CALIFORNIA PEST RATING PROPOSAL

Candidatus Phytoplasma palmae (Lethal yellowing of palm phytoplasma)
(syn. Coconut lethal yellowing pathogen (Nutman & Roberts, 1955))

Current Rating: A

Proposed Rating: A

Comment Period: 6/6/2019 through 7/21/2019

Initiating Event:

CDFA regulations established a State Exterior Quarantine against Lethal yellowing (LY) of palm phytoplasma in 1978. This quarantine is against the LY phytoplasma, its hosts and possible carriers-, in the geographic areas of the US where the disease caused by LY phytoplasma is known to occur. Reports of changes in the distribution of the disease and additions and subtractions to the host list have triggered a review of the California State Exterior Quarantine. This phytoplasma poses a risk to California palm agriculture, palm nurseries, and palms growing in landscapes. Therefore, the status of this pathogen and the threat to California are reviewed herein-, and a permanent rating is proposed.

History & Status:

Background: Lethal yellowing of palms is a disease caused by *Ca.* Phytoplasma palmae, which has been classified as a member of the 16S rDNA RFLP group 16SrIV, subgroup A (16SrIV-A). It is fastidious, phloem-limited, and transmitted by the neotropical planthopper *Haplaxius* (syn. *Myndus*) *crudus* (American palm cixiid) (Howard et al., 1983; Eziashi and Omamor, 2010). Diseases caused by *Ca.* Phytoplasma palmae with strains in 16SrIV groups A-F are of global significance, responsible for the destruction of millions of fruit, nut, oil, and ornamental palms during the past 200 years.

Worldwide distribution: Lethal yellowing is limited in its distribution to the Americas (Center for Environmental and Regulatory Information Systems Pest Tracker 2019). LY was first reported in Key West, Florida in 1955 (Martinez and Roberts, 1967) and on the mainland of southern Florida in Miami in 1971 (McCoy et al., 1983). The distribution of the pathogen in Florida was reviewed by Harrison and Elliot in 2008 when it was restricted to limited areas in the southern one-third of the state. During the last decade, the pathogen became established throughout most of South Florida and spread slightly northward to Sarasota County on the west coast and Indian River County on the east coast (Bahder and Helmick, 2018).

In 2002, LY was found on the Pacific coast of Mexico in the States of Oaxaca and Guerrero killing coconut palms (Harrison et al., 2002c) and was recently detected in the State of Baja California Sur, where it was found in native Mexican fan palms (*Washingtonia robusta)*-, and a new host, *Brahea brandegeei* (Poghosyan et al., 2019).

During the 1970s, LY was believed to be in Texas killing palms in the Rio Grande Valley (McCoy et al., 1980), although newer research showed that the original diagnosis and report of LY were incorrect, and the responsible pathogen was *Ca.* Phytoplasma palmae subgroup 16SrIV-D, which causes a separate and distinct disease, Texas Phoenix Palm Decline (TPPD), in the southern coastal region of Texas (Harrison et al., 2002b). This led researchers to a reconsideration that Texas has only had TPPD (16SrIV-D) and not LY (16SrIV-A) (Ong and McBride, 2009). The status of TPPD in California was reviewed and a pest rating of A was assigned to that pathogen (Chitambar, 2015). Following a recent report of detections of LY in Louisiana, that state is the only confirmed US location other than Florida (Ferguson and Singh, 2018).

Worldwide Distribution: ***Caribbean:*** Antigua, Bahamas, Cayman Islands, Cuba, Dominican Republic, Haiti, Jamaica, Saint Kitts and Nevis, and Antigua; ***Central America:*** Belize, Honduras, and Guatemala; ***North America:*** Mexico and the United States (Florida and Louisiana) (Harrison et al., 2002a; Myrie et al., 2006; Myrie et al., 2014; Harrison and Oropeza, 2008; Ferguson and Singh, 2018)

Hosts of *Lethal yellowing* in Arecaceae:

1. ***Adonidia merrillii*** **- Christmas palm**
2. ***Acrocomia mexicana*** **– Cascabel palm**
3. ***Aiphanes lindeniana*** **- Ruffle palm**
4. ***Allagoptera arenaria*** **- Seashore palm**
5. ***Arenga engleri*** **- Formosa palm**
6. ***Brahea brandegeei*** - **San Jose hesper palm**
7. ***Borassus flabellifer*** **- Palmyra palm**
8. ***Caryota mitis*** **- Clustering fishtail palm**
9. ***Caryota rumphiana*** **- Giant fishtail palm**
10. ***Chelyocarpus chuco*** **- Round leaf palm**
11. ***Cocos nucifera*** **- Coconut palm**
12. ***Copernicia alba*** **- Wax palm**
13. ***Corypha taliera*** **- Tali palm**
14. ***Cryosophila warscewiczii*** **- Root spine palm**
15. ***Cyphophoenix nucele*** **- Lifou palm**
16. ***Dictyosperma album*** **- Princess palm**
17. ***Dypsis cabadae*** **- Cabada palm**
18. ***Dypsis decaryi*** **- Triangle palm**

19. ***Gaussia attenuata* - Llume palm**
20. ***Howea belmoreana* - Belmore sentry palm**
21. ***Howea forsteriana* - Kentia palm**
22. ***Hyophorbe verschaffeltii* - Spindle palm**
23. ***Latania lontaroides* - Red latan palm**
24. ***Livistona chinensis* - Chinese fan palm**
25. ***Livistona rotundifolia* - Anahaw palm**
26. ***Nannorrhops ritchiana* - Mazari palm**
27. ***Phoenix canariensis* - Canary Island date palm**
28. ***Phoenix dactylifera* - Date palm**
29. ***Phoenix reclinata* - Senegal date palm**
30. ***Phoenix rupicola* - Cliff date Palm**
31. ***Phoenix sylvestris* - Wild date palm**
32. ***Pritchardia affinis* – Loulu fan palm**
33. ***Pritchardia pacifica* – Fiji fan palm**
34. ***Pritchardia remota*- Nihoa fan palm**
35. ***Pritchardia thurstonii* – Lau fan palm**
36. ***Ravenea hildebrandtii* – Dwarf majesty palm**
37. ***Roystonia regia* - Royal palm**
38. ***Syagrus schizophylla* – Arikury palm**
39. ***Trachycarpus fortunei* - Windmill palm**
40. ***Veitchia arecina* – Mongomery's palm**
41. ***Washingtonia robusta* – Mexican fan palm**

Ref: Narvaez et al., 2015; Bahder and Helmick, 2018; Poghosyan et al., 2019.

