Citrus Disease Identification for North Florida

Jamie Burrow, Megan Dewdney, and Michael Rogers
University of Florida, IFAS, CREC

Thursday, January 21, 2016

UF | IFAS Extension
UNIVERSITY of FLORIDA

Citrus Canker

- Citrus canker is caused by a bacterial pathogen *Xanthomonas citri* subsp. *Citri*
- All varieties are susceptible, but early oranges and grapefruit are most susceptible
- Causes lesions on leaves, stems and fruit
- Severe infection can cause general tree decline
  - Defoliation
  - Twig dieback
  - Fruit drop and blemishing

Citrus Canker Spread

- When there is moisture on lesions, bacteria ooze out and can spread to new growth or other trees
- Wind-blown rain is the main means of dispersal
- Wind speeds >18 mph force bacteria through stomata or wounds

Citrus Canker Spread

- Movement of infected or exposed trees, seedlings and propagative material primary means of spreading canker over long distances
- Contaminated clothing, tools, landscaping equipment, ladders or containers are potential sources of infection
- Decontaminate all equipment associated with citrus tree work (70% alcohol solution or 1 ounce of bleach to 1 gallon of water)

Leaf symptoms

- Early symptoms appear as slightly raised, tiny blister-like lesions
- As lesions age, they turn tan to brown and a water soaked margin appears surrounded by a yellow ring or halo

Leaf symptoms

- Center of the lesion becomes raised and corky
- As the leaf tissue dies, it can fall out leaving a hole in leaf
- Lesions are visible on both sides of the leaf

Stem symptoms

- Older lesions become dark brown or black raised corky lesions surrounded by an oily or water-soaked margin
- Mature lesions appear scabby or corky
- Stem symptoms usually indicate the bacteria has been present for a long time period

Fruit symptoms

- Lesions are dark brown to black and raised, often surrounded by yellow halos
- Lesions cause blemishes and early fruit drop

Citrus Greening

UF | IFAS Extension
UNIVERSITY of FLORIDA

Fact or Fiction

- Huanglongbing
  - HLB
  - Citrus greening
- Spread by an insect

History

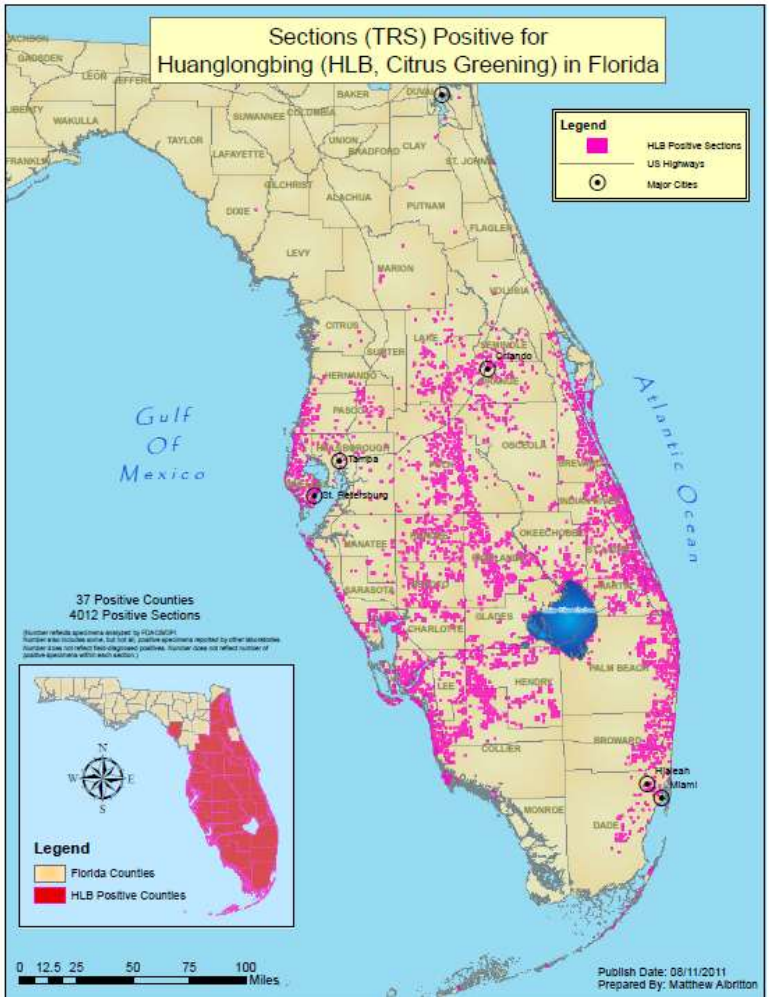
- 1919: First reported in China
- 1921: Reported in the Philippines, but thought it was zinc related
- 1937: In South Africa, thought to be mineral toxicity
- 1941-1955: Most extensive work on greening conducted in southern China

