Citrus Greening

NPDN
National Plant Diagnostic Network

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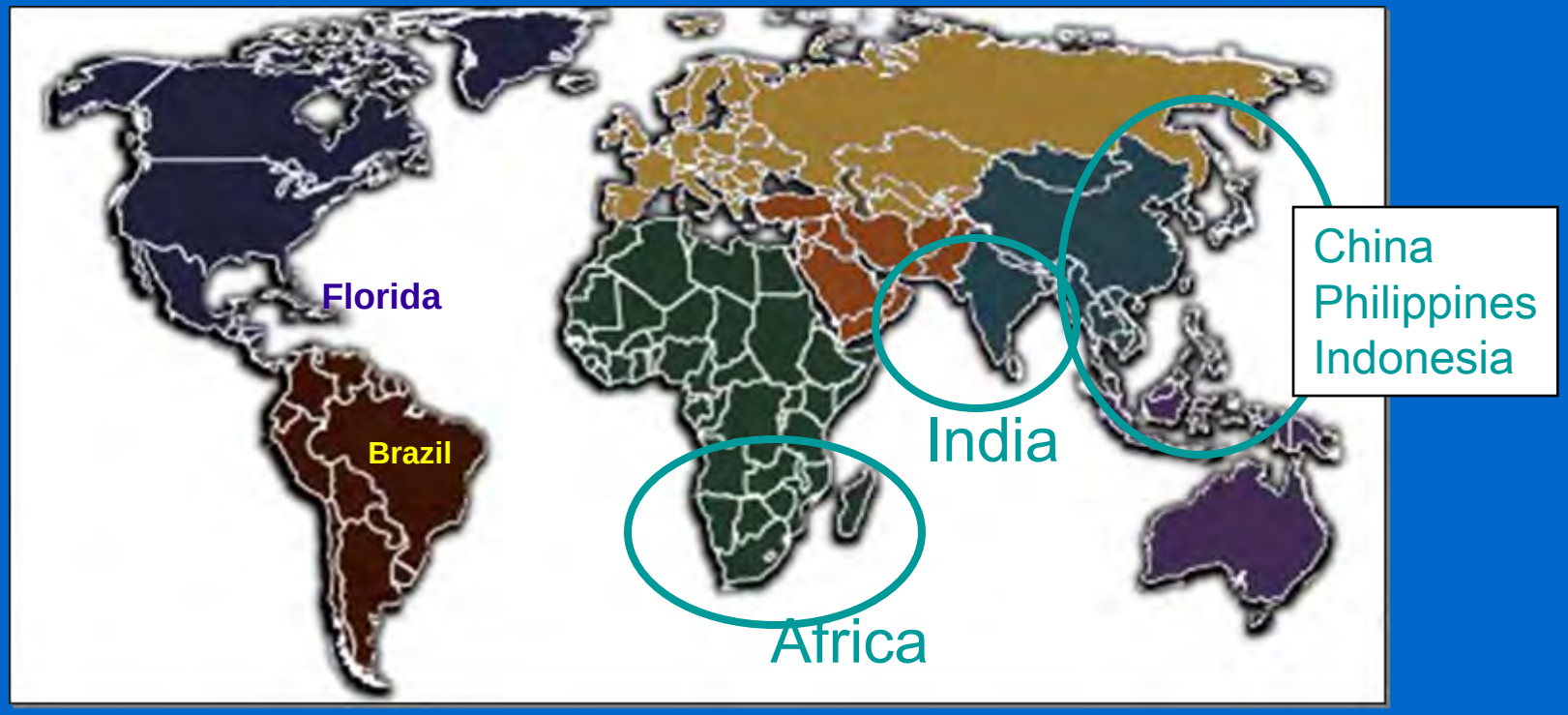
Citrus Greening
or
Huanglongbing

- Introduction
- Distribution
- Symptoms
- Host
- Vector
- Management

Introduction

- Original observations of the disease were made by farmers in southern China in the late 1800s
- Citrus greening was confirmed in Florida in 2005
- The Chinese name, Huanglongbing, meaning yellow shoot or yellow dragon refers to the leaf yellowing that may appear on a single shoot or branch

Worldwide Distribution of Citrus Greening



Countries with established Citrus Greening:

