Lethal Yellowing (LY) of Palm[1]

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Summary

- Lethal yellowing (LY) is a phloem-limited disease caused by a phytoplasma and transmitted by a planthopper.
- Historically, LY has occurred only in the southern one-third of Florida. The disease was observed for the first time in Sarasota and Manatee Counties on the west coast of Florida in 2007 and in Indian River County on the east coast in 2012.
- LY symptoms are highly variable among *Cocos nucifera* (coconut) cultivars and among other palm genera.
- Palms with greater than 25% leaf discoloration or a dead apical meristem (bud) due to LY should be removed.
- Management of LY includes trunk injections of oxytetracycline HCl (OTC) every four months, and planting of palm species that are not hosts of LY.
- Very few palm species native to Florida and the Caribbean Basin appear to be susceptible to LY.

Introduction

Lethal yellowing (LY) is a palm disease that was prevalent in Florida landscapes in the southern one-third of the state. In 2007, the disease was observed in Sarasota and Manatee Counties on the west coast of Florida, counties where it had not been observed previously. In 2012, the disease was observed in Indian River County on the east coast of Florida. LY is also observed in field nurseries. This disease has significantly reduced the number of tall-type *Cocos nucifera* (coconut) in Florida and the Caribbean Basin, and localized outbreaks continue to occur. While sporadic cases still emerge from time to time in South Florida, LY is not as prevalent as it once was. While the exact reason for a reduction in disease pressure from LY is unknown, it is likely due to a combination of factors such as aggressive OTC programs, aggressive monitoring and removal programs, and the death of highly susceptible hosts from the infection itself.

Pathogen and Hosts

LY is caused by a phytoplasma, a type of bacteria that lacks a cell wall and cannot be cultured in the laboratory. The phytoplasma has been classified as a member of group 16S rDNA RFLP group 16SrIV, subgroup A (16SrIV-A). The proposed name for the pathogen is "*Candidatus* Phytoplasma palmae."

It is spread by the planthopper *Haplaxius crudus*, a common planthopper in southern Florida. The phytoplasma is a systemic pathogen that is found only in the phloem tissue

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(vascular tissue transporting photosynthates) of palms. It is not known to survive outside either its plant or insect hosts. The planthopper is a piercing and sucking insect, meaning it feeds on the contents of the plant host vascular system, including the phloem. The insect moves the phytoplasma from palm to palm as it moves during its feeding cycles.

Until recently, the geographic range of LY in Florida was limited to the subtropical southern one-third of the state. This was believed to be due to the movement of the vector, *H. crudus* further north due to milder winters. Recently, however, after some harsher winters and cold snaps, *H. crudus,* has been confirmed as far north as Gainesville and is capable of overwintering. Due to a seemingly statewide distribution of *H. crudus* and the absence of LY from much of the state now, the recent movement of LY further north is likely due to some unknown factor.

At least 37 palm species have been documented with LY (Table 1).

Another palm disease caused by a phytoplasma that is similar to, but genetically distinct from, the LY phytoplasma was observed in 2007 on *Phoenix canariensis*, *P. dactylifera* and *P. sylvestris* growing in the south-central coastal region of west Florida (Sarasota to Tampa). The symptoms and management of this disease, called lethal bronzing disease (LBD), formerly Texas Phoenix Palm Decline, on *Phoenix* species appear to be the same as those for LY. See https://edis.ifas.ufl.edu/pp163 for further information on this disease.

Symptoms

As with any disease, diagnosis is based on a series of symptoms. Furthermore, no single symptom is diagnostic of LY. Rather, it is the appearance and chronological progression of symptoms that accurately identifies the disease. The difficulty with LY diagnosis is that symptoms vary according to the palm species, and in the case of coconuts, the particular cultivar involved.

Fruit Drop and Flower Necrosis

The first obvious symptom on mature palms (those able to produce fruit) is a premature drop of most or all fruits. For coconuts, the calyx (stem) end of the fruit will usually have a brown to black, water-soaked appearance (Figure 1). Next, inflorescence (flower) necrosis (death) develops. Normally light yellow to creamy white in color, emerging flower spikelets are instead partially or totally blackened. Male flowers abscise from flower spikelets and no fruit is set. These symptoms will only be observed if the palm is flowering or fruiting when the disease develops.

