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Pecan Bacterial Leaf Scorch

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Pecan bacterial leaf scorch (PBLS) is an important and chronic disease that affects pecan in Arizona, as well as other pecan production regions of the United States. This disease was first noticed throughout the southeastern United States in 1972 and mistakenly thought to be a fungal disease. In 2000, the disease was correctly identified as a bacterial disease known as PBLS, impacting mostly the eastern growing region of the US. Currently, there are more than 25,000 acres, of which 14,000 is in fruit bearing age. Pecan acreage continues to grow by 2,000 acres annually. In 2015, the AZ pecan industry contributed more than $54 million dollars to the state's economy. Pecan bacterial leaf scorch was first detected in 2015 not only in Arizona, but also in California, New Mexico, and Texas. PBLS is a primary concern for pecan trees under stressful conditions including nutritional, physiological, and environmental stress. PBLS is a rapidly emerging disease to Arizona pecan industry and this document is designed to help pecan growers answer commonly asked questions about PBLS.

Disease and Vector Biology

1. What is PBLS?

PBLS is a systemic bacterial disease that affects all pecan varieties. and the bacterial pathogen also can infect many other plants (more than 359 species) from 75 different plant families. Agricultural crops affected include citrus, coffee, grape, olive, peach, pear, plum, almond, blueberry, blackberry, and alfalfa, Some ornamental plants that can also be infected include oleander, chitalpa, oak, maple, mulberry, sweet gum, elm, sycamore, ash, poison hemlock, periwinkle, goldenrod, eastern baccharis, pepper vine, English ivy, Boston ivy, Virginia creeper, umbrella sedge, American beautyberry. See the resource sections at the end of the document for a complete list of host plants that can harbor the bacterium. Even though the infection process on different hosts is always the same, symptoms and the diseases caused by the bacterium may vary among plant species. Examples of diseases include Pierce's disease on grape, citrus variegated chlorosis, phony peach disease, almond leaf scorch, olive quick decline syndrome, alfalfa dwarf disease, and a number of leaf scorch diseases such as oleander leaf scorch, coffee leaf scorch, and plum leaf scorch. Visible symptoms of infection may or may not present even though the pathogen can colonize most plant species.

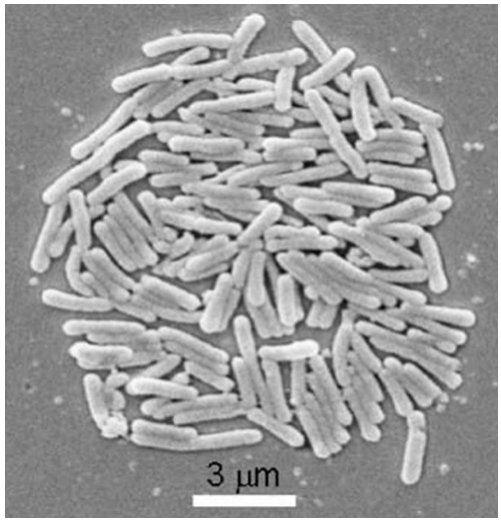

Figure 1. *Xylella fastidiosa*, the causal agent of PBLS (image source: E. Alves)

2. What causes PBLS?

PBLS is caused by the bacterium *Xylella fastidiosa* (Figure 1). The bacteria are located in the water-conducting vascular vessels of the trees (the xylem). It is important to note that the bacteria are harmless to humans.. The bacterium reproduces in the plant as well as in the insects acting as vectors who spread the infection amongst host plants. It reproduces asexually using binary fission, a type of cell division in which each dividing daughter cell receives a copy of the single parent chromosome.