History

- 1960: Appeared in Thailand
- 1965: Researchers demonstrated HLB was transmissible by grafting and the citrus psyllid
- 1966: Filipino and Indian researchers recognized the similarities between various named diseases

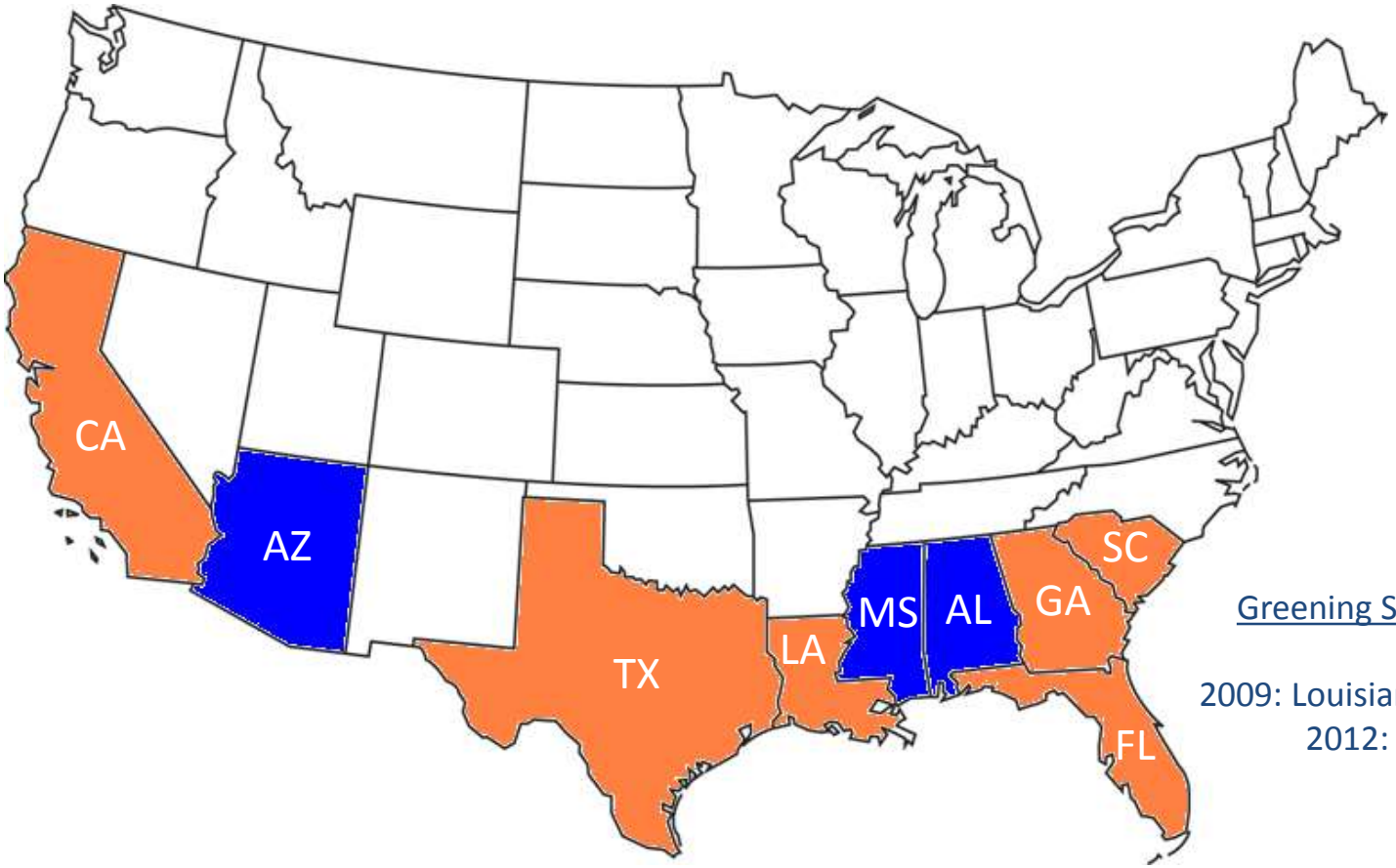
History

- 1998: Asian citrus psyllid arrived in Florida
- 2004: Disease confirmed in Brazil
- 2005: Disease confirmed in Florida
- 2005 to the present: Disease continues to spread throughout Florida



UF | IFAS Extension
UNIVERSITY of FLORIDA

United States Locations



ACP and HLB

ACP only

Greening Spread Through the Years
2005: Florida
2009: Louisiana, Georgia, South Carolina
2012: California and Texas

