

Pierce's disease of grapevine and other diseases caused by *Xylella fastidiosa*

1. Background

Pierce's disease is a destructive disease on grapevine and is caused by the bacterium called *Xylella fastidiosa*. This disease is present mainly in the southeastern and southwestern regions of the United States and also in Central America. Although Pierce's disease has been in California since 1880's, it has been relatively limited in certain areas because the bacterium is only transmitted by local sharpshooter species that don't fly far away from their native habitats. In 1989, a newly introduced sharpshooter called glassy-winged sharpshooter (GWSS) was found in Orange and Ventura counties of California. In difference from those native sharpshooters, GWSS feeds on a wider range of plants, reproduces readily on grapevine, and moves much faster, which implies that GWSS is a more efficient vector of Pierce's disease. In response to the introduction of this dangerous vector, California State has formed a task force to combat Pierce's disease and the new vector.

There is no record to show that Pierce's disease of grapevine occurs in Nevada. However, this disease poses a significant threat to Nevada ornamental plants because of the movement of nursery stocks from California to Nevada. During the summer of 2001, our nursery inspectors found suspected GWSS egg masses on nursery stocks from California. Later on, State Department of Agriculture personnel have found an alive GWSS in a landscaping area in Las Vegas. This finding shows that GWSS may have been established already in the southern region of the state. To confirm whether or not the ornamental plants in Las Vegas area are infected by the bacterium *Xylella fastidiosa*, a survey for the bacterium was pursued during the summer. All samples collected from both Reno and Las Vegas area showed negative after laboratory testing. However, confident conclusion on the status of *Xylella fastidiosa* on ornamental plants in Nevada cannot be drawn until a more extensive survey is done.

As Nevadans are trying to introduce grapevine cultivation into the state, Pierce's disease should be considered as a major factor that may limit any potential production of grapes. Also, ornamental plants are very important for every resident of Nevada to help change dissert landscape and beautify our surroundings. Any kind of introduction of *Xylella fastidiosa* and its natural vectors to Nevada is of significant risk to our plant industry. So far, it is not known whether or not GWSS in Las Vegas carries *Xylella fastidiosa*. However, if future survey continues to show negative of the bacterium from samples from Las Vegas, it is very likely that GWSS is not carrying the bacterium. The State Department of Agriculture is monitoring the occurrence of both the bacterium and GWSS in the state, and has issued a treatment order that requires any plants shipped to Nevada from infested states found infested with nymphal or adult GWSS to be treated with pesticides. This order will prevent any movement of bacteria-carrying sharpshooters into the state.

2. Definition

Pierce's disease by definition is a disease of grapevine caused by the bacterium *Xylella fastidiosa* and is named after the person Newton B. Pierce. As a California's first professionally trained plant pathologist, Newton B. Pierce described and characterized this disease as "California vine disease". Although he was specialized in bacteriology, the bacterium *Xylella fastidiosa* as the pathogen of this disease was not figured out during that time, partially because this bacterium could not be isolated from the infected tissue and cultured on common nutrient media. In 1973, it was found that the xylem vessels of grape plants showing symptoms of Pierce's disease were filled with fastidious xylem-limited bacteria, later confirmed to be *Xylella fastidiosa*. After the bacterium was proven to be the pathogen of this disease, various researches were carried out by scientists in an effort to find a special nutrient medium that could allow the bacterium to grow in vitro. Currently, this bacterium can grow on specially formulated nutrient media.

3. Symptoms

Symptoms of Pierce's disease may vary with cultivars and susceptibility of the plants. In general, symptom shows up on leaves first as a sudden drying and scalding of margin area of the leaf while the other part of the leaf remains green (Fig. 1). Scalded areas continue to move towards the central area of leaf until the entire leaf becomes scorched or dead. Infected leaves may detach from the distal end of the petioles, leaving the bare petioles attached to canes. On canes, the bark tissue matures unevenly, showing islands of brown bark surrounded by green bark. In the spring, infected plants are delayed in growth. In the later season, plants show dwarfed vines and shrunk or dried small fruits. Yellow to brown streaks may be shown in the current-season wood of infected vines. Root system is also hurt by the bacterium. Infected plants may die within months or years depending on the tolerance of the plants. The expression of these symptoms is due to the occupation of the xylem vessels by the bacterial cells and some matrix material produced by both bacteria and the plant, which severely blocks the water and mineral transportation system in a plant.