3. Is the Xylella strain causing PBLS the same as the strain causing leaf scorch of oleander or chitalpa?

There are different *X. fastidiosa* strains. Like cold and flu viruses, the bacterium *X. fastidiosa* is constantly mutating and evolving. Subsequently, there are at least seven distinctive *Xylella* strains specializing on various plant hosts worldwide. The strain responsible for PBLS is subspecies multiplex, which can infect many hardwood trees and shrubs. In contrast, oleander leaf scorch and chitalpa leaf scorch is caused by subspecies Sandyi and Tashke, respectively. Genetic analysis shows that these three *Xylella* strains are unrelated subspecies and very different from each other. Research has demonstrated that

there is host specialization or host specificity among the *Xylella* strains. For example, the multiplex strain responsible for PBLS infects hardwood trees, but does not produce disease on grape. Similarly, the fastidiosa strain can infect grape, almond, alfalfa, and weeds, but does not infect oleander, citrus, peach, or oak trees.

4. Why can PBLS affect tree health?

The bacterium *Xylella* resides, grows, and multiplies in the xylem, damaging this tissue and causing the tree to be unhealthy. In a plant, water moves through the xylem. The bacteria aggregate to form a community structure called a biofilm, which will restrict the flow of water to the rest of the plant. As xylem vessels in leaf veins become blocked, moisture stress occurs and the scorching symptom develops in leaves.

The tree roots are also affected by the bacteria. Even before leaf scorching is visible, the bacteria are already damaging the tree roots and the affected tree cannot function as if it were a healthy tree. Overall tree health will continue to decline and become unproductive over time. There is no effective treatment for PBLS at this time. A younger and smaller infected tree will decline by infection more quickly than a larger tree. Adjusting management practices to minimize stress on infected trees will slow down tree decline pace. Such practices include avoiding moisture stress and excessive nut load by application of irrigation and fertilization, or oversized tree by pruning.

5. How does PBLS spread?

PBLS is spread by two methods. By the insect vector and by grafting infected scion wood. The most frequent method is by leafhopper (sharpshooter in particular), and spittlebug. These insects have piercing, sucking mouthparts that facilitate acquisition and transmission of the bacteria to and from the plant xylem. The other method for disease spread is grafting and/or possibly root grafting. Because the bacterium can colonize the plant without showing visible symptoms (asymptomatic) and western pecans are majority improved varieties grafted to selective rootstock, graft transmission through *Xylella*-infected scions is a possible source of pathogen introduction to new pecan orchards. Therefore, nurseries should use caution when grafting trees, using plant material from mother trees determined to be free of the pathogen. Recent evidence suggests that the disease is likely seed transmissible, but more studies are ongoing to confirm this possibility in pecan.

6. What do the vectors look like?

The bacterium *X. fastidiosa* is spread primarily by a type of leafhopper known as a sharpshooter (Figure 2A-D). The major insect vector in Arizona is probably the smoke-tree sharpshooter. It is not clear whether other sharpshooters, including glassy-winged sharpshooters, blue-green sharpshooters, or green sharpshooters play roles in PBLS spread in Arizona (Figure 2A-D). Other xylem-sucking insects including spittlebugs and froghoppers are considered to be potential vectors.

The smoke-tree sharpshooter is approximately 6 millimeters (0.24 inch) long and shorter than glassy-winged sharpshooter (0.55 inch in length) (Figure 2A). They can fly between 3 to 16 feet at a time, up to 0.25 miles a day and tend to feed and lay eggs on last-year's growth and meristematic tissue. they also excrete copious amounts of liquid as they feed ("leafhopper rain"). Nymphs (immature stage) are gray and have a body shape similar to adults. They are wingless and not as mobile as adults.