Bangladesh, Bhutan, Brazil, Burundi, Cambodia, Cameroon, Central African Republic, China, Comoros, Ethiopia, Hong Kong, India, Indonesia, Japan, Kenya, Laos, Madagascar, Malawi, Malaysia, Mauritius, Myanmar, Nepal, Pakistan, Papua New Guinea, Philippines, Reunion, Rwanda, Saudi Arabia, Somalia, South Africa, Sri Lanka, Swaziland, Taiwan, Tanzania, Thailand, Vietnam, Yemen, Zimbabwe

Economic Importance

- Losses vary from partial to complete tree death
- In the Philippines, greening was largely responsible for reducing area of citrus by 60% between 1961 and 1970
- In Thailand, up to 95% of trees in areas are affected
- In South Africa, crop losses of 30-100% were recorded (prior to 1970)

Economic Importance

- Without control measures a grove of trees can become totally infected in 5-10 years.
- With the onset of symptoms most trees will become unproductive in 2-5 years.
- Without control measures total life of affected groves estimated at 7-10 years after planting.
- Quantitative data on damage on fruit yield and quality is lacking.

Economic Importance

In Brazil (Bassanezi et al 2006)

- Fruit number and weights reduced
- Fruit diameter reduced 17%
- Brix reduced 13%
- Ratio reduced 32%
- Juice % reduced 7%
- Acid content increase 29%

Photo by M. Garnier

Candidatus Liberobacter *asiaticus*

Causal Agent

- Symptoms of the African disease are expressed under cool conditions (20-25 C)
- Symptoms of the Asian disease are expressed under both warm and cool conditions up to 35 C
- The greening disease in Florida is caused by the Asian type

Symptoms of Greening

- Tree stunting
- Sectoring of symptoms
- Heavy leaf drop
- Off-season flushing and blooming
- Few fibrous roots or new root growth
- Roots may decay
- Tree Dieback

Foliar symptoms

Picture courtesy of M. Zekri, University of Florida

Blotchy mottle is independent of veins

Symptoms may not appear
for 2 years or more
After infection

Leaves have higher potassium content and
lower calcium, magnesium and zinc concentration

Citrus greening

Homeowner Blight- Florida

Photos courtesy of S. Halbert, Florida Department of Plant Industry

Secondary symptoms are small leaves upright and chlorotic symptoms similar to zinc and iron deficiencies


Photo by R.H. Brlansky


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Photo by R.H. Brlansky


Photo by R.H. Brlansky

Fruit symptoms

- Fruit may be small, lopsided and taste bitter or salty
- Higher acid and lower sugar
- Premature drop
- Do not color properly, remaining green on shaded side (= greening name origin)
- Seeds turn dark, shrunken and abort

Picture courtesy M. Zekri
University of Florida

Host Range of the Pathogen

- Only in Rutaceae family
  - Kumquat
  - *Murraya paniculata*, Orange Jasmine, Mock Orange ornamental shrub
  - Experimentally: Common Jasmine orange (*Murraya paniculata* var. *paniculata*)
  - Bacteria can multiply in Chinese box orange (*Severinia buxifolia*) and Wood apple (*Limonia acidissima*)

Greening or Not

- Many symptoms of other diseases or problems can mimic greening
- Typically confirmation is by a molecular test – polymerase chain reaction (PCR)

Susceptibility of Citrus

- All citrus cultivars, species, hybrids and some citrus relatives are susceptible
- Severity of symptoms on different hosts vary from geographical region
- Some citrus selections are more severely affected.

Susceptibility of Citrus

- Asian strains
  - Severe (Sweet orange, mandarin)
  - Moderate (Grapefruit, pummelos, lemon, sour orange)
  - Tolerant (Mexican lime, trifoliate orange and some trifoliate orange hybrids)

Modes of Transmission

- Can be transmitted by bud grafting but not at high rates due to necrosis in sieve tubes and uneven distribution of the bacteria
- Dodder (*Cuscuta* spp.)
- Citrus Psyllid is the primary vector
  - Occurs with high psyllid populations when the host is flushing which is when the psyllid migrations are highest

How Fast Can It Spread?

- Disease could stay hidden for years
- May have been in Brazil for 10 years.
- Detections of up to 120 miles from sources point to a 12-15 mi/yr spread

Insect Vector

- 2 species of Citrus psyllid are vectors
  - The African Citrus Psyllid, *Trioza erytreae* occurs in Africa, Reunion, Yemen and vectors the African strain of greening. It survives well in cool upland areas
  - The Asian Citrus Psyllid, *Diaphorina citri* is in Asia, India, Saudi Arabia, Reunion, and North, South and Central America. It is more resistant to high temperatures and survives in hot lower altitudes.