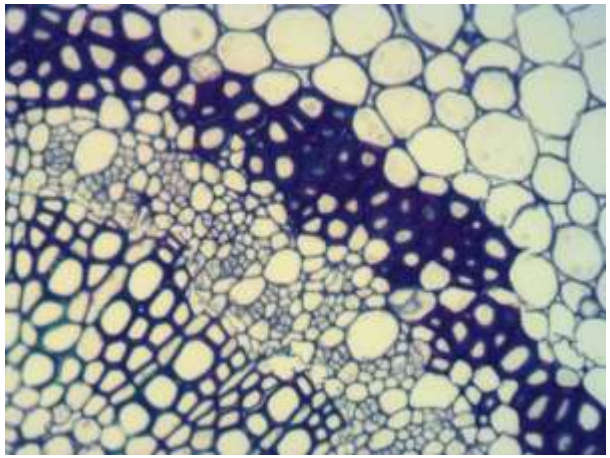
Map retrieved from http://www.martinsaphug.com/learn/maps-2/united-states-and-canada/

Importance

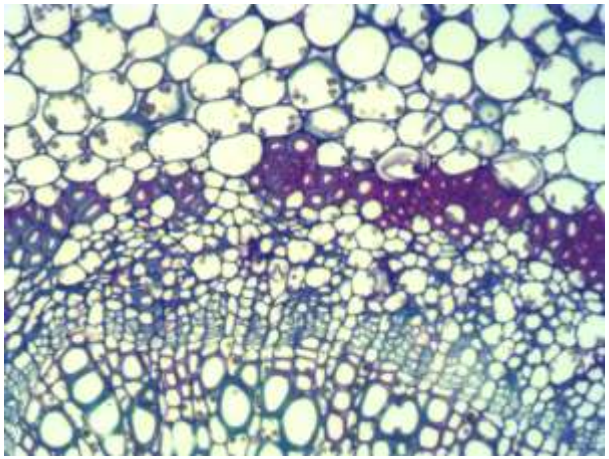
- Affects fresh market fruit
- Affects processed fruit
- No cure for the disease

Biology

- Caused by a bacteria
- Found within the phloem of the tree
- Causes damage to the vascular system



Healthy



Infected

Biology

- Affects all citrus varieties
- Affects plants in the *Rutaceae* family
- Affects box orange and orange jasmine

Murraya paniculata
(orange jasmine)

Biology

- Some plants host the vector only
- Some plants host the vector and are susceptible for greening

Known Host Plants of Huanglongbing (HLB) and Asian Citrus Psyllid

Plant Name	*Liberibacter asiaticus* Huanglongbing	*Diaphorina citri* Citrus Psyllid
Aegle marmelos (L.) Corr. Serr. - bael, Bengal quince, golden apple, bela, sulva		X
Aeglopsis chevalieri (Swingle, Chevalier) - aeglopsis	X	X
Afraegle gabonensis (Swingle) Engl. - Gabon powder-flask		X
Afraegle paniculata (Schum.) Engl. - Nigerian powder-flask		X
Atalantia ceylanica (Arn.) ex Wight & Arn. - see *Pleiospermium ceylanicum*	X	X
Atalantia monophylla (L.) Corr. - Indian atalantia		X
Balsamocitrus dawei Engl. - Uganda powder-flask	X	X
Burkillanthus malaccensis (Ridl.) Swingle - Malay ghost-lime	X	
Calodendrum capense Thunb. - Cape chestnut	X	
Choisya ternata Kunth - Mexican orange	X	
Citropsis gilletiana Swingle & M. Kellerman - Gillet's cherry-orange		X
Citropsis schweinfurthii (Engl.) Swingle & Kellerm. - African cherry-orange		X
Citrus aurantiifolia (Christm.) Swingle - lime, Key lime, Persian lime, lime, limón agrio, limón real, lima mexicana, limero	X	X
Citrus aurantium L. - sour orange, Seville orange, bigarde, marmalade orange, naranja agria, naranja amarga		X
Citrus depressa Hayata - shiikuwasha, shekwasha, unknown	X	
Citrus grandis (L.) Osbeck - see *Citrus maxima*	X	
Citrus hassaku hort. ex Tanaka - hassaku orange	X	
Citrus hystrix DC - Mauritius papeda, Kaffir lime	X	X
Citrus ichangensis Swingle - Ichang papeda	X	
Citrus jambhiri Lushington - rough lemon, jambhiri orange, limón rugoso, rugoso	X	X
Citrus junos Sieb. ex Tanaka - yuzu (Jpng, Vtn)	X	
Citrus halleensis hort. ex Tanaka - this is not a published name, could they mean *Citrus hindsiana* hort. ex Tanaka, kydia sinkan?	X	
Citrus limon (L.) Burm. f. - lemon, limón, limonero	X	X
Citrus × *limonia* Osbeck - potted orange, Rangpur lime, rosebelle lime, lemandarin, limón de Cayena, limón grande	X	
Citrus maxima (Burm.) Merr. - pummelo, pomelo, shaddock, pompelmoes, toronja	X	X
Citrus medica L. - citron, cidra, cidro, toronja		X
Citrus meyeri Yu. - Meyer lemon, dwarf lemon		X
Citrus × *nobilis* Lour. - king mandarin, tangor, Florida orange, King-of-Siam	X	X
Citrus nobilis hort. ex Tanaka - tankanbi?	X	
Citrus × *paradisi* Macfad. - grapefruit, pomelo, toronja	X	X
Citrus reticulata Blanco - mandarin, tangerine, mandarino	X	X
Citrus sinensis (L.) Osbeck - sweet orange, orange, naranja dulce, naranja	X	X
Citrus tamba (Hayata) hort. ex Tanaka - sour mandarin, tanki mandarin	X	
Citrus unshiu (Siebold) Marc. - satsuma orange, satsuma mandarin		X
Clausena anisum-olens (Blanco) Merr. - anis (Philippines)		X
Clausena excavata Burm. f. - clausena		X
Clausena indica Oliv. - clausena	X	X