One arborescent monocot ***Pandanus utilis*** (screwpine), is also a host (Thomas and Donselman, 1979).

Symptoms: LY is a fatal disease and infected palms generally die within 3-5 months after the first appearance of the symptoms (Bahder and Helmick, 2018). LY chronologically progresses through a series of symptoms exhibited in infested plants so that no single symptom is diagnostic of this disease. The first obvious symptom on mature palms is premature drop of most or all fruits over a period of a few days and not over a prolonged period. For coconuts, the calyx (stem) end of the fruit will usually have a brown to black, water-soaked appearance (Bahder and Helmick, 2018). Inflorescence necrosis follows fruit drop. However, fruit drop-, and inflorescence necrosis only occur when the palm tree is mature enough to produce fruit, during flowering and fruiting seasons, and when flowers or fruits have not been trimmed from the trees.

The next symptom is the discoloration of foliage beginning with the oldest leaves and progressing upward through the crown (Arellano and Oropeza, 1995). In some cases, as with tall-type coconut cultivars (*Cocos nucifera*), a solitary yellowed "flag leaf" is visible in the middle of the leaf canopy. Typically, yellowed leaves remain turgid, eventually turn brown, desiccate, and droop forming a skirt around the trunk for several weeks before falling. For dwarf coconut cultivars, leaves generally turn a reddish- to grayish-brown color, and may be folded around the midvein. For other palm species, such as *Adonidia merrillii* (Christmas palm), *Borassus flabellifer* (palmyra palm), *Dypsis decaryi* (Triangle palm), *Phoenix* spp. (date palms), and *Veitchia arecina* (Montgomery palm), successively younger leaves turn varying shades of reddish-brown to dark brown or gray rather than a distinctive yellow color (Bahder and Helmick, 2018).

Unless monitored carefully, leaf discoloration may often be confused with senescence (natural or that caused by nutritional deficiency), Texas Phoenix Palm Decline, or *Ganoderma* butt rot (fungal disease-causing dry rot within trunks of palms). However, in the early stages of LY, a greater number of dead leaves than normal for natural senescence are visible. This symptom may easily be overlooked if dying or dead leaves are regularly removed from diseased trees without noting the total number of leaves that die on a given tree over a given period (Harrison and Jones, 2004).

The death of the spear (youngest) leaf is the next symptom as the foliage discoloration advances upward through the crown. This may occur quickly in some palm species, such as coconut palm, when less than one-third or one-quarter of the oldest leaves have discolored and turned necrotic, and in *Phoenix* species, when about two-thirds of the oldest leaves have discolored. Death of the spear leaf means death of the apical meristem and the inevitable loss of the tree. Once that happens, no new leaves will develop and the remaining leaves from the oldest to the youngest will continue to discolor and drop. Death of the spear leaf is not always obvious and unless it is dead, hanging from the canopy, or on the ground, it will require close examination to determine if it is healthy or not. Eventually the entire crown of the palm withers and topples, leaving a bare trunk. PCR testing of plant sap allows for sensitive detection of the LY phytoplasma in inflorescence, spear leaf and trunk tissues and has made it possible to non-destructively sample palms for LY diagnosis (Harrison and Elliot, 2008a).

Transmission: LY is spread mainly by the insect vector *Haplaxius crudus (*American palm cixiid). The adults feed on palms and the nymphs develop on the roots of grasses and sedges (Howard et al., 2001; Kramer, 1979). This insect is not known to occur in California and if introduced, could establish but would likely be limited to warmer areas of the state (K. Beucke, CDFA pers. comm.). The phytoplasma does not survive outside the plant or insect vector. Also, LY is spread through human movement of vectors and infected hosts (Gurr et al., 2016; Dollet et al., 2009). Although LY DNA has been detected in embryos of fruit from infected coconut palm, there is no evidence that it is transmitted through seed (Cordova et al., 2003).

Damage Potential: Lethal yellowing is a fatal disease of at least 41 confirmed palm species plus one non-palm in the Americas and has killed millions of palms. (Harrison et al., 1999). Although not a producer of coconuts, California has a date industry and the date palm, *Phoenix dactylifera,* is a host. The California fan palm, *Washingtona filifera*, is native to the state and its susceptibility to LY is unknown. However, a related species, *W. robusta*, is a confirmed host and is widely planted in California. Susceptible species of ornamental palm trees in existing landscapes are an extremely valuable and iconic part of life in California. The ornamental palm nursery industry could also be negatively impacted if this pathogen became established.

Official Control: California maintains a State Exterior Quarantine against the Lethal yellowing of palm phytoplasma from select counties in Texas and Florida (http://pi.cdfa.ca.gov/pqm/manual/pdf/325.pdf). This quarantine includes the prohibition of all articles including LY susceptible hosts (plants and plant parts excluding seed), and grasses and sedges that may carry the insect vector *Haplaxius (=Myndus) crudus*. Grasses and sedges are enterable if accompanied by an official certificate of treatment.

Other states have quarