Citrus: Should We Still Plant Them?

The Question of the Hour.

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Outline

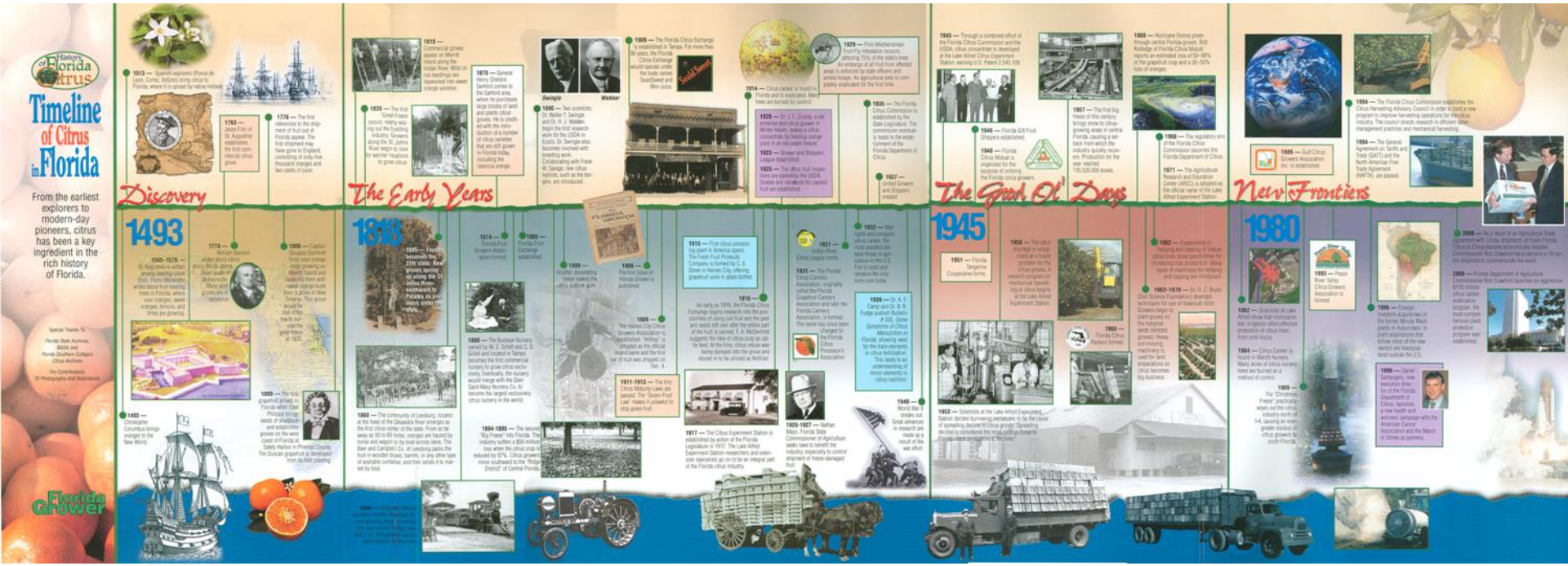
- Florida Citrus History
- Citrus Canker
- Citrus Greening
- Homeowner Options for Growing Citrus
- Anything new on the horizon?
- Summary: The answer to the question.

Florida Citrus History

- 1565-Citrus arrived with Spaniards in St. Augustine
- 1763-First commercial citrus grove established
- 1860-Leesburg was declared the first citrus center of the state
- 1915-First citrus processing plant in America opens
- 1945-Citrus concentrate is developed
- 1989-”Christmas Freeze” practically wiped out the citrus industry north of I-4

Florida Citrus History

- Florida is closely linked to citrus
- Today, it is a $9 billion industry



Florida Citrus Disease-Pest History

- 1933-Citrus Canker (bacterial disease)
- 1993-Citrus Leafminer (pest)
- 1998-Asian Citrus Psyllid (pest)
- 1986 and 1995 – Citrus Canker returns
- 2005-Citrus Greening (bacterial disease)
- 2010-Citrus Black Spot (fungal disease)
- Future…the possibility of diseases we don't have yet!

