

## Scouting for Citrus Greening<sup>1</sup>

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Scouting for citrus greening has become an essential practice for citrus production since the first positive confirmation of greening in Florida in August 2005. The disease affects the entire commercial citrus growing area in Florida and continues to spread throughout the state. When greening-infected trees are not removed, they serve as an inoculum source for the greening bacteria, as well as a source for transmission by the Asian citrus psyllid to surrounding healthy trees. As a result, scouting for citrus greening is an important pest-management component for reducing the incidence and spread of this disease.

This publication describes the following: 1) when to scout; 2) different methods of scouting and their applications; 3) symptoms of greening and how to distinguish these symptoms from those of other diseases/disorders; and 4) what to do when a greening-infected tree is identified.

### Scouting Frequency

Citrus groves should be inspected for greening every two to three months. If greening has previously been found in a grove or has been confirmed nearby, scouting more than four times a year is strongly recommended.

Greening symptoms are most visible during the fall and winter months, but can be observed year round. During the spring flush, scouting becomes more difficult because new leaves typically do not express greening symptoms, and the older, symptomatic leaves become hidden behind the new flush.

### Scouting Methods

Various methods can be used to scout for greening, including walking through groves or riding on all-terrain vehicles (ATVs) or on elevated platforms (Fig. 1). Multiple types of elevated platforms are available, including tractor- or truck-mounted platforms. Choosing or designing an ideal platform for individual situations will vary based upon grove conditions and tree size. However, simply driving through row middles will not be sufficient to thoroughly scout for greening as symptoms are difficult to see and properly identify from a distance.

Greening symptoms can be found on the inner or outer edges of the canopy, thus making the symptoms difficult to locate. The size of the trees and acreage to be scouted will determine the most practical method

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**Figure 1.** Walking, ATV, and elevated platform used to inspect for greening

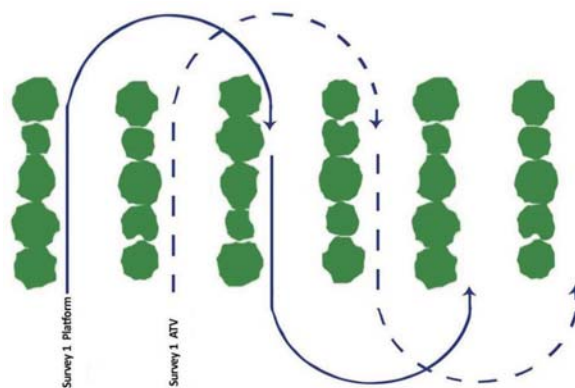
to use, but walking the grove will allow for the most thorough inspection of trees. Small, young trees can easily be surveyed by walking, and medium trees can be surveyed by both ATV and walking. Large trees can best be scouted by using a combination of elevated platforms, which allow for maximum viewing of the upper canopy, combined with ATVs and walking for more close-up inspection of the lower canopy.

The row chosen to scout in a grove will determine the subsequent middle to travel the next time the grove is scouted (Fig. 2). For example, in a block of large, mature trees, the first inspection may consist of every-other row being scouted from an elevated platform with alternate rows being scouted from an ATV. The method used to scout each row would be switched during the next scouting, thus alternating the scouting method in each row with each subsequent inspection. This pattern ensures that, over the course of two scouting events, each side of each row is inspected from the ground and from an elevated position.

### Grove Conditions and Scouting

Scouting is more difficult when a grove is poorly maintained. Grove middles should be mowed and easily accessible by walking or equipment so scouts can focus on the trees instead of watching the ground for potential hazards.

Nutrient deficiencies can easily be confused with greening symptoms; therefore, a grove expressing



**Figure 2.** A diagram depicting how to use two scouting methods to thoroughly scout a grove. During each scouting, alternating rows are scouted either from a platform or ATV. The method used to scout each row will alternate during each subsequent scouting to ensure trees are viewed from several angles

numerous nutrient deficiencies is more difficult to scout for greening than is a properly fertilized grove.

A well kept grove is also easier to scout for greening. Tree size and canopy volume can affect safe movement of scouts through a grove, especially on elevated platforms. Open hedged rows allow easier access and prevent scouts having possible contact with limbs or branches, which can cause slips or falls from elevated platforms.

### Marking Suspect Trees

Scouts should mark suspect trees with flagging tape. Once a tree branch has been flagged, the scout's name and date should be clearly written on the flagging tape. After an entire row has been scouted, a flag on each end of the row with the number of suspect trees in that row will assist with relocating the trees at a later time (Fig. 3). Although a wide selection of flagging tape is available, use only one color or pattern to identify suspect greening trees. Use a different tape color or pattern to identify trees positively confirmed by laboratory analysis.