Boron deficiency in coconut will also cause premature nut drop. However, nuts dropped due to boron deficiency will not have the discolored, water-soaked appearance at the calyx (stem) end of the nut (Figure 1).

Figure 1. Fruits that prematurely dropped from *Cocos nucifera* due to Lethal Yellowing. Note dark, water-soaked calyx (stem) end. Credits: N.A. Harrison

Foliage Discoloration

For tall-type coconut cultivars, the next symptom is a yellowing of the foliage, beginning with the lowest (oldest) leaves and progressing upward through the crown (Figure 2). In some cases, this symptom is seen as a solitary yellowed leaf ("flag leaf") in the middle of the leaf canopy (Figure 3). Typically, yellowed leaves remain turgid, and eventually turn brown, desiccate, and hang down forming a skirt around the trunk for several weeks before falling (Figure 3).

Foliar discoloration varies markedly among coconut cultivars and other palm genera. For most tall-type coconut cultivars, leaves turn a golden yellow before dying, while on dwarf cultivars, leaves generally turn a reddish- to grayish-brown (Figures 4 and 5). Leaflets on the green form of the 'Malayan Dwarf' cultivar may be folded around the midvein. Affected leaves appear noticeably flaccid rather than turgid, giving an overall wilted appearance to the palm canopy (Figure 4), but this is not a consistent symptom.

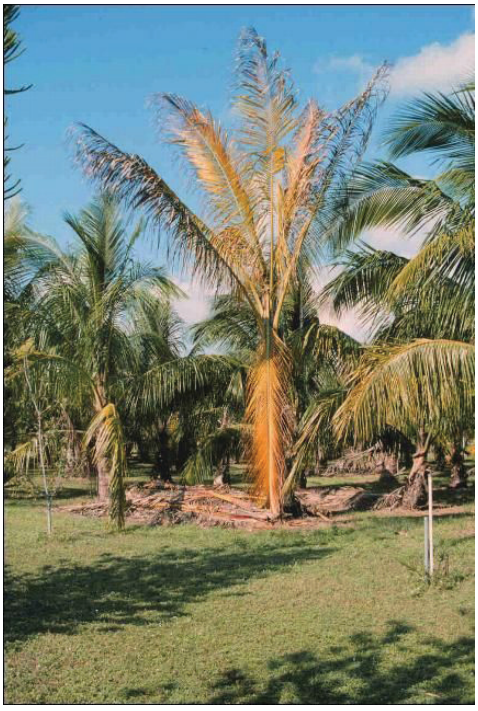

Figure 2. Foliar yellowing symptoms of *Cocos nucifera* due to Lethal Yellowing.
Credits: N.A. Harrison

Figure 3. 'Jamaica Tall' *Cocos nucifera* on left is exhibiting Lethal Yellowing symptoms of a solitary yellowed leaf ("flag leaf") in middle of canopy plus dead leaves hanging down around trunk.
Credits: T.K. Broschat

Foliar yellowing develops on such species as *Caryota mitis* (clustering fishtail palm) (Figure 6), *C. rumphiana* (Figure 7), *Chelyocarpus chuco*, *Corypha elata*, *Dictyospermum album* (hurricane or princess palm),*Hyophorbe verschaffeltii* (spindle palm) (Figure 8), *Livistona chinensis* (Chinese fan palm) (Figure 9),*Pritchardia* spp., and *Trachycarpus fortunei* (windmill palm).

For other palm species, such as *Adonidia merrillii* (Christmas palm), *Borassus flabellifer* (palmyra palm) (Figure 10), *Dypsis decaryi* (Triangle palm) (Figure 11), *Phoenix* spp. (Canary Island date palm, date palm, wild date palm) (Figures 12, 13, and 14), and *Veitchia arecina* (Montgomery palm), successively younger leaves turn varying shades of reddish-brown to dark brown or gray rather than a distinctive yellow.