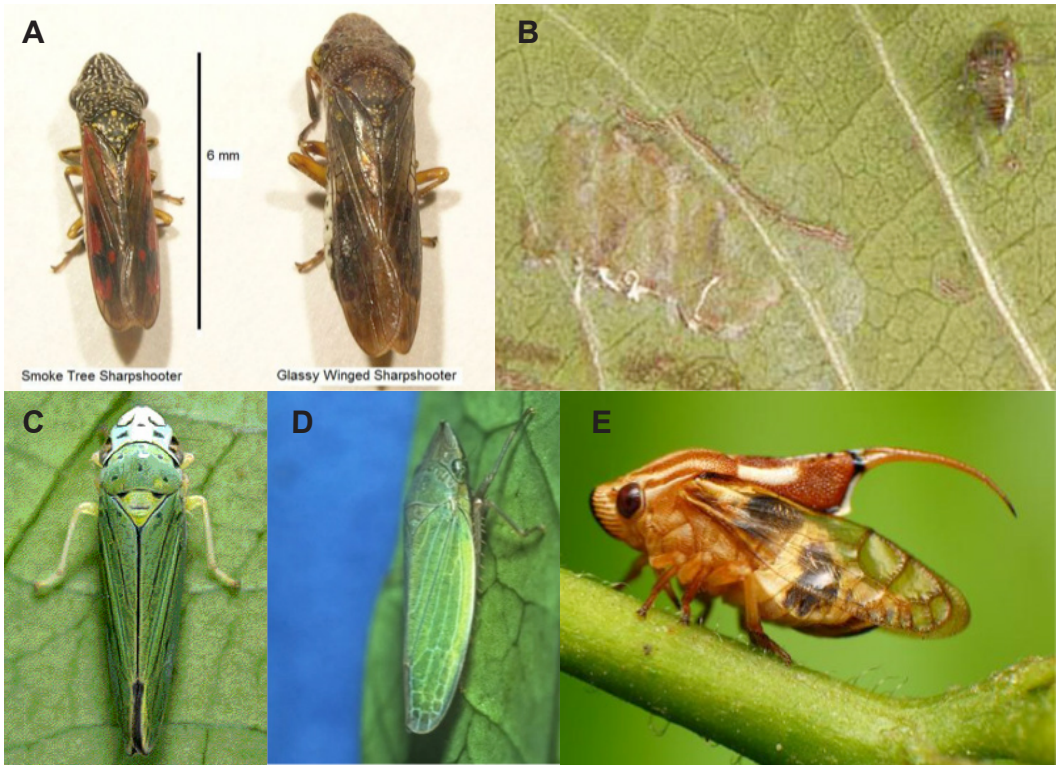

Figure 2. Insect vectors. A: adult smoke-tree and glassy-winged sharpshooters; B: eggs (left center) and nymphs (upper right) of glassy-winged sharpshooters; C: adult blue-green sharpshooter; D: adult green sharpshooter; E: adult spittlebug (image source: T. Conklin)

