar	21.3 oz	14	1	14-21
Malathion 5EC, foliar	72 oz	7-10	Open	10-14
Hero (liquid), soil, foliar[y]	10.3	14	6	14-21 (non-bearing trees only)
BotaniGard ES, foliar	32 oz	7-14	Open	Not known
Mycotrol-O	32 oz	7-14	Open	Organic production; not known

y, Special Local Need (SLN Section 24C): 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).

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

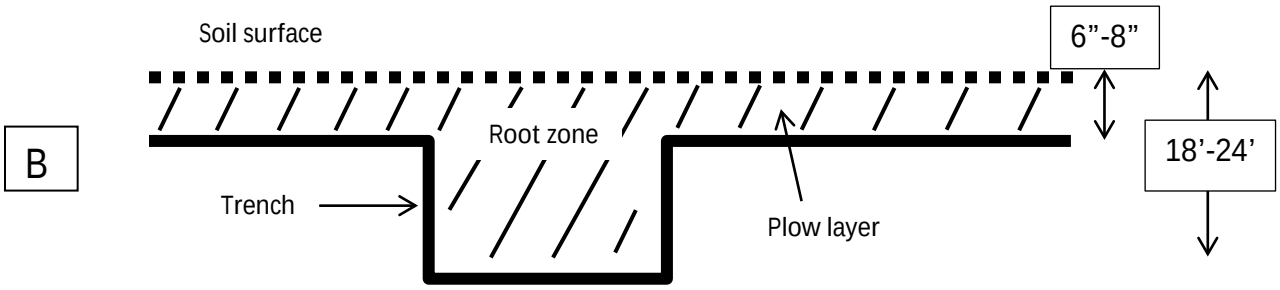


= trench perimeter surrounding two-trees in every direction (at 25'x25' spacing, ~500' trench; at 20'x25' spacing, ~450' trench)

= trench perimeter surrounding three-trees in every direction (at 25'x25' spacing, ~700'; at 20'x25' spacing, ~630' trench)

= Laurel wilt affected tree = Healthy tree = Fungicide treated tree (spot treatment)

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



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