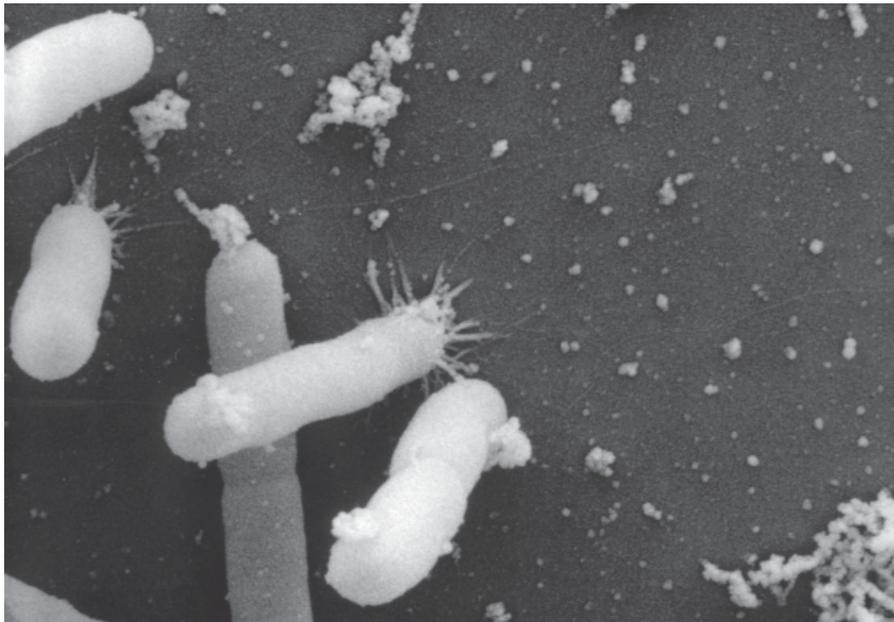


# Bacterial Leaf Scorch of Blueberry

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Relative to total sales, blueberries are the number one fruit commodity in Georgia, surpassing even peaches. Recently, a new disease has been identified in the Georgia blueberry production region. This disease has been named “bacterial leaf scorch,” and it is caused by the bacterium *Xylella fastidiosa* (Figure 1). Koch’s postulates was recently utilized to confirm this new disease; the suspected disease causing agent (bacterium) was isolated from a diseased plant, cultured, and reintroduced into a healthy plant in which subsequent disease symptoms developed that were similar to the original plant. For bacterial leaf scorch, Koch’s postulates were conducted by Dr. C. J. Chang (University of Georgia) in the summer of 2006, and they were fulfilled in November 2006. Through initial field surveys conducted in the summer of 2007, it was determined that this disease has the potential to become a major threat to blueberry production in Georgia and elsewhere, especially in the southern highbush blueberry varieties. Among these varieties, ‘FL86-19’ (alias ‘V1’) has proven to be the most susceptible. However, ‘Star’ and other varieties are also showing substantial disease incidence and severity in several locations. At this early stage, little is known for sure about the epidemiology (means of dissemination and spread) of this disease, and the basic research to determine the means of spread and interaction within the south Georgia environment needs to be completed. In addition, research-based control methods also need to be established for this disease. Current recommendations are based on information derived from other plant systems, such as wine grapes, and information needs to be developed specifically for blueberries.



**Figure 1.** Electron microscope photograph of *Xylella fastidiosa* bacteria (Pierce’s disease of grape isolate) attached to a membrane surface. The bacteria and associated bacterial and plant-associated products will clog the xylem elements, the conductive tissues which transport water and nutrients from the roots, causing scorch symptoms and eventual plant death. Photo by H.C. Hoch, Cornell University; *Journal of Bacteriology*. 189:7507–7510.

## Causal organism

The *Xylella fastidiosa* bacterium is pathogenic on numerous plant species. In addition, it is known to inhabit many host plants without causing disease symptoms; among these are various grasses and herbaceous weeds generally found throughout the blueberry production region of Georgia; native blueberries also likely harbor the bacterium. So, there is generally a bacterial reservoir readily available for infection.

Little is known about the specific *Xylella fastidiosa* strain found in blueberry. This bacterium may be genetically identical to the subspecies causing Pierce's disease of grape or the one causing phony peach, major *Xylella*-incited diseases that also occur in Georgia, or it may be distinct from both. As in other *Xylella*-incited diseases, it is assumed that the bacterium blocks xylem vessels, thereby preventing water and nutrient flow from the soil throughout the plant. This bacterium only survives in plant xylem or within the insects that vector it. In general, *Xylella* diseases are more prevalent in warmer environments; this is related in part to the fact that the insect vectors, primarily sharpshooters, survive better in warmer environments, but the bacterium also overwinters more successfully within host plants in warmer climates. Though it is speculation at this point, the increase in bacterial leaf scorch in Georgia may be at least partially related to warmer winters that may have aided survival of vectors and the bacterium. Without regard, south Georgia and Florida provide ideal environments for both the bacterium and the vectors to survive.