Citrus Greening

Fact or Fiction

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

History

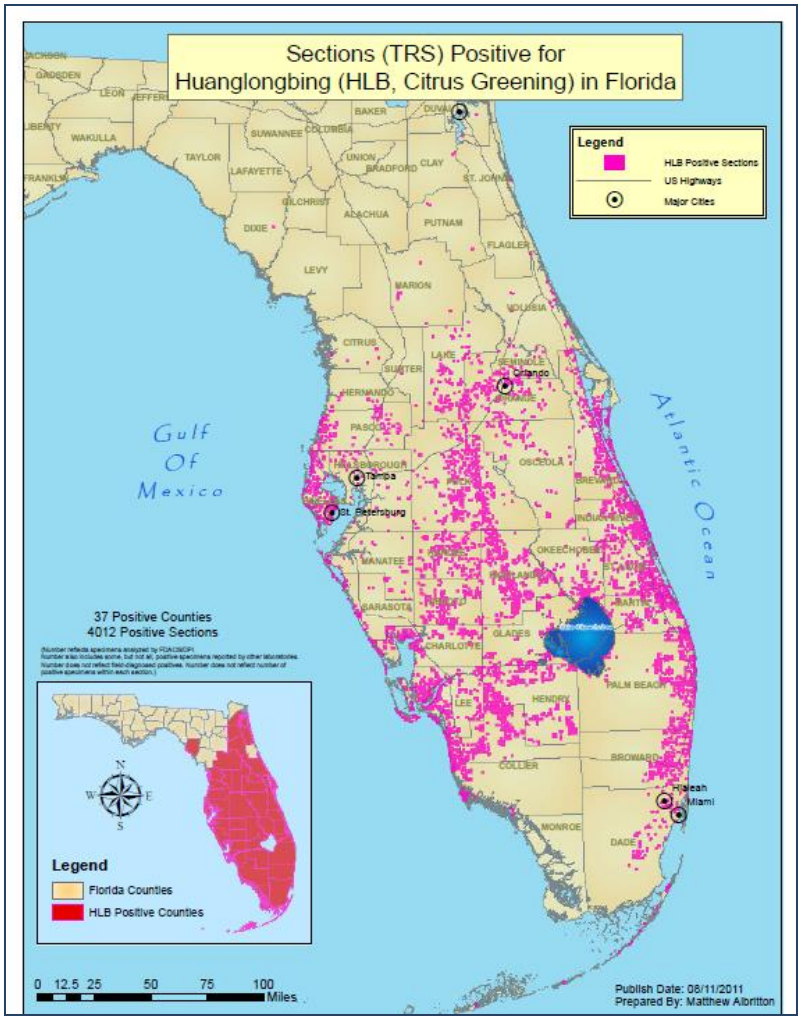
- 1919: First reported in China
- 1921: Reported in the Philippines, but thought it was zinc related
- 1937: In South Africa, thought to be mineral toxicity
- 1941-1955: Most extensive work on greening conducted in southern China