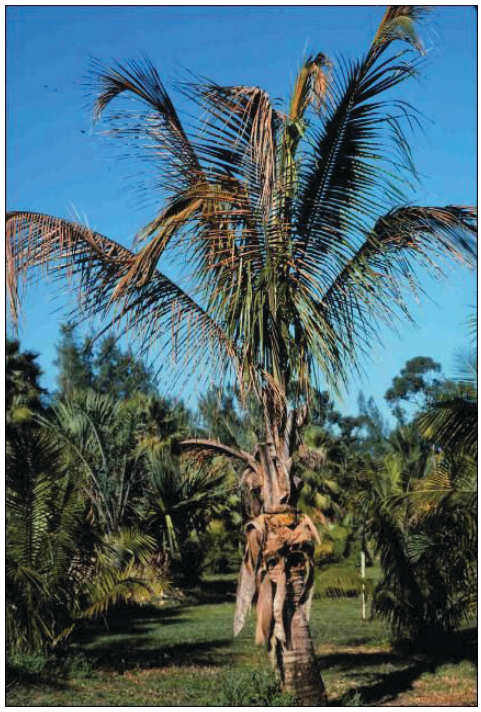

Figure 4. Green form of 'Malayan Dwarf' *Cocos nucifera* with Lethal Yellowing exhibiting discoloration of leaves (grayish-brown rather than yellow) and overall wilted appearance.
Credits: N.A. Harrison

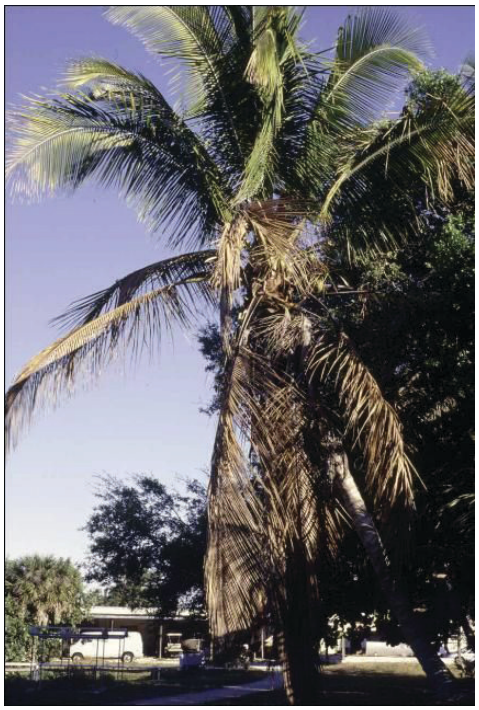

Figure 5. 'Maypan' *Cocos nucifera* with Lethal Yellowing exhibiting discoloration of leaves (grayish-brown rather than yellow).
Credits: N.A. Harrison

Figure 6. Foliar yellowing symptoms of Lethal Yellowing on *Caryota mitis*.
Credits: N.A. Harrison

Figure 7. Foliar yellowing symptoms of Lethal Yellowing on *Caryota rumphiana*.
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Figure 8. Foliar yellowing symptoms of Lethal Yellowing on *Hyophorbe verschaffeltii*.
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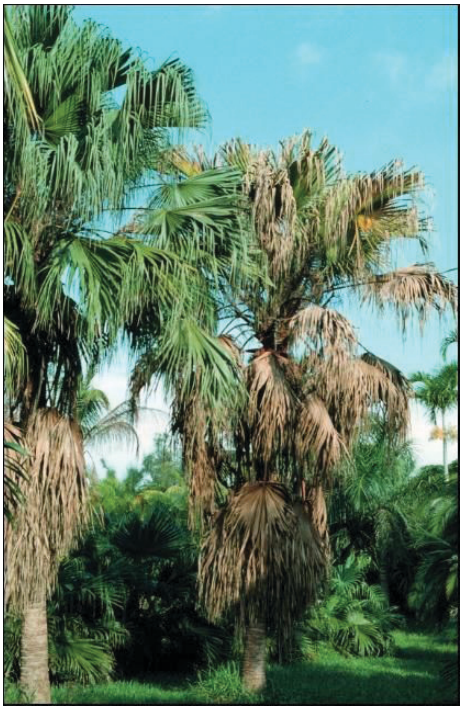