Plant Name	*Liberibacter asiaticus* Huanglongbing	*Diaphorina citri* Citrus Psyllid
Clausena lansium (Lour.) Skeels - wampi, wampee	X	X
Citrus australis F. M. Bailey - see *Microcitrus australis*	X	
Fortunella glauca (Lindley) Swingle - Australian desert lime		X
Fortunella spp. - kumquat	X	
Fortunella crassifolia Swingle - Meiwa kumquat		X
Fortunella margarita (Lour.) Swingle - Nagami kumquat, oval kumq uat		X
Fortunella polyandra (Ridley) Tanaka - Malaysian kumquat		X
Limonia acidissima L. - kelota wood apple	X	X
Merrillia caloxylon (Ridley) Swingle - flowering merrillia		X
Microcitrus australasica (F. J. Muell.) Swingle - finger-lime	X	X
Microcitrus australis (Planch.) Swingle - Australian round-lime		
Microcitrus papuana (F. J. Wimer) - desert-lime		
Microcitrus Tvdiary - see *Microcitrus/n*		X
× *Microcitrusella* Tvdiary - finoctrusella		X
Murraya exotica L. - see *Murraya paniculata*		X
Murraya koenigii (L.) Spreng. - curry leaf	X	X
Murraya paniculata (L.) Jack - Lakeview, orange-jessmine, Chinese-box, naranja ramada	X	X
Naringi crenulata (Roxb.) Nicolson - naringi		X
Pamburus missionis (Wight ex Wight) Swingle - pamburus		X
Poncirus trifoliata (L.) Raf. - trifoliate orange	X	X
Severinia buxifolia (Poiret) Ten. - Chinese box orange	X	X
Swinglea glutinosa (Blanco) Merr. - tabog	X	X
Toddalia asiatica (L.) Lam. - orange climber		X
Toddalia lanceolata Lam. - toddalia	X	
Triphasia trifolia (Burm.f.) P. Wilson - trifoliate limeberry	X	X
Vepris lanceolata (Lam.) G. Don - white ironwood		X
Zanthoxylum fagara (L.) Sarg. - wild lime, lime prickly-ash		X

Updated 12/22/2008

http://www.freshfromflorida.com/content/download/24041/486974/hostlist.pdf

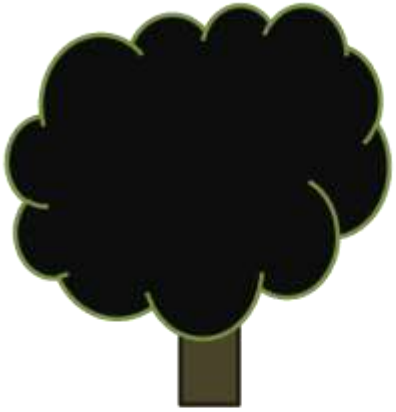
UF | IFAS Extension
UNIVERSITY of FLORIDA

Bacterium

- *Candidatus* Liberibacter asiaticus
- Gram negative
  - Defines type of bacteria
- Phloem limited
- Fastidious bacterium
  - Cannot grow in culture
- Reproduces/multiplies in both the psyllid and the tree

Photo Credit: *Huanglongbing: A Destructive, Newly-Emerging, Century-Old Disease of Citrus*, J.M. Bové

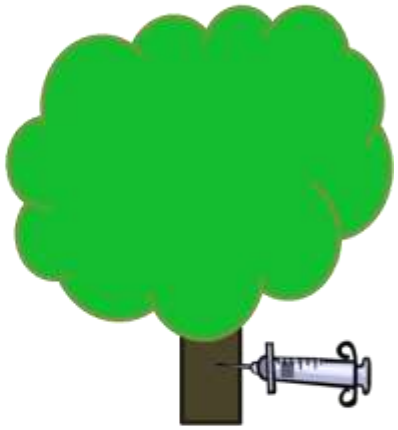
LAS must be present and associated with all diseased plants examined.