History

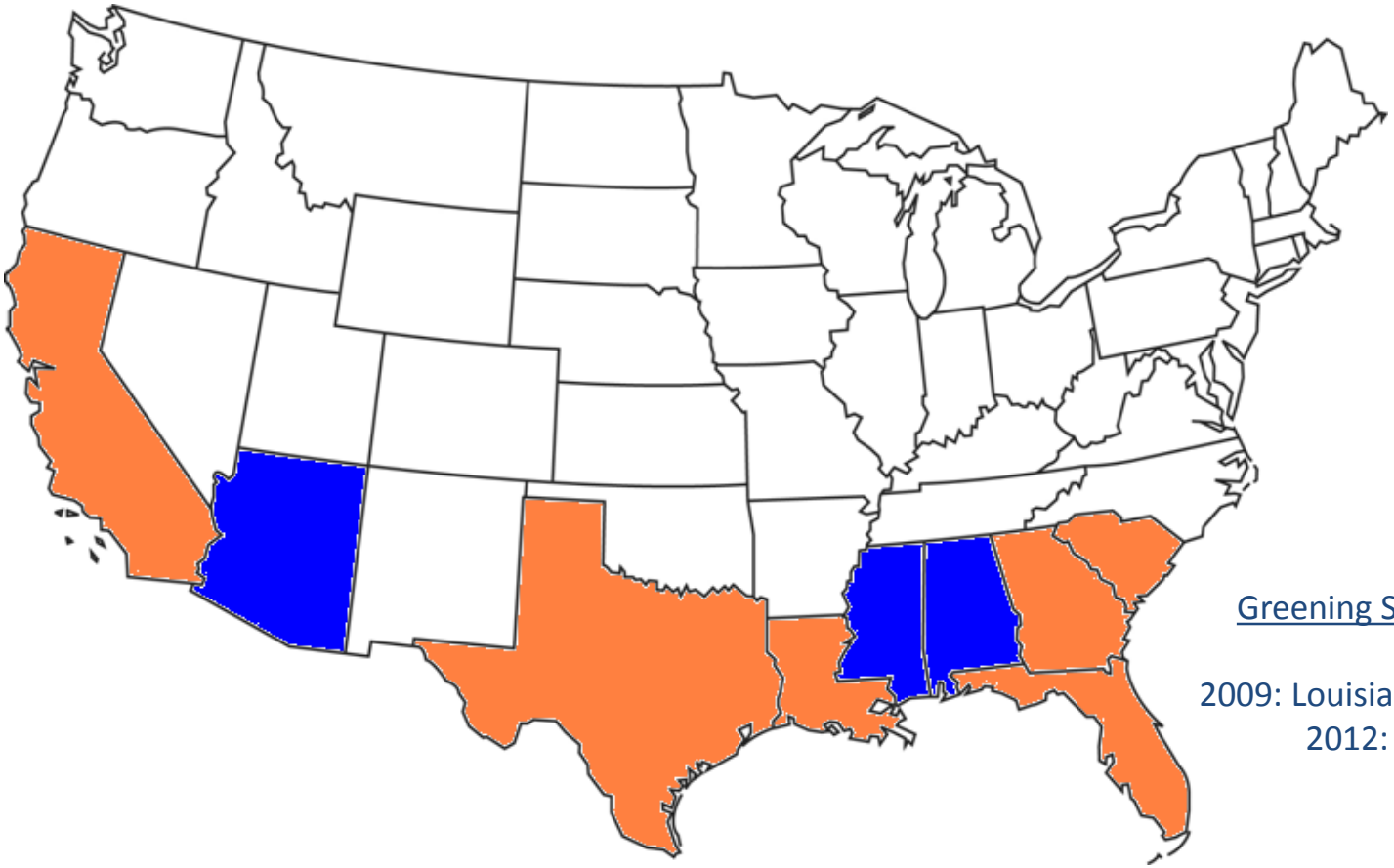
- 1960: Appeared in Thailand
- 1965: Researchers demonstrated HLB was transmissible by grafting and the citrus psyllid
- 1966: Filipino and Indian researchers recognized the similarities between various named diseases

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



United States Locations



ACP and HLB

ACP only

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

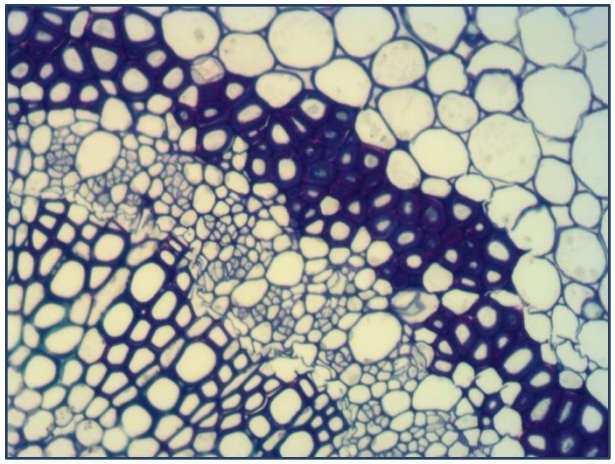
Map retrieved from http://www.martinsaphug.com/learn/maps-2/united-states-and-canada/