Figure 9. Foliar yellowing symptoms of Lethal Yellowing on *Livistona chinensis*.
Credits: N.A. Harrison

Figure 10. Foliar browning symptoms of Lethal Yellowing on *Borassus flabellifer*.
Credits: N.A. Harrison

Figure 11. Foliar browning symptoms of Lethal Yellowing on *Dypsis decaryi*.
Credits: N.A. Harrison

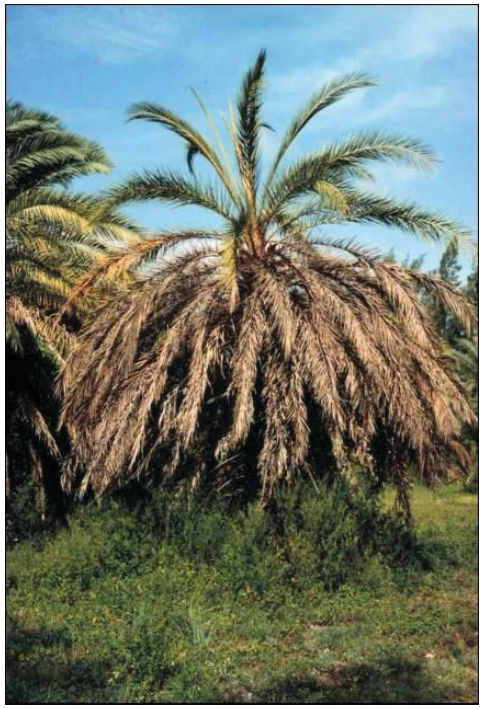

Figure 12. Foliar browning symptoms of Lethal Yellowing on *Phoenix dactylifera*.
Credits: N.A. Harrison

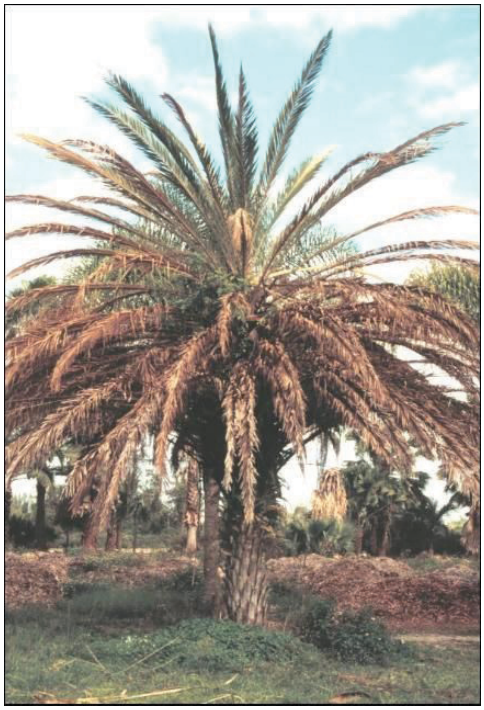

Figure 13. Foliar browning symptoms of Lethal Yellowing on *Phoenix sylvestris*.
Credits: N.A. Harrison

Death of the Apical Meristem (Bud)

Figure 14. Foliar browning symptoms of Lethal Yellowing on *Phoenix reclinata*.
Credits: N.A. Harrison

As foliage discoloration advances up through the crown (canopy), the spear (youngest) leaf collapses and hangs down in the crown. This indicates the apical meristem (bud or growing point of the palm) has died.

For most palm species, including coconuts, death of the apical meristem usually occurs when one-half to two-thirds of the crown has become yellow or brown. However, for *Phoenix* species and *Borassus flabellifer*, spear leaf collapse and death of the apical meristem occurs when one-third or less of the crown has become discolored (Figure 15). For *Adonidia* and *Veitchia*, the spear is usually unaffected until after all other leaves have died.

Eventually, the entire crown of the palm withers and topples, leaving a bare trunk standing (Figure 16). Infected palms usually die within 3 to 5 months after the first appearance of symptoms.