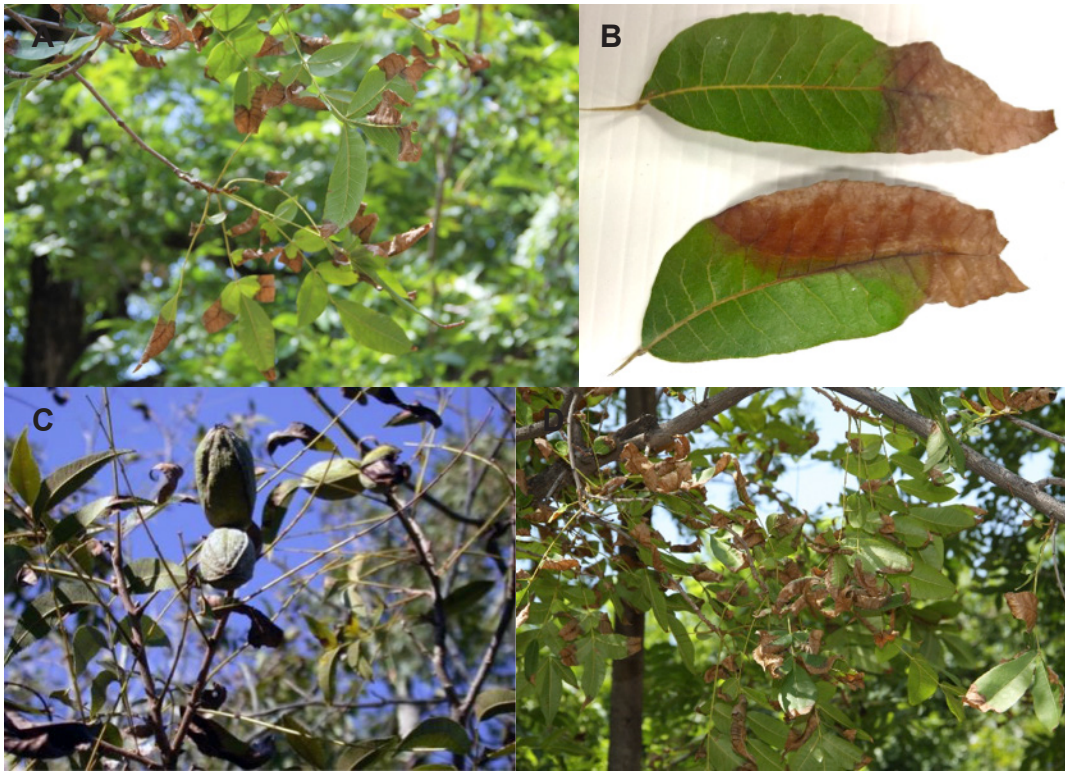

Figure 3. Leaf scorch symptom on leaflets (image C source: R. A. Melanson).

Disease Diagnosis

1. How can I diagnose PBLS?

The most characteristic symptom of PBLS is the tip and margin burn toward the base and midrib of the leaflet (Figure 3A, B, and D). The affected area dies, turns tan to brown and has a dark brown border separating the dead tissue from the green tissue (Figure 3A and B). As the disease progresses, affected leaflets fall, the rachises remain attached to the tree for a period of time before dropping from the tree (Figure 3C). Symptoms often occur from late spring to fall. Leaves at branch tips are the first to scorch. Branches with leaf scorch symptoms or dieback occur randomly throughout the tree canopy. Some pecan varieties appear to have less leaf scorch symptoms than other varieties.

2. How do I tell the difference between PBLS and physiological leaf scorch symptoms?

While the symptoms seem distinctive, it is often difficult to be certain of the cause of a marginal leaf burn. PBLS symptoms can be confused with leaf scorch caused by soil compaction, a nutrient deficiency or toxicity, chemical injury, poor soil, and other diseases, and drought conditions. Therefore, a laboratory analysis is required to determine whether scorch is due to a bacterial infection. The Extension Plant Pathology laboratory at the University of Arizona can confirm the presence of Xylella using both ELISA and PCR methods. A good sample of leaves should consist of 15 compound leaves with typical scorch symptom. The submission form can be downloaded at this link: https://cals.arizona.edu/azpdn/sites/cals.arizona.edu.azpdn/files/docs/PDDL_form.pdf.

Preventative Options

1. How can I prevent my tree from getting bacterial leaf scorch?

The leafhopper, sharpshooter, and spittlebug are the insects responsible for spreading PBLS; therefore, managing these insect populations is the best way to prevent your tree from becoming infected. Yellow sticky traps, available for purchase from several retailers, can be used to monitor vector populations (Figure 4). Foliar- and soil- applied pesticides may reduce insect populations, even though it is not possible to keep all these insects from gaining access to the trees. Chemicals effective for sharpshooter control include imidacloprid, clothianidin, acetamiprid, dinotefuran, and thiamethoxam.

2. If I purchase or propagate a pecan tree, how do I know whether it has PBLS?

When propagating a pecan tree, make sure to collect scions from a healthy, non-infected tree, and graft scion onto a pathogen-free rootstock without typical leaf scorch symptoms. If the tree comes directly from a certified nursery, there is a very low probability that it has PBLS. Trees from other vendors have the potential to be infected, so customers should be vigilant for leaf scorch symptoms. If a scion is suspected to harbor the bacterium, hot water treatment can be used to eliminate *Xylella* from the infected scion. See the resource section at the end of the document for the procedure of hot water treatment (Melanson et al. 2015).