A sample is taken from the infected plant material. LAS must be isolated from the plant material and grown in pure culture.

This step has yet to be achieved.

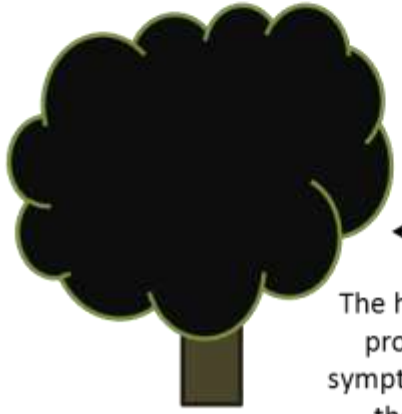
A sample of the possible disease causing organism from a pure culture is inoculated into healthy plant material of the same species or variety from which it was originally taken.



Koch's Postulates

The procedure required to show that *Ca.* Liberibacter asiaticus (LAS) causes Huanglongbing

The healthy tree must produce the same symptoms displayed by the original tree.



A sample needs to be taken from the inoculated host.

The bacterium must be reisolated in pure culture from the inoculated host and the new culture must have the same characteristics as seen in the original pure culture.

Burrow, J.D. and Dewdney, M.M.
Revised: April 2013 Original: May 2008

Spread

- Asian citrus psyllid
- Grafting with infected bud wood
- Is not seed transmissible
- **NOT** by contact, tools or equipment

Asian Citrus Psyllid

- Egg to adult in two weeks at 75-80°F
- Eggs are laid on feather stage flush
- 5 nymphal stages
- Nine to ten generations per year
- Life cycle between 15-47 days
- Females may lay more than 800 eggs during their lifetime

Asian Citrus Psyllid

- Psyllids fly or are carried by the wind to new plants
- Psyllids feed on an infected tree and then transmit the bacteria to healthy trees