Diagnosis

The plant symptoms described above are relied upon to make the initial field diagnosis. Since the phytoplasma is not culturable, a molecular diagnostic test is used to confirm the presence of the pathogen. This requires drilling into the palm trunk. If pathogen confirmation is necessary, samples can be submitted at the UF/IFAS Fort Lauderdale Research and Education Center in Davie, FL. Sampling instructions and submission forms are available at https://flrec.ifas.ufl.edu/research/entomology-and-nematology-/.

Figure 15. Collapsed spear leaf of *Phoenix sylvestris* is hanging down from crown (see arrow). Once this spear leaf breaks off or falls from the crown, it is not readily apparent that the apical meristem (bud) has died.
Credits: N. A. Harrison

Figure 16. Death of *Cocos nucifera* apical meristem (bud) from Lethal Yellowing causes crown to wither and topple from trunk.
Credits: N. A. Harrison

Disease Management

Chemical control of LY is achieved by application of the antibiotic oxytetracycline HCl (often referred to as OTC) administered to palms by liquid injection into the trunk.

As a therapeutic measure, systemic treatment on a 4-month treatment schedule should begin as early in symptom expression as possible. Symptomatic palms with >25% discolored leaves should be removed, since they are unlikely to respond to OTC treatment. For susceptible *Phoenix* species, if the apical meristem (bud) is already dead, the palm will not respond to OTC treatment.

The antibiotic can also be used preventively to protect palms when LY is known to occur in the area. The amount recommended depends on the size of the treated palm. Always follow directions for use on the label.

The one question often asked regarding OTC injections concerns the length of time one must continue to inject. Unfortunately, there is no definitive answer. The mode of action of the antibiotic is to prevent protein synthesis and replication of the phytoplasma. In time, this can remove the infection, but because thorough studies on how long it takes to eliminate infections and the lack of a reliable transmission assay, it cannot be stated exactly how long one must treat to remove the infection. Also, in the environment, even if the palm is theoretically cured and treatment stops, (if the disease is in the area) it is possible for a new infection to occur by means of the insect vector.

Use of host palm resistance represents the most practical long-term solution for LY control.

Coconut cultivars, such as the 'Malayan Dwarf' or hybrid 'Maypan' (Malayan Dwarf x Panama Tall), have exhibited acceptable levels of resistance in most areas. However, recent reports of LY losses in 'Malayan Dwarf' and 'Maypan' of 70% and 83%, respectively, at localized sites in southeastern Florida and 95%–99% for these cultivars in Jamaica cast doubt on the long-term resistance of these cultivars.

Many palm species are apparently not susceptible to LY and so provide important alternative choices for ornamental landscape plantings. To date, LY has not been reported on most palm species native to Florida or regions of the Caribbean Basin where LY has been active. These include *Sabal palmetto* (cabbage palm), *Roystonea regia* (royal palm), *Acoelorraphe wrightii* (Paurotis or Everglades palm), and *Thrinax* species (thatch palms).

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Table 1. Palm species susceptible to Lethal Yellowing (LY) disease*

Adonidia merrillii	*Dictyosperma album*	*Phoenix reclinata*
Aiphanes lindeniana	*Dypsis cabadae*	*Phoenix rupicola*
Allagoptera arenaria	*Dypsis decaryi*	*Phoenix sylvestris*
Arenga engleri	*Gaussia attenuata*	*Pritchardia affinis*
Borassus flabellifer	*Howea belmoreana*	*Pritchardia pacifica*
Caryota mitis	*Howea forsteriana*	*Pritchardia remota*
Caryota rumphiana	*Hyophorbe verschaffeltii*	*Pritchardia thurstonii*
Chelyocarpus chuco	*Latania lontaroides*	*Ravenea hildebrantii*
Cocos nucifera	*Livistona chinensis*	*Syagrus schizophylla*
Copernicia alba	*Livistona rotundifolia*	*Trachycarpus fortunei*
Corypha taliera	*Nannorrhops ritchiana*	*Veitchia arecina*
Crysophila warsecewiczii	*Phoenix canariensis*	
Cyphophoenix nucele	*Phoenix dactylifera*	
*These are the palm species in which the LY phytoplasma has been detected in symptomatic palms.		