Fig.1. Scorch symptom on a leaf of grapevine infected by *Xylella fastidiosa*

4. Other diseases caused by *Xylella fastidiosa*

Besides Pierce's disease of grapevine, *Xylella fastidiosa* also causes diseases on other important ornamental plants and agricultural crops. The most common diseases are

oleander leaf scorch, bacterial leaf scorch of oak, almond leaf scorch, phony peach disease, citrus variegated chlorosis, bacterial leaf scorch of coffee, maple leaf scorch (Fig.2), mulberry leaf scorch, bacterial leaf scorch of elm, bacterial leaf scorch of sycamore, and alfalfa dwarf disease. The bacterium has diverse strains that may have specific host ranges. However, most strains can infect a large number of plant species. For example, the grape strain that causes Pierce's disease of grapevine can infect about 193 species of plants including grasses, fruit trees, ornamental plants, forest trees and agricultural crops, according to a host-range research report.



Fig. 2. Scorch symptom on a maple leaf infected by *Xylella fastidiosa*

5. Transmission

Pierce's disease can be transmitted by grafting. However, in most cases, the disease is transmitted by xylem-feeding insects such as sharpshooter leafhoppers and spittlebugs. The sharpshooters can acquire the bacterium by feeding on the infected plants for less than 2 hours, and then obtain an ability to transmit this bacterium for life long. However, the adults do not pass the bacterium to their progeny, which means the new generations of sharpshooters do not carry the bacterium unless they feed on the infected plants. In California, there are four types of sharpshooters that can transmit *Xylella fastidiosa*. They are green sharpshooters, blue-green sharpshooters, red-head sharpshooters and glassy-winged sharpshooters (Fig. 3). Obviously, there are significant differences in morphology and color among these sharpshooters.



Fig.3. Appearance of a glassy-winged sharpshooter

6. Detection

Early detection of Pierce's disease and others caused by *Xylella fastidiosa* is very critical because it will allow us to take effective actions to get rid of the diseases as early as possible. Any scorching sign should be suspected for infection by *Xylella fastidiosa* although lack of water and/or hot weather also cause some types of dry leaf or sunburn. To distinguish bacterium-induced leaf scorch from general sunburn and dry wilt, a close examination of leaves is required to make a right judgment. General speaking, bacterium-induced scorch usually starts from margin area of the leaf and move further toward to the central part. In contrast, sunburn occurs randomly on the leaf and dry wilt appears to occur uniformly on the entire leaf. While an effort is made to inspect plants for the disease, a survey for any sharpshooters in an area is of the same importance. Once nymphs or adults of sharpshooters are found, application of insecticides is very necessary to prevent sharpshooter from spreading the disease. To further confirm the diagnosis of Pierce's disease and other diseases caused by *Xylella fastidiosa*, laboratory analysis is required. Nevada Department of Agriculture Plant Pathology Laboratory now has the facility to test for *Xylella fastidiosa*.

7. Control

There are several strategies to prevent *Xylella fastidiosa*-caused diseases and to treat infected plants. Uses of disease-free plant materials will eliminate the occurrence of the disease. Biocontrol or chemical control of sharpshooters will prevent or slow down disease spreading. Wasp is an efficient natural biocontrol agent so far. Chemotherapy can be used to treat plants with Pierce's disease. For example, some micronutrients such as zinc, manganese and copper are toxic to the bacterium. If these micronutrients are sprayed on leaves, they can be taken up by the plants. Antibiotics such as tetracycline and penicillin are effective in inhibiting the bacterium. Genetically modified plants may be available sometime and the plant should be conferred with resistance to both the bacterium and sharpshooters.