Importance

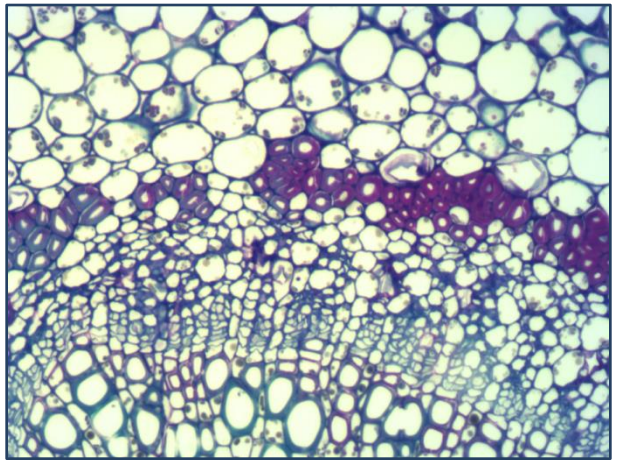
- Affects fresh market fruit
- Affects processed fruit
- No cure for the disease

Biology

- Caused by a bacteria
- Found within the phloem of the tree



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, milva		X
Aeglopsis chevalieri Swingle: Chevalier's aeglopsis	X	X
Afraegle gabonensis (Swingle) Engl.: Gabon powder-flask		X
Afraegle paniculata (Schum.) Engl.: Nigerian powder- flask		X
Atalantia missionis (Wall. ex Wight) Oliv.: *see Pamburus missionis*	X	X
Atalantia monophylla (L.) Corr.: Indian atalantia		X
Balsamocitrus dawei Stapf: Uganda powder- flask	X	X
Burkillanthus malaccensis (Ridl.) Swingle: Malay ghost-lime	X	
Calodendrum capense Thunb.: Cape chestnut	X	
× Citroncirus webberi J. Ingram & H. E. Moore: citrange	X	
Citropsis gilletiana Swingle & M. Kellerman: Gillet's cherry-orange		X
Citropsis schweinfurthii (Engl.) Swingle & Kellerm.: African cherry-orange		X
Citrus amblycarpa (Hassk.) Ochse: djerook leemo, djeruk-limau	X	
Citrus aurantiifolia (Christm.) Swingle: lime, Key lime, Persian lime, lima, limón agrio, limón ceuti, lima mejicana, limero	X	X
Citrus aurantium L.: sour orange, Seville orange, bigarde, marmalade orange, naranja agria, naranja amarga		X
Citrus depressa Hayata: shiikuwasha, shekwasha, sequasse	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: xiang cheng, yuzu	X	
Citrus kabuchi hort. ex Tanaka: this is not a published name; could they mean *Citrus kinokuni* hort. ex Tanaka, kishu mikan?	X	
Citrus limon (L.) Burm. f.: lemon, limón, limonero	X	X
Citrus × limonia Osbeck: potted orange, Rangpur lime, mandarin line, lemandarin, limón de Canton, limón grande	X	
Citrus maxima (Burm.) Merr.: punmelo, pomelo, shaddock, pompelmous, toronja	X	X
Citrus medica L.: citron, cidra, cidro, toronja		X
Citrus meyeri Tan.: Meyer lemon, dwarf lemon		X
Citrus × nobilis Lour.: king mandarin, tangor, Florida orange, King-of-Siam	X	X
Citrus oto hort. ex Tanaka: mandarin?	X	
Citrus × paradisi Macfad.: grapefruit, pomelo, toronja	X	X
Citrus reticulata Blanco: mandarin, tangerine, mandarina	X	X
Citrus sinensis (L.) Osbeck: sweet orange, orange, naranja dulce, naranja	X	X
Citrus sunki (Hayata) hort. ex Tanaka: sour mandarin, sunki mandarin	X	
Citrus unshiu (Mack.) 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
Cuscuta australis R. Br.: dodder, cúscuta	X	
Eremocitrus 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: Malayan kumquat		X
Limonia acidissima L.: Indian 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 H. F. Winters: desert-lime		
Microcitrus 'Sydney': see *Microcitronella*		X
× Microcitronella 'Sydney': faustrimedin		X
Murraya exotica L.: see *Murraya paniculata*		X
Murraya koenigii (L.) Sprengel: curry leaf	X	X
Murraya paniculata (L.) Jack: Lakeview, orange-jasmine, Chinese-box, naranjo jazmín	X	X
Naringi crenulata (Roxb.) Nicholson: naringi		X
Pamburus missionis (Wall. ex Wight) Swingle: pamburus		X
Poncirus trifoliate (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

