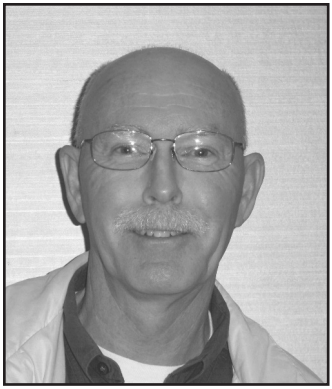

MANAGEMENT OF GRAFT-TRANSMISSION OF THE PECAN BACTERIAL LEAF SCORCH PATHOGEN

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Pecan bacterial leaf scorch disease (PBLS) is caused by the bacterium *Xylella fastidiosa*. This bacterium has a very broad host range of plants, infecting over 100 species. In addition to pecan, other economically important hosts of *X. fastidiosa* include grape, citrus, coffee, blueberry, peach, and numerous hardwood and ornamental plants (Hopkins and Purcell, 2002). The pathogen inhabits the water-conducting tissue (xylem) of its hosts and restricts transport of water and nutrients through infected trees. The bacterium will move throughout infected trees from leaves to roots. In pecan, severe disease results in leaf loss, and reduced tree growth and nut weight (Sanderlin and Heyderich-Alger, 2003). Infection is usually permanent with annual disease development. The disease will likely reduce crop production throughout the life of a tree following infection. There are currently no practical management practices for PBLS after infection has been established in a pecan tree. The only way to manage PBLS is to avoid infection of trees.

In order to prevent infection, it is necessary to understand how the pathogen moves from an infected plant to a non-infected pecan tree. One of the two known ways that pecan can be infected by the pathogen is through graft-transmission which requires a little human assistance. When scion wood is collected from infected trees, the bacterium may be present in the xylem tissue of the scions. As the scion begins to grow following grafting, the bacterium can move into the developing tissue producing PBLS in the new tree. Similarly, the pathogen can move from infected rootstock into a growing graft infecting the new tree. The obvious way to prevent graft-transmission of the pathogen is to avoid using infected trees as scion sources and infected rootstocks.

Infected trees can usually be identified by PBLS symptoms. Typical symptoms include leaflets developing a tan to brown discoloration that begins at the leaflet margin and spreads inward in a smooth unbroken form. Leaflets usually fall off shortly after symptom development leaving leaf stems with

some or all of the leaflets missing still attached to the limb before it also drops. Symptoms may occur as early as late May, but tend to become obvious in mid-June at leaf maturity and continue development through the summer and fall. The development of leaflets with scorch and leaflet drop is an ongoing process through the summer that can result in an accumulation of dead leaflets under trees with PBLS.

Identification of the disease symptoms can sometimes be challenging, particularly in late summer and fall. Leaf spots caused by other microorganisms or nutritional deficiencies that show up primarily on aging leaves may produce symptoms that are similar to PBLS. When these spots merge, they form blotches of dead tissue that can look like leaf scorch symptoms. A careful examination of leaflets for an unbroken pattern of tan tissue as opposed to merged spots which usually produce demarcation lines or rings within the dead tissue can aid in the separation of PBLS from other problems. Of course, it is possible for trees to have both PBLS and symptoms of other foliar problems at the same time. Similarly, identification of the disease in rootstocks in late summer and fall may be a little more difficult because nursery trees often are not well protected from senescent type foliar fungi and often do not have optimum nutritional supplements resulting in an abundance of late season foliar disorders. It is best to examine both trees and rootstocks in mid-summer before other foliar problems usually become prominent. Because symptom intensity can change with time, it is best to observe trees that will be used in the grafting process more than once in the summer.

Hot-water treatment to eliminate the pathogen from graft wood. It is not always possible to identify infected trees prior to graft wood collection or to know the source of the graft wood. There is a simple inexpensive procedure that uses hot water to essentially eliminate the pathogen from scion wood. This procedure has been used with other plant species to remove internal pathogens and insects and is a tried and proven technique (Frison and Ikin, 1991; Haviland, et al., 2005; Von Broembsen and Marais, 1978). Hot-water treatments of various types have been used to reduce the viability of pathogens and insects in seeds and cuttings from several plant species including the elimination of *X. fastidiosa* from grape cuttings. The technique for pecan involves the addition of one step in the normal graft wood collection, storage, and use process and basically consists of the following.

- Collect and store scion wood in your preferred standard method during tree dormancy.
- Prior to grafting, remove scion wood from cold storage for hot-water treatment.
- Submerge scion sticks in water at 115 degrees Fahrenheit for 30 minutes.
- At 30 minutes, remove the scion wood and immediately submerge in room temperature water to remove residual heat from the wood (takes about a minute).

- The wood is now ready to use for grafting.

When performing the hot-water treatment, it is important that the scion wood be completely submerged in the water rather than floating on the surface. A weight can be added to bundles of sticks to keep them submerged. We found that scion sticks can withstand a temperature of 125ºF for several minutes without any apparent damage, although 30 minutes at 125 is not recommended (Sanderlin and Melanson, 2008). This allows for a temperature range to conduct the procedure in without having to maintain precise temperature control. A simple way to treat a few dozen pieces of graft wood is to heat a large pot of water on a stove top to 125ºF, then as the temperature stabilizes, submerge the wood and start timing for 30 minutes. Keep a thermometer in the water during the procedure. If the temperature begins to drop below 115ºF simply apply enough heat to keep the temperature within the correct range. The larger the volume of water, the slower the temperature will change relative to the air temperature. A slow-cooker (Crock Pot) with the lid on also worked well for maintaining the temperature in the 115 to 125 range for 30 minutes without the need to reapply heat. While this small scale procedure is applicable for personal use, larger scale use such as that which would be necessary for commercial nurseries requires a larger container that could treat hundreds of pieces of graft wood and would probably require the use of a thermostat controlled heating unit. Such a unit was built and tested successfully by an Extension Specialist with the University of Maryland to kill various insects on plant tissues with hot-water. The basic hardware for the unit included a 100-gallon cattle watering tank, an instantaneous hot-water heater of the type that can be purchased from local retailers, a water pump for water circulation, a temperature gauge, and PVC pipe to make a cage to hold the plant material. The design of his unit can be viewed on the internet by typing the title "Keeping the heat on pests" into a search engine or at the following internet address www.agnr.umd.edu/news/images/amer nurseryman.pdf.

In tests conducted in 2005 and 2006, the procedure was effective in eliminating graft-transmission of *X. fastidiosa* through pecan scion wood with a diameter range of 0.3 to 0.9 inches — the smallest and largest in the tests (Table 1). There were no significant differences in the diameter of the sticks used for grafting with either hot-water treated or non-treated scion wood. Also, the diameter of the scion wood used in the tests did not have an effect on percent graft success or on graft-transmission of the pathogen. In each year, there were no differences in graft success between non-treated scions and hot-water treated scions indicating that the hot-water treatment had no effect on scion viability. In our tests, scions were immediately used for grafting following hot-water treatment. It may be possible to treat the graft wood with hot-water at the time the wood is collected in the winter, then store and use in the spring. This has been done with other plants but was not tried with pecan.

It may also be possible to eliminate the pathogen from dormant rootstock

Table 1. Summary of results of two-year test of hot-water treatment.[a]

Treatment	Year	Scions Used	Graft Success[b]	Average Scion Diameter[c]	Graft-Transmission[b]
No Treatment	2005	30	80.0	0.44	12.5
Hot-Water[d]	"	40	62.5	0.45	0
No Treatment	2006	75	86.7	0.46	26.2
Hot-Water	"	125	92.0	0.46	0

[a]All scion wood was collected from limbs with pecan bacterial leaf scorch.

[b]Graft success and graft transmission are expressed as a percentage.

[c]Scion diameter is measured in inches. Diameter range in 2005 was 0.31 to 0.60 inches; in 2006, the diameter range was 0.29 to 0.85 inches.

[d]Hot-water treated scion wood was submerged in water at 115° F for 30 minutes.

trees using the hot-water treatment. Bare-root trees dug from a nursery or container grown trees with the soil removed from the roots should be treatable. The entire tree including the root system would need to be submerged in 115ºF water prior to planting. Although dormant rootstock submersion has not been tested with pecan, it is anticipated that it should work well for removal of the pathogen. Small diameter roots may have greater sensitivity to hot water than the scion wood but the larger roots would probably not be damaged. Tests are needed to determine the water temperature that roots can withstand without significant damage.

With diligent observation for infected trees and rootstocks and use of the simple hot-water treatment procedure, it should be possible to greatly reduce the introduction of the pathogen through graft-transmission into new trees.

In addition to avoiding infected graft sources and using the hot-water treatment, the use of budding for propagation should also essentially eliminate graft-transmission of the pathogen as there will be little, if any, xylem tissue in the buds before growth begins. However, budding has not been tested as a means to avoid graft-transmission of *Xylella fastidiosa*.

As stated previously, there are two known ways the bacterium can enter pecan trees. The natural method of pathogen movement is by certain spittlebug and leafhopper insects that feed exclusively in the xylem tissue of plants. Several potential insect vectors that can acquire the pathogen from infected pecan and transmit to non-infected trees have been identified (Sanderlin and Melanson, 2010). These include the pecan spittlebug, *Clastoptera achatina*, the diamond-backed spittlebug, *Lepyronia quadrangularis*, the Johnsongrass sharpshooter, *Homalodisca insolita*, and the glassy-winged sharpshooter (GWSS), *Homalodisca vitripennis*.

Of these four, the pecan spittlebug and the GWSS are likely to be significant vectors to pecan. The pecan spittlebug lives entirely on pecan and hickory and has the potential to regularly transmit the pathogen within orchards that already have infected trees. The GWSS is considered to be a major vector of *Xylella* to vineyards in California (Purcell and Saunders, 2000). This insect is native to the southeastern states and has been observed in several pecan orchards feeding on young succulent pecan shoots. It has the potential to be a significant vector because it can live a long time on pecan, is a strong flyer covering a relative large area, and feeds on many other *Xylella* susceptible hosts and could thus introduce the pathogen into orchards that have no previous infection. Much work is needed to determine the most common spittlebug and leafhopper vectors in pecan orchards, their distribution and population dynamics, and to evaluate management practices to reduce pathogen spread in pecan.

LITERATURE CITED

Frison, E. A. and R. Ikin, eds. 1991. FAQ/IBPGR Technical guidelines for the safe movement of grapevine germplasm. Food and Agriculture Organization of the United Nations. Rome/ International Board for Plant Genetic Resources. Rome, Italy.

Gill, S., C. Schuster, D. Ross, G. Rosenkranz, P. Shrewbury, and S. Klick. 2007. Keeping the heat on pests, Using a hot water immersion system effectively can control some plant pests during propagration. www.agnr.umd.edu/news/images/amer nurseryman.pdf.

Haviland, D. R., W. J. Bentley, and K. M. Daane. 2005. Hot-water treatments for control of

Planococcus ficus (Homoptera: Psueudococcidae) on dormant grape cuttings. Journal of Economic Entomology 98:1109-1115.

Hopkins, D. L. and A. H. Purcell. 2002. *Xylella fastidiosa*: Cause of Pierce's disease of grapevine and other emergent diseases. Plant Disease 86:1056-1066.

Purcell, A. H. and S. R. Saunders. 2000. Glassy-winged sharpshooter expected to increase plant disease. Plant Health Progress doi: 10.1094/PHP-2000-0627-02-RS.

Sanderlin, R. S. and K. I. Heyderich-Alger. 2003. Effects of pecan bacterial leaf scorch on pecan growth and yield components of cultivar Cape Fear. Plant Disease 87:259-262.

Sanderlin, R. S. and R. A. Melanson. 2008. Reduction of *Xylella fastidiosa* transmission through pecan scion wood by hot-water treatment. Plant Disease 92:1124-1126.

Sanderlin, R. S. and R. A. Melanson. 2010. Insect transmission of *Xylella fastidiosa* to pecan. Plant Disease 94:465-470.

Von Broembsen, S. and P. G. Marais. 1978. Eradication of *Phytophthora cinnamon* from grapevine by hot water treatment. Phytophylactica 10:25-27.