Figure 4. Yellow Sticky Trap with glass-winged sharpshooters (Image source: D. Haviland)

3. Can I do anything to prevent my tree from spreading bacterial leaf scorch?

Once your pecan tree has PBLS, there is no cure. It becomes a source of the *Xylella* bacterium that causes the disease and spreads through the vectors, which acquire and spread the bacteria to healthy trees. Therefore, the infected branches should be pruned off, but the extent of pruning is difficult to determine because the bacterium is highly mobile in the xylem. If a tree is severely infected and has become unproductive, it should be removed to reduce further spread, but tree removal may not eradicate the bacterium from a pecan orchard.

Management Options

1. Are there resistant varieties available?

No resistance has been found in 30 pecan varieties tested to date. However, there are some variations in disease susceptibility among these varieties. In mixed planting, PBLS tends to occur first in susceptible varieties and they become more severely infected than the other varieties. In addition, there are no resistant rootstocks available.

2. If a tree with PBLS is found in my pecan orchard, what can I do to treat the symptoms?

PBLS is a chronic bacterial infection and there is no cure. Once a tree has the bacterium and does not receive proper tree care, it will gradually decline and become unproductive over time. The rate of tree health decline depends on many factors including variety, tree age, and extent of infection, as well as tree vigor and other stresses. A good fertilizer and irrigation program may help reduce tree stress, promote good tree health, and maintain productivity. Fertilizing and watering may make the infected tree appear asymptomatic, but will not eliminate the bacterium from the tree.

3. If my tree has PBLS, can nutrition and watering improve the health of my tree or extend the life of the tree?

Fertilizing and watering will reduce tree stress, promote good tree health, and maintain productivity. It will also extend the life span of the tree. However, the tree will not be cured of PBLS. As time progresses, the tree may decline further and become less productive. Ultimately, tree removal may be the last resort.

4. If my tree is infected with *Xylella* bacteria, why can't I treat it with an antibiotic?

Antibiotics have not been proven to be an effective treatment in the field. Some earlier research trials on Pierce's disease control in grape showed that application of tetracycline antibiotics and streptomycin helped suppress the disease symptom temporarily, but repeated applications are required for long-lasting remission and this is not economically viable. Other researches suggested that the control effect of the antibiotics on the bacterium was not significant. In addition, there are no antibiotics approved by government regulatory agencies for commercial application on pecan.

5. Can I replant a pecan tree in the same spot where I have a diseased tree?

If you are going to replant a pecan tree in the same location, be sure to remove and kill the infected tree's stump with an herbicide to kill all the roots. It is best to wait for a period of time to make sure the herbicide's active ingredient has broken down and is no longer available to be absorbed by the roots of a new tree.

6. Why can't PBLS be eliminated by removing all the infected pecan trees in a location and spraying to kill the sharpshooters?

It is theoretically possible to eradicate the PBLS disease. However, realistically the removal of all infected pecan trees would be very costly and nearly impossible to accomplish. Since symptom expression may be delayed following infection, the *Xylella* bacterium can reside in a tree for months or years before visible symptoms occur. This makes it impractical to locate all the infected pecan trees. Moreover, it requires 100% cooperation from all pecan growers to remove their infected trees. To completely remove all plant sources of the *Xylella* bacterium, all susceptible plant species would need to be removed, not just pecan, but weeds, herbaceous annual, perennial shrubs and many hardwood trees as well. In addition, sharpshooters and spittlebugs reproduce quickly on a wide range of host plants. While chemicals are effective in killing them, they do not completely eradicate the entire vector population. Pesticide applications only reduce vector population levels.

Resources

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List of plant hosts affected: https://gd.eppo.int/taxon/XYLEFA/hosts

EFSA. 2016. Scientific report on the update of a database of host plants of *Xylella fastidiosa*: 20 November 2015. EFSA J. 14, 4378–4418. 10.2903/j.efsa.2016.4378

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