To date, the disease has been an obviously observed field problem of southern highbush blueberry varieties only. It is not known whether this disease is also causing problems in rabbiteye varieties. The bacterium can, in fact, colonize rabbiteye plants, but whether or not it results in chronic or acute disease has not been determined for rabbiteye varieties. However, there is no doubt at this point that the disease is causing chronic and acute losses in southern highbush varieties.

## Disease cycle and causal conditions

The disease cycle of this bacterium in grape, peach, and plum is well known, and it is likely the same in blueberry. Infected hosts serve as reservoirs and overwintering sites of the bacterium. In the spring and early summer, insect vectors, sharpshooters and spittle bugs, transmit the bacterium through feeding on infected plant tissues and subsequent feeding on healthy plants. In other systems, the glassy-winged sharpshooter, *Homalodisca coagulata*, is the most important vector. The glassy-winged sharpshooter can be found abundantly in south Georgia and Florida, where it is known to be the major vector of *Xylella* in peach, while also preventing production of European wine grapes. Once the insect has acquired the bacterium, it is transmitted to a new plant as the insect injects the bacterium into the xylem (the conductive tissues that transmit water and nutrients from the roots to the other plant tissues) during feeding. This bacterial species is unique in that it is limited to life in the plant xylem. Movement of the bacterium occurs throughout the plant xylem system. At some point, bacteria form colonies, and through a combination of tyloses, gumming and bacterial exudate production, the xylem is clogged. In time, clogging of vessels reaches a point at which individual stems or whole plants will no longer be able to carry sufficient water and nutrients to support life. At this point symptoms develop, and eventually the plant will die. Plant death can be relatively rapid but, in general, symptom development starts in one year and continues through at least a second season before plant death.

Though it has not been proven, it is assumed that this bacterium can be transmitted through propagation from infected plants. If so, then this is particularly troubling, since massive numbers of plants can be disseminated rapidly to expand the epidemic. The combination of propagation and insect vectoring could cause rapid spread throughout the entire region. However, it is likely that infected plants would not be used for propagation very often, since they would show disease symptoms. In addition, propagated, infected plants may

be killed rapidly in the nursery – preventing additional spread. This raises many questions and much research is needed to address the specific question of propagative spread through cuttings.

Root grafting may also serve as a potential transmission mechanism. In high-density beds, this may be particularly important as a means of spread, but again, there has been no research conducted to date to support this premise.

## Symptoms

The initial symptom is a marginal leaf scorch (burn), which unfortunately is similar to that observed with extreme drought, fertilizer salt burn, or root rots (Figure 2). Sometimes, the scorched leaf area is bordered by a darker band between the healthy and scorched tissue. This leaf symptom can be uniformly distributed throughout the plant, but in the early stages, scorching may be limited to individual stems or perhaps one side of the plant – indicating that only a partial xylem blockage has occurred, which may be limited to one cane or one stem. Spring growth is characterized by twigs of very thin diameter. Eventually, leaves abscise (drop), and young twigs/stems may yellow (Figures 3-4). After leaf drop, the plant eventually dies (Figure 5). Often, where a plant has died from bacterial leaf scorch, a neighboring plant will show symptoms the following year.

The most unique symptom of bacterial leaf scorch is actually observed once leaves have dropped – the yellowed stems and twigs. The plant can drop virtually all leaves and yet remain otherwise healthy in appearance; the stems and root systems appear sound, and vascular discoloration is not generally observed. Once the leaves have dropped from the plant, the plant takes on a skeleton-like appearance. Dieback is not generally associated with this disease in the early stages; of course, the final result is plant death, and at that point it is not possible to diagnose the cause of death.



2a



2b



2c

**Figure 2.** Scorch symptoms (late summer) observed on plants infected with *Xylella fastidiosa*. In some cases, the marginal leaf burn is very distinct, and it is surrounded by a dark line of demarcation between green and dead tissue. In other cases, the symptoms are very similar to those of anthracnose leaf spot; in fact, disease causing and saprophytic organisms do opportunistically infect the marginal dead tissue, further confusing accurate identification.



3a



3b

**Figure 3.** Scorch symptoms (late summer) observed on plants infected with *Xylella fastidiosa*. The symptom observed here is the best indicator that the plants are actually dying of bacterial scorch as opposed to root rot, anthracnose, fertilizer salt or chemical injury, or simple drought stress, any of which can mimic bacterial leaf scorch. Prior to complete plant death, all leaves abscise (fall off), and the remaining stems take on a yellow, "skeletal" appearance. The root system and stems do not show any obvious lesions or dieback symptoms, and the plant will generally appear healthy, with the exception of complete defoliation.



**Figure 4.** Panoramic view of an individual plant with bacterial scorch symptoms. Some surrounding plants are also starting to show early symptoms as well.



5a



5b

**Figure 5.** Plants that have died from bacterial leaf scorch. At this stage, it would be very difficult to determine that bacterial leaf scorch was the cause of death, especially once plants have been hedged. Symptoms are virtually identical to those of root rot, but in this case, there is no excessive moisture or low areas that would be often associated with root rot. Also, the pattern of spread is different from root rot, in that scattered dead plants are observed; root rot mortality is often clumped, especially around low, wet areas.

The bacterium cannot be easily observed with a light microscope, so confirmation is only possible through ELISA or PCR techniques in a lab. In addition, observation of bacterial growth on specialized media is also recommended for confirmation of this disease.

## Cultural controls

- It is essential that new plants not be propagated from *Xylella*-infected plants. At this point, there is no testing program for propagation. However, propagators should never take cuttings from plants they have not personally inspected for visual disease symptoms. Never use diseased plants for propagation, whether they have symptoms of *Xylella* or viruses or other diseases of blueberry.
- Identification of *Xylella*-infected plants is possible in the field, and once such plants are identified, they should be flagged and immediately destroyed. By doing this, it is hoped that the epidemic will be slowed.
- There may also be a tie-in between plant stress and successful infection by *Xylella*; therefore, reduction of plant stresses, such as drought stress, may at least slow symptom development if not prevent it altogether.
- We have observed potential varietal field resistance in some southern highbush blueberries, but this has not been confirmed scientifically. The 'FL86-19' variety is particularly susceptible to infection and disease development by *Xylella*. When compared with other southern highbush or rabbiteye varieties, the 'FL86-19' variety quickly develops symptoms and high bacterial titers after manual inoculations, which correlates well with observed susceptibility in the field. On the other hand, 'V5' has been observed to have presumed field resistance to this bacterium (Figure 6). Though this presumed resistance needs to be confirmed through further research, this is encouraging, since it likely indicates that breeding can be used to develop varieties that are highly resistant to *Xylella*.



**Figure 6.** Potential resistance. In this planting, a single row of 'V5' plants was alternately planted after 10 rows of 'FL86-19' plants (repeated numerous times). The surrounding 'FL86-19' plants were all infected, with significant mortality, and they have been removed at this point; the 'V5' plants consistently show no symptoms of disease or mortality after five years at this site. From this anecdotal information, it is not possible to determine conclusively that this is resistance, but it is encouraging, and it very likely indicates field resistance in the 'V5' line.

## Chemical controls

Right now, no chemical controls actively kill the bacterium. However, it may be possible to slow or even break the disease cycle by vector management, killing the insects that transmit the bacterium. There are several insecticides which are active against leafhoppers, and several of these are registered for use on blueberries.

- Application of soil-applied neonicotinoid products (imidacloprid or thiamethoxam) should take place as plants begin their initial spring flush. With any of the neonicotinoid materials, their systemic qualities will be best observed when there is good moisture and active growth. In parallel fashion, neonicotinoid longevity is much better with soil application than with foliar application. Product longevity and performance, extrapolating from ornamentals, are influenced by rate, so applying the highest labeled rate is best. For blueberries, the neonicotinoids labeled for soil application include imidacloprid products (Admire 2F, Admire Pro, Advise 2FL, Alias 2F, Courage 2F, Imida E-AG 2F, Nuprid 2F) and a thiamethoxam product (Platinum 2EC).

- During the late spring period, which may correlate with the period of actual vectoring by sharpshooters, foliar-applied pyrethroids and organophosphates should be utilized to augment or complement the neonicotinoid drench, especially if glassy-winged sharpshooters are observed in sticky traps.

As mentioned throughout this fact sheet, additional research is needed to address the basic questions we have relative to this new menace to the blueberry industry. However, it is likely this disease will mimic similar diseases in other plant systems. As such, we can extrapolate the need for a management program to include cultural and chemical control and breeding programs. Southern highbush blueberry producers should actively incorporate suggested management practices for this disease, as they have others. Otherwise, the epidemic will likely increase throughout the region, resulting in major losses.

Contact your local county Cooperative Extension agent for additional information or specific chemical recommendations.

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