Asian Citrus Psyllid Adults

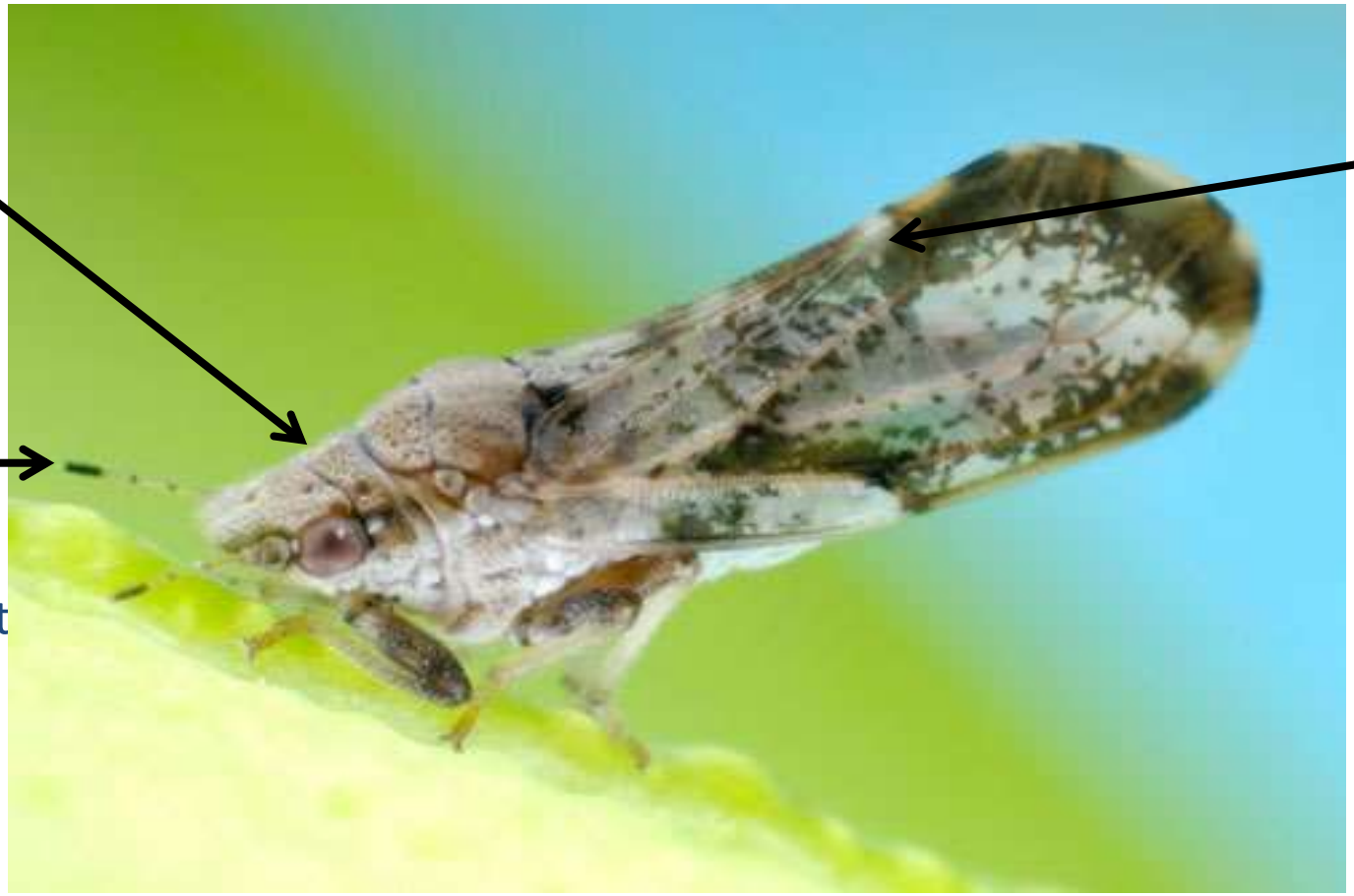


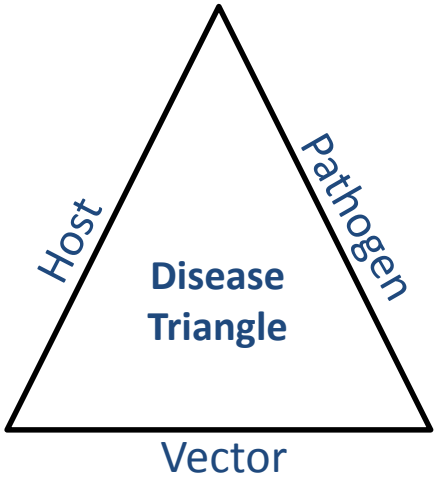
Photo Credit: Jeffrey Lotz, FDACS-Division of Plant Industry

Asian Citrus Psyllid Damage

- Nymphs produce a waxy secretion
- Notching on leaves

Transmission of *Candidatus* Liberibacter asiasticus by the Asian Citrus Psyllid

(How Huanglongbing is spread)



Disease Triangle

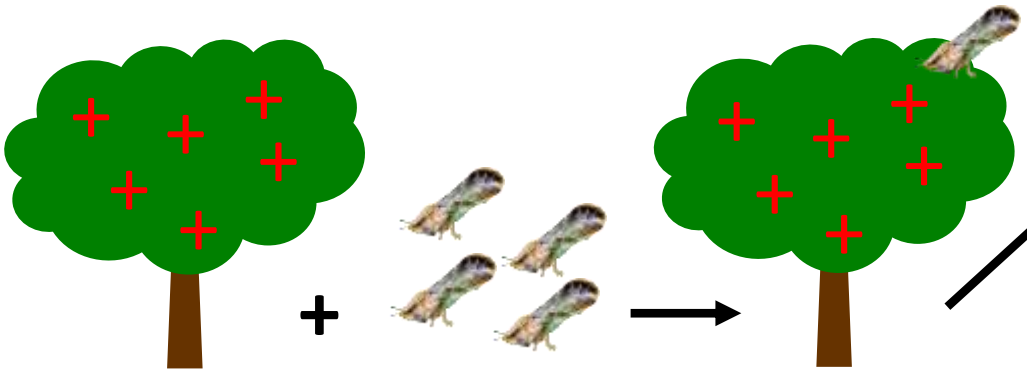
In order for the bacteria to spread, all components of the disease triangle must be present. For the spread of HLB, a citrus tree is the host, the bacteria is the pathogen, and psyllid is the vector.

Terms Defined

Candidatus Liberibacter asiasticus: the name of the bacterium that causes the disease Huanglongbing (HLB or citrus greening)

Healthy: does *not* have the HLB bacterium in the plant

Infected: the HLB bacteria is present in the plant



Citrus tree infected with the HLB bacterium.

Psyllids are in need of food; therefore, they feed on citrus trees.

Psyllid feeds on the phloem to acquire the bacteria.

Once the psyllid reaches the phloem, it can acquire the bacterium after an hour or more of feeding.

Once the bacterium is in the psyllid, the bacterium replicates and the psyllid is able to transmit the bacteria into other citrus trees.

Psyllids can move up to approximately 1.25 miles over 11 days to another citrus tree.