Bacterium

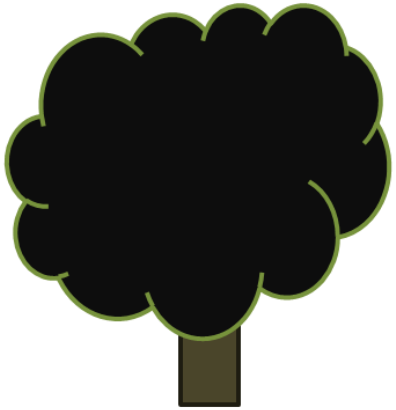
- *Candidatus* Liberibacter asiaticus
- Gram negative
  - Defines type of bacteria
- Phloem limited
- Fastidious bacterium
  - Cannot grow in culture
- Reproduces/multiplies in both the psyllid and the tree

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

Koch's Postulates

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

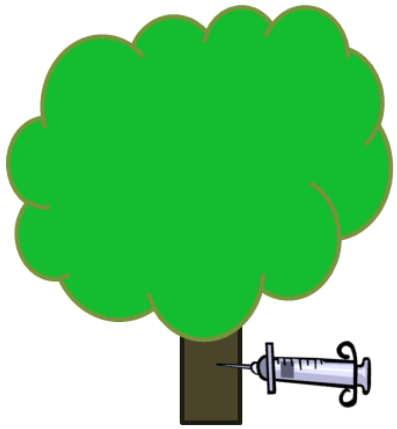
LAS must be present and associated with all diseased plants examined.



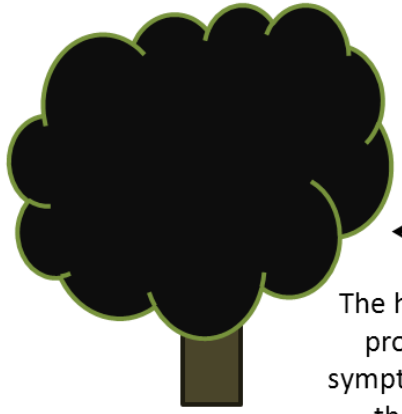
A sample is taken from the infected plant material. LAS must be isolated from the plant material and grown in pure culture.

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.



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.
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Spread

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

Asian Citrus Psyllid

- 5 nymphal stages
- Ten generations per year
- Life cycle between 15-47 days
- Egg to adult in two weeks at 75-80^{o}F

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 Damage

- Spreads the greening bacteria
- Nymphs produce a waxy secretion
- Notching on leaves

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

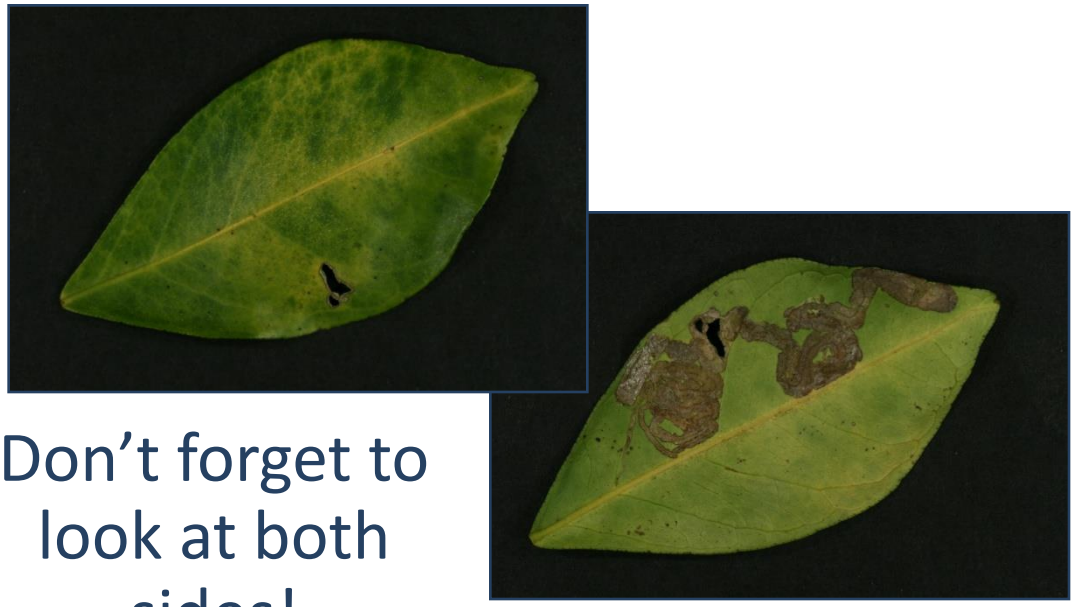
- Blotchy mottle patterns
- Yellow veins
- Vein corking
  - Raised veins with a corky appearance
  - Found on mature leaves