To locate the suspect or positive greening-infected trees again after scouting, so the trees can be removed, a GPS system or grove map may be helpful. Even with GPS mapping, however, a physical flag or other marker on the tree is recommended.



**Figure 3.** Flagging to mark greening-suspect trees

## Safety while Scouting

The goal of the scouting crew is to locate and identify suspect trees with greening symptoms while remaining safe. If a grove has recently had a chemical application, follow the chemical label directions regarding the re-entry interval (REI). Weather is also an important part of a safe scouting program. Heat stress, sunburn, lightning and rainy weather can impact the health and safety of scouts.

Operators of ATVs or elevated platforms are responsible for transporting the survey crew safely and efficiently. If the driver approaches a dangerous area (such as a canal, hog routing, sandy area, or fallen limb), the scouting crew should exit the equipment until the operator can safely pass the hazard. Once the operator passes the hazard, the scouting crew can safely return to the elevated platform. Operators of elevated platforms must also be careful of electrical lines and other such obstacles and hazards.

The potential for slips and falls is always present when working in a grove. A first-aid kit should be kept in a central location, and employees should be instructed on the proper procedures in case of injury, with a well defined emergency safety plan in place, including numbers to call for emergency assistance.

## Greening Symptoms

Greening symptoms are not always prominent or easily distinguished from other tree health problems. When scouting a grove for greening the first time, scouts should be looking for trees that do not look normal and should examine these trees carefully. Overall, a greening-infected tree will appear unhealthy and may have a general yellow appearance with shoot die back, sparse foliage, and a thin canopy.



**Figure 4.** Diagnostic blotchy-mottle leaf pattern of citrus greening



**Figure 5.** Yellow veins are possible greening symptoms

Generally, yellow shoots with upright, narrow leaves displaying yellow veins and blotchy-mottle symptoms are seen on infected trees (Fig. 4, Fig.5). Blotchy mottle is the most diagnostic symptom and the earliest leaf symptom (Fig. 4). However, greening affects all parts of the tree -- leaves, fruit and stems. Early in disease development, symptoms may be restricted to a single branch or a small segment of the tree. Yellow veins (Fig. 5), vein corking (Fig. 6) and green islands (Fig. 7) are all common leaf symptoms found on trees infected with greening, but alone these symptoms are not necessarily diagnostic of greening. If these symptoms are found, the tree should be inspected further in an attempt to locate the characteristic blotchy-mottle symptom. As the disease progresses, the entire tree will be affected, and symptoms will become more prominent.



**Figure 6.** Vein corking and blotchy mottle in greening-positive leaves

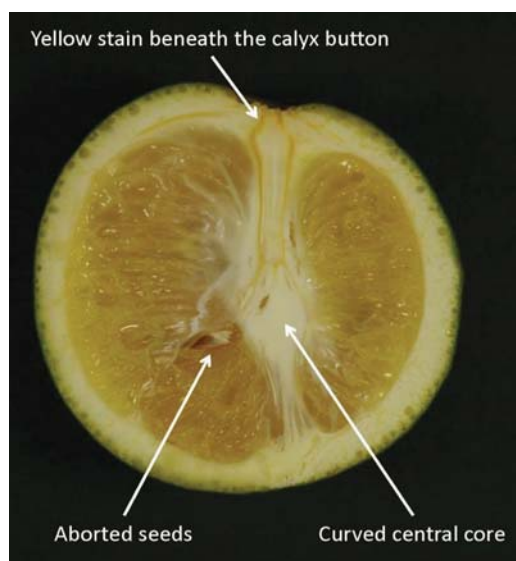


**Figure 7.** Green islands commonly found on leaves on greening positive trees

Greening fruit may be affected externally and internally. Externally, fruit will be lopsided, misshapen, smaller than average and/or have an abnormal color change (Fig. 8). Internally, the fruit may exhibit aborted seeds, a curved central core and a yellow stain beneath the calyx (button) (Fig. 9). The fruit may have a salty, bitter taste. Often fruit that is infected with greening will abscise prematurely and, as a result, can be seen on the ground surrounding an infected tree (Fig. 10). This symptom can be easy to spot when scouting, particularly near harvest time. Note that not all fruit on an infected tree will necessarily be affected, and it is possible to find symptomatic and asymptomatic fruit on the same tree or even on the same limb.