UF | IFAS Extension
UNIVERSITY of FLORIDA

Leaf Symptoms

- Blotchy mottle patterns
  - Mature leaves
  - Asymmetrical pattern
  - Inside or outer edges of canopy
  - Pattern will appear on both sides of the leaf

Leaf Symptoms

- Blotchy mottle patterns
- Yellow veins
  - Not a definite symptoms of HLB, but one should inspect the tree more closely if found
  - Found on young and mature leaves

Leaf Symptoms

- Blotchy mottle patterns
- Yellow veins
- Vein corking
  - Raised veins with a corky appearance
  - Found on mature leaves

Commonly Mistaken for HLB

- Broken limb
- Foliar symptoms of trees with foot rot (Phytophthora)

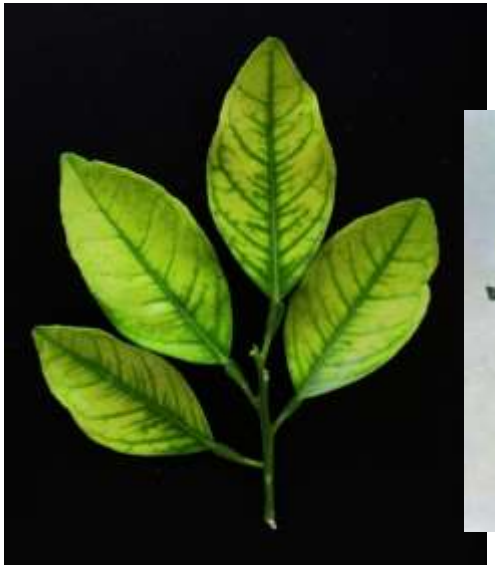
Commonly Mistaken for HLB

- Insect damage
- Herbicide/Chemical damage

Don’t forget to look at both sides!

Nutrient Deficiencies vs. HLB

- Zinc
  - Small and narrow leaves with yellow mottle on green background
- Iron
  - Green veins on a light yellow to white colored leaf



Nutrient Deficiencies vs. HLB

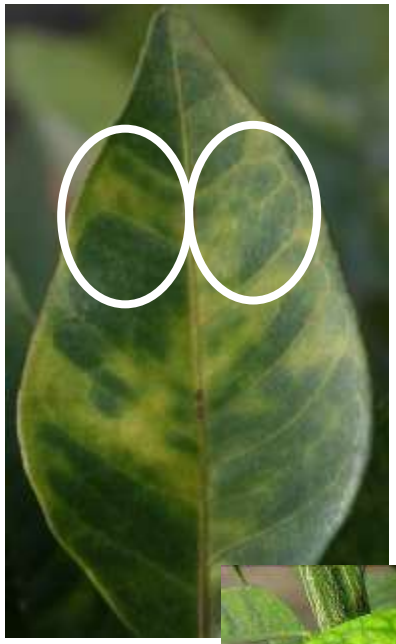
- Manganese
  - Dark green veins with a lighter green background
- Magnesium
  - Inverted ‘V’ pattern

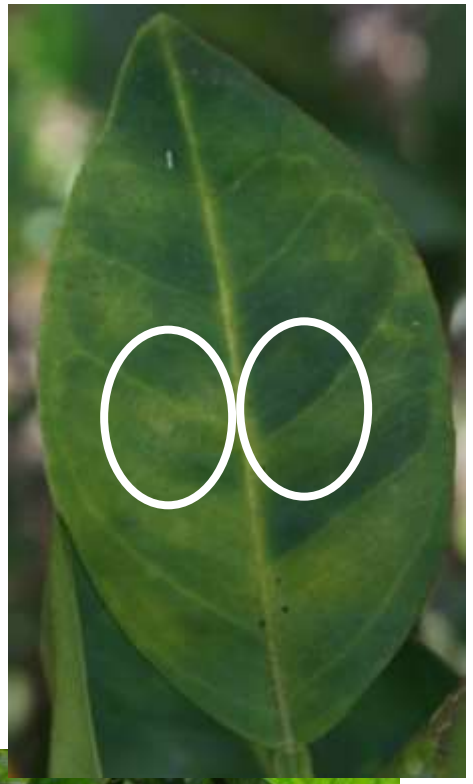

Mongi Zekri

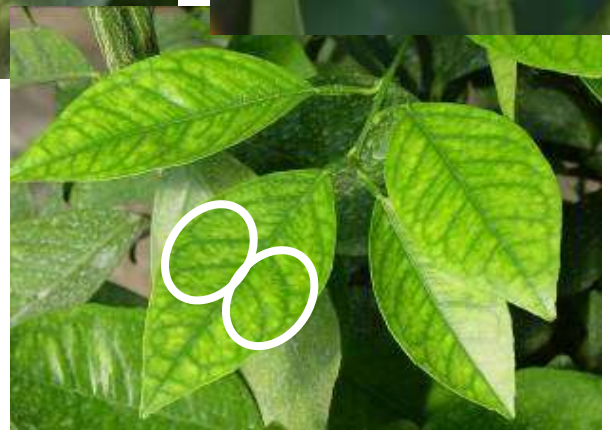

Tom Obreza

Identifying a Leaf Sample

- Circle areas on opposite sides of the midvein. Are they the same on both sides?
  - Nutrient deficiencies are symmetrical and HLB symptoms are asymmetrical
- Look at the other side of the leaf