Commonly Mistaken for HLB

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

Commonly Mistaken for HLB

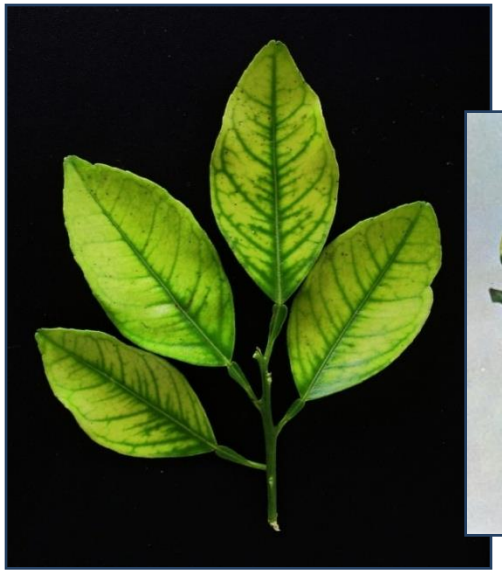
- Insect damage
- Herbicide/Chemical damage

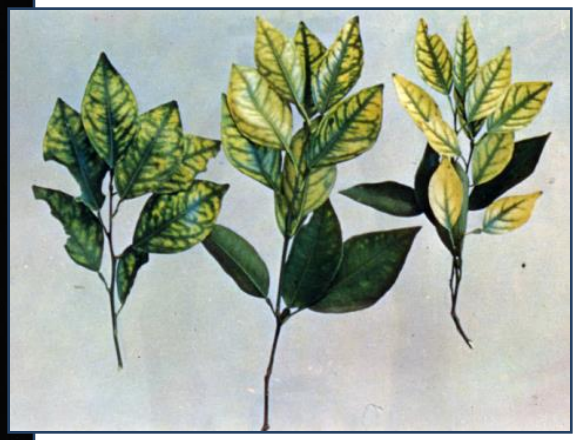


Don’t forget to look at both sides!