**Figure 8.** Abnormal color change (left) and lopsided fruit (right), indicating greening infection



**Figure 9.** Internal fruit symptoms of greening-infected fruit

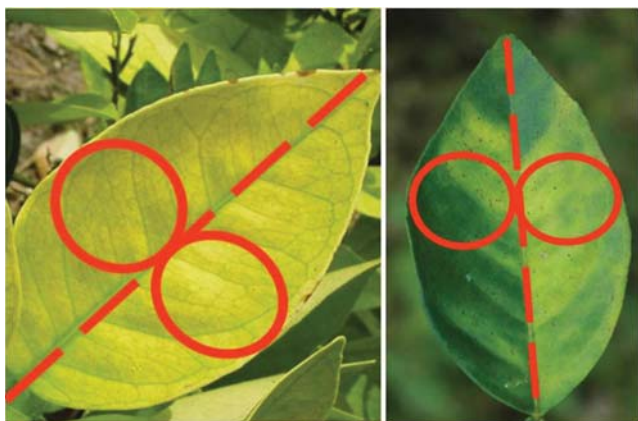


**Figure 10.** A greening-infected tree, in which the symptomatic fruit have abscised and fallen to the ground at the base of the tree: note the healthy fruit still hanging on the tree.

## Symptoms Commonly Mistaken for Greening

Recent applications of oil or other chemicals may cause leaves to be shiny with spray residue. These effects can cause greening symptoms to be more difficult to detect visually.

Additionally, nutrient deficiencies can be mistaken for greening. However, scouts can easily distinguish the symptoms of greening infection from symptoms of nutrient deficiencies by determining whether the chlorosis (yellowing) is asymmetrical or symmetrical (Fig. 11). Nutrient deficiencies result in a symmetrical pattern, but greening is apparent in asymmetrical yellowing. If only a few trees in a grove display the symptoms of nutrient deficiencies, those trees should be carefully inspected as this may be an early indication of something wrong with those trees even if not diagnostic of greening.



**Figure 11.** Nutrient deficiency (left) compared to greening symptoms (right): notice the symmetry on either side of the midvein in the nutrient-deficient leaf compared to the asymmetrical pattern of the symptoms on the greening-infected leaf.

Insect damage can also be confused with the symptoms of citrus greening. Upon closer inspection, however, insect damage can be easily distinguished from greening. Insect damage, such as the damage resulting from leafminers, can cause a blotchy or off-color appearance on the top side of the leaf as shown in Fig. 12a. However, looking at both sides of the leaf reveals that the blotchy pattern is actually associated with leafminer mines on the underside of the leaf (Fig 12b).



**Figure 12.** A leaf with apparent blotchy mottle on the upper leaf surface (top) caused by significant leafminer damage on the lower leaf surface (bottom)

Leaf damage resulting from herbicides or other chemicals that are sprayed is often apparent in yellow patterns that cross the midvein. Mottling patterns resulting from greening will not cross the midvein. (Herbicide damage is typically seen in the lower canopy whereas other chemical toxicities may be seen anywhere in the canopy.)

Various diseases or physical damage can cause trees to exhibit symptoms similar to greening. Yellow veins can be caused by *Phytophthora* (foot rot) or by a broken limb. If yellow veins are found, the tree should be inspected further to identify the possible cause of the symptom.

## Diagnostic Testing

At this time, Polymerase Chain Reaction (PCR) is the only procedure to positively identify citrus greening. However, a field diagnostic test using iodine can assist in distinguishing greening from other tree health problems. This iodine-based test can easily be performed by any grower or scout by making a dilute iodine solution using tincture of iodine and water. A strip of tissue can be cut from a suspect leaf and dipped in the iodine solution for 1-2 minutes. The strip can then be examined for dark staining along the cut edge. This test capitalizes on the high starch accumulation caused by greening and the reaction of starch with iodine, which produces a

dark-blue to black color. However, because disorders other than greening may cause high starch accumulation in citrus leaves, this test should not be considered definitive; it is only a tool to aid in identifying leaves for laboratory PCR testing. A complete description of the iodine-based test and its uses and limitations is available in EDIS Publication HS1122, *An Iodine-Based Starch Test to Assist in Selecting Leaves for HLB Testing*, <http://edis.ifas.ufl.edu/HS375>.

Three sites are equipped to receive samples from growers and positively identify the greening bacterium using PCR analysis. Please contact the facility directly to determine the proper procedure and requirements for submitting samples for testing.

Southern Gardens Diagnostic Laboratory, 111 Ponce de Leon Avenue, Clewiston, FL, 33440, 863-902-2249

UF/IFAS Southwest Florida Research and Education Center, 2686 SR 29 N, Immokalee, FL, 34142, 239-658-3400, <http://swfrec.ifas.ufl.edu/hlb/>

Florida Division of Plant Industry, P.O. Box 147100, Gainesville, FL, 32614-7100, 1-800-282-5153

### **Additional Information**

2008 Florida Citrus Pest Management Guide: Huanglongbing (Citrus Greening). EDIS Publication PP-225, <http://edis.ifas.ufl.edu/CG086>

An Iodine-Based Starch Test to Assist in Selecting Leaves for HLB Testing. EDIS Publication HS1122, <http://edis.ifas.ufl.edu/HS375>

Citrus Research and Education Center Greening Website -- <http://greening.ifas.ufl.edu>