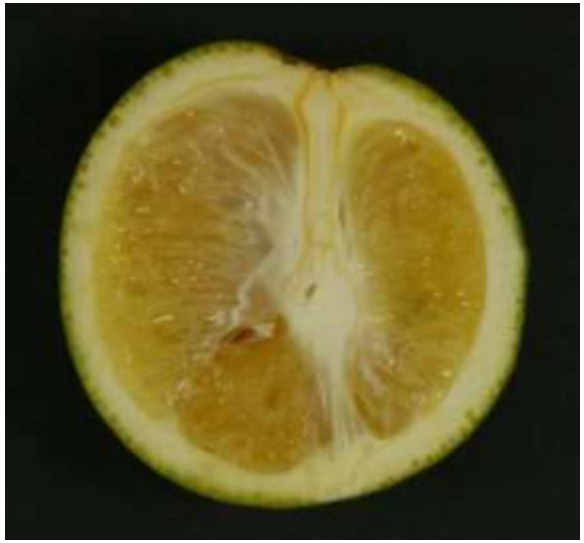


Fruit Symptoms

- Unmarketable, bitter fruit
- Cannot be used for fresh
- Can be used in processing for juice, but may have a flavor consequence

Internal Fruit Symptoms

- Yellow stain beneath the calyx button
- Curved central core
- Aborted seeds



External Fruit Symptoms

- Lopsided
- Misshapen
- Small
- Does not color properly

Tree Symptoms

- Leaf and fruit drop
- Yellow shoot
- Severely infected trees
  - Stunted
  - Sparse foliation
  - Twig dieback
- Off-season bloom

Common Fungal Diseases on Citrus






Photo Credit: Megan Dewdney, UF/IFAS Citrus Research and Education Center

UF | IFAS Extension
UNIVERSITY of FLORIDA

Citrus Scab

- Fungal disease
- Lesions change from pink to light tan
- Deforms leaves
- Described as wart-like

Citrus Scab






Photo Credit: Megan Dewdney, UF/IFAS Citrus Research and Education Center

Melanose

- Fungal disease
- Red-brown to black
- Feels like sandpaper
- Appears on fruit, leaves and stems

Melanose





Photo Credit: Megan Dewdney, UF/IFAS Citrus Research and Education Center

Greasy spot

- Fungal disease
- Yellow mottle pattern with reddish - brown blisters
- Looks like drops of grease as lesions age
- Affects all citrus, especially grapefruit, Pineapples, Hamlins and tangelos

Greasy spot

Photo Credit: Megan Dewdney, UF/IFAS Citrus Research and Education Center

Alternaria Brown Spot

- Fungal disease
- Fruit lesions protruding or sunken, crater-like
- Leaf lesions are smooth with a chlorotic halo that follow the veins on leaves
- Affects various tangerines and tangelos
  - Honeybell

Alternaria Brown Spot






Photo Credit: Megan Dewdney, UF/IFAS Citrus Research and Education Center

Postbloom Fruit Drop (PFD)

- Peach to orange-colored lesions on petals
- Fruit and petals fall leaving button
  - Can last up to 18 months on tree
  - Diagnostic for disease
- Leaves around infected flowers often twisted and small
  - Can look like a rosette

Postbloom Fruit Drop (PFD)

Photo Credit: Megan Dewdney, UF/IFAS Citrus Research and Education Center

Resources

- Rogers, Michael E. and Philip A. Stansly. Biology and Management of the Asian Citrus Psyllid, *Diaphorina citri* Kuwayama, in Florida citrus. http://edis.ifas.ufl.edu/in668
- Mead, F.W. and T.R. Fasulo. Asian Citrus Psyllid, *Diaphorina citri* Kuwayama (Insecta: Hemiptera: Psyllidae) https://edis.ifas.ufl.edu/in160
- Asian Citrus Psyllid. http://entomology.ifas.ufl.edu/creatures/citrus/acpsyllid.htm
- Stelinski, Lukasz L., Xavier Martini, and Kirsten S. Pelz-Stelinski. Traveling Psyllids http://www.crec.ifas.ufl.edu/extension/trade_journals/2013/2013_June_traveling.pdf

Any questions?

UF | IFAS Extension
UNIVERSITY of FLORIDA