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

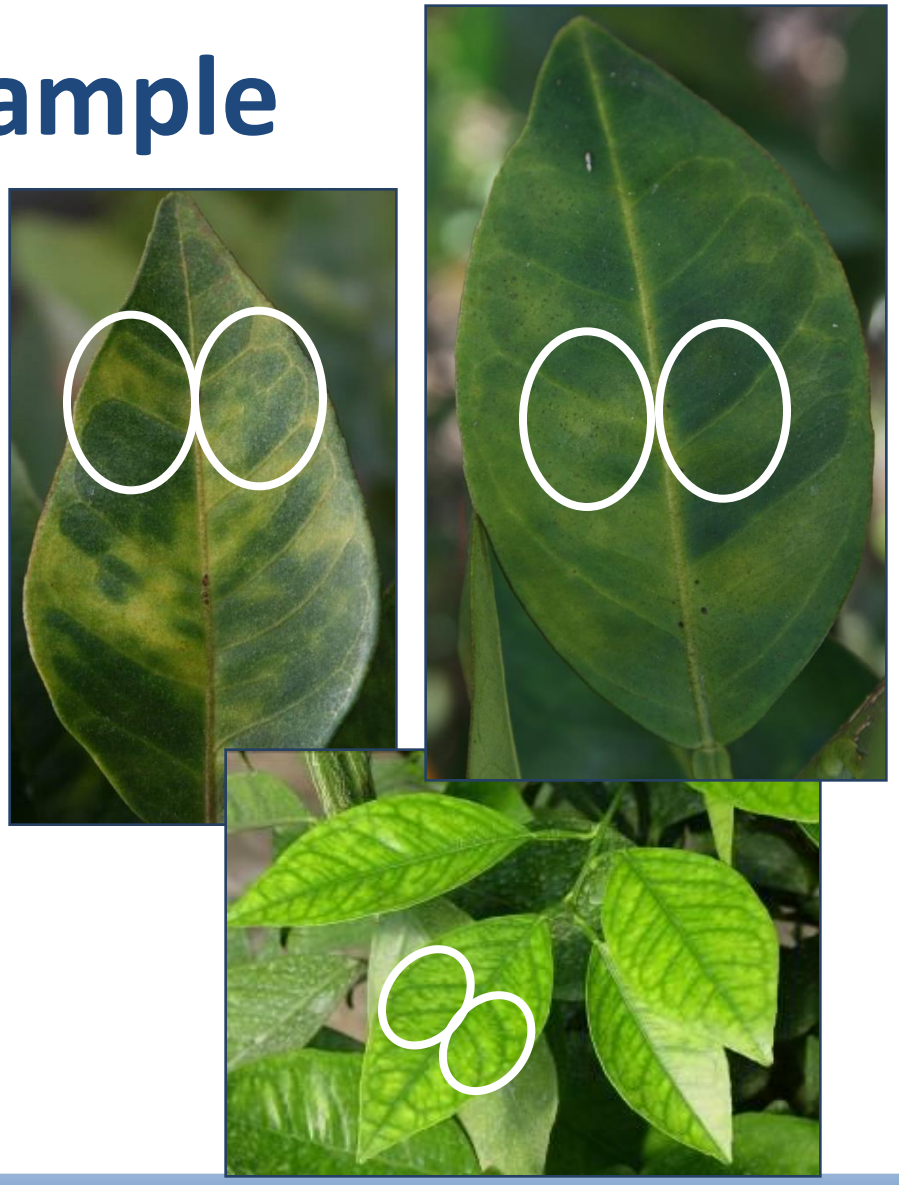
- Manganese
  - Dark green veins with a lighter green background
- Magnesium
  - Inverted ‘V’ pattern


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 process, but may have a flavor consequence

Internal Fruit Symptoms

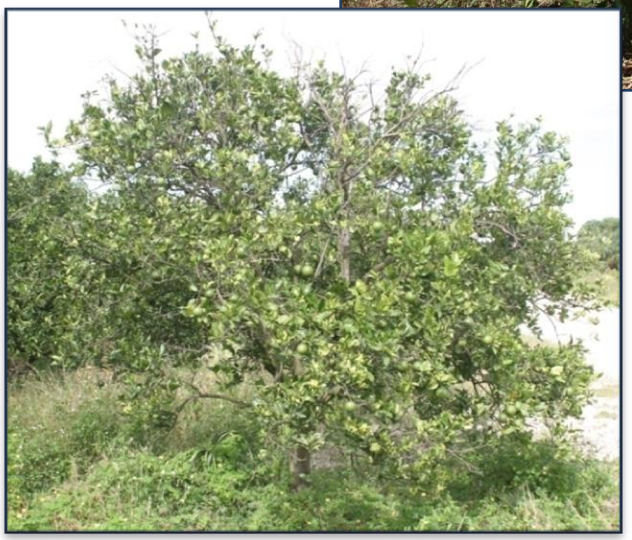
- Yellow stain beneath the calyx button
- Curved central core
- Aborted seeds

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



Unsure-is it greening or not?