- Adults are small (3-4 mm), with mottled brown wings.
- Adults sit at an angle on to the shoot or leaf on which they feed
- Nymphs are yellowish-orange and found on the new growth and do not fly

Photo credits: Adult psyllids byJeffrey W. Lotz, Florida Department of Agriculture and Consumer Services, http://www.bugwood.org/

Vector Relations

- Acquisition 15-30 min
- Latent period: 8-12 days
- Inoculation access period: ~ 1 hr
- Transmission of bacteria is in a persistent manner
- Acquisition by adults, large nymphs, 4^{th} and 5^{th} instars (a report of 2^{nd} and 3^{rd})
- Persists and reproduces in the vector for life
- Transovarial transmission not proven

Insect Vector

- The fourth and fifth instar nymphs can acquire citrus greening bacteria and transmit the disease as nymphs or adults

Photo credits: Jeffrey W. Lotz, Florida Department of Agriculture and Consumer Services, http://www.bugwood.org/

•Asian citrus psyllid female and eggs on newly-emerged growth flush.
(Image courtesy of Michael Rogers, Extension Entomologist, IFAS, University of Florida, Lake Alfred).

Eggs are bright yellow-orange, and almond-shaped. Eggs are laid on the tips of shoots or in the crevices of unfolded “feather flush’

Detection and Diagnosis

- Biological indexing on sweet orange seedlings
- Observation the bacterium in phloem sieves tubes by electron microscopy
- DNA/DNA hybridization
- PCR

Control of Vectors

- Insecticides
  - Used in Asia and elsewhere with varying results
  - Systemic pesticides used for psyllid control on young non-producing trees and contact pesticides used on older trees
  - Interferes with biological control
- Biological control
  - Successful in Reunion Island

Control of the Greening Pathogen

- Thermotherapy
  - Treatment of budwood, seedlings or other plant material at high temperature (i.e. 47 C for 2 hr)
- Shoot-tip grafting
- Chemotherapy
  - Injection or treatment with antibiotics
- Breeding for resistance

Other Suggested Control Measures

- Produce greening-free trees
- Use shoot-tip grafted material
- Use sticky yellow traps to identify nursery and groves that have psyllids
- Remove abandoned trees/groves
- Remove alternate hosts

Other Suggested Control Measures

- Control measures will vary depending upon the regulations in your local area. Contact your State Department of Agriculture for the
- Quarantine
- Increase planting density of trees to increase production

References

- Bassanezi, R. B. Montesino, L. H. Busato L. A. and Stuchi E. S.. 2006. Damages caused by Huanglongbing on sweet orange yield and quality in Sao Paulo. Proceedings of the Huanglongbing-Greening International Workshop, Ribeirao Preto, Brazil page 39 (Abstract).
- Chung K.-R. and Brlansky, R. H.. Citrus Diseases Exotic to Florida: Huanglongbing (Citrus Greening). University of Florida/IFAS. EDIS PP133.
- da Graca, J.V. 1991. Citrus Greening Disease.
- Garnier, M., and Bove, J.M. 2000. Huanglongbing (Greening). In Compendium of Citrus Disases. Pages 46-48.
- Nariani, T.K. 1981. Integrated approach to control citrus greening disease in India. Proc. Int. Soc. Citriculture 1:471-472.
- Teixeira, D. d. C., Saillard, C., Eveillard, S., Danet, J.L., Inacio da Costa, P., Ayres, A.J., and Bove, J. 2005. *Candidatus* Liberibacter *americanus* associated with citrus huanglongbig (greening disease) in Sao Paulo State, Brazil. Int. J. Syste. Evol. Microbiol 55:1857-1862.

Additional Websites

- http://spdn.ifas.ufl.edu/Citrus%20_Greening.htm
- http://www.doacs.state.fl.us/pi/chrp/greening/citrusgreening.html
- http://www.invasive.org/browse/subject.cfm?sub=4695
- http://ipm.ifas.ufl.edu/agriculture/citrus/asian.shtml
- http://www.anrcatalog.ucdavis.edu/pdf/8205.pdf

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Authors

- P.D. Roberts, prd@ufl.edu, University of Florida, Southwest Florida Research and Education Center
- R. H. Brlansky, rhby@ufl.edu, University of Florida, Citrus Research and Education Center

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