- Three options for testing
  - Southwest Florida Research and Education Center, Immokalee
  - Division of Plant Industry, Gainesville
  - Plant Disease Clinic, Gainesville

What to do if a tree has greening

- No known cure once a tree is infected
- You cannot prune away an HLB infection
- Tree removal is the only known effective control
- Trees usually decline within 3-5 years of infection and ultimately die

Homeowner Options

- Prevention
- Tree Removal and replant
- Refuse to remove tree
- Remove ornamental hosts
- Alternative crops

Option #1: Prevention

- Maintain a healthy tree
- The source of spread is the psyllid; therefore, prevention of the psyllid is key!
- You cannot prevent psyllids flying onto your citrus trees
- Limited chemicals for homeowner usage

Option #1: Chemical Prevention

- Non-systemic (foliar applied)

- Systemic (soil applied and taken up by roots)

Remember - the label is the law!

Option #1: Chemical Prevention

- Non-systemic
  - Horticultural oil
  - Malathion
  - Carbaryl
- Systemic
  - Imidacloprid

Option #1: Organic Prevention

- Horticultural mineral oil
- Neem oil

Remember - the label is the law!

Option #1: Organic Prevention

- Kaolin
  - Clay product
  - White covering on the tree
    - Photosynthesis???
      - Reduces heat stress; therefore, maintaining photosynthesis
      - Improves productivity
      - Reduces sunburn (mandarin)
  - Will need to purchase from specialty garden stores

S. L. Lapointe, U.S.Horticultural Research Lab, Ft. Pierce, FL

Option #2: Tree Removal and Replant

- A psyllid won't feed on a dead tree
- After removal of the tree
  - Burn
  - Put in lawn waste

Option #2: Tree Removal and Replant

- When removing an infected tree be sure to kill the stump with a herbicide to prevent sprouting
  - Sprouts will contain the bacteria and be a source of inoculum

Option #2: Tree Removal and Replant

- If other trees nearby, some roots will graft together-be careful applying a herbicide!
- You can replant in the same area, but should wait depending on the chemical used

Option #2: Tree Removal and Replant

- No regulated time period to replant
- Be cautious and alert when buying a citrus tree
- Citrus trees are more scarce and more expensive than they used to be – buying one is an INVESTMENT!
- Buy from a reputable local garden center or nursery who is knowledgeable about citrus

Option #2: Tree Removal and Replant

- DO NOT buy a tree without a tag!
  - FDACS Rule 5B-62.020(3)
    - All retail citrus trees must be tagged with information to identify the variety of the rootstock and scion stock and producing nursery. Each individual tree shall be identified with a slip-on label displaying the following information:
      a. The producing nursery's certificate of nursery registration number… It is not necessary to include the name of the producing nursery on the label.
      b. The variety name, rootstock and month and year acquired.

Option #3: Refuse to remove tree

- Tree remains a source for psyllids to feed and continue to spread the bacteria
- It will become unproductive!

Option #3: Refuse to remove tree

- Nutrient programs?
  - Will not cure the tree, only prolong the life

Growing citrus in the dooryard is no longer a simple task.

Options 4 and 5 will assist in a different way.

Option #4: Remove ornamental hosts

- Remove host plants

Murraya paniculata
(orange jasmine)

Option #5: Alternative Crops

- Peaches
- Blueberries
- Pomegranates
- Persimmons
- Chestnuts

Alternative Crops-Considerations

- Pick something you like
- Ornamental flowers, but not edible
- Maintenance
- Varmits (squirrels, raccoons, deer, etc.)

Anything new on the horizon?

- Research is on-going
- Research is wide-ranging
- Research takes time!

Summary

- The answer to the question
- Ask yourself these questions
  - Do I have time to take care of my tree(s)?
  - Do I have the financial means to purchase the necessary products to prevent citrus greening?
  - If I answered yes to the above questions, will I make the commitment?

Growing citrus today is an investment of time, money, and resources.

Are you willing or are you unable?

There are many opinions on whether residents should or should not grow citrus, but in reality, the decision is left to the stewardship of the homeowner and their willingness to be an asset to the citrus industry.

*According to the Merriam-Webster Dictionary, stewardship is defined as the conducting, supervising, or managing of something; the careful and responsible management of something entrusted to one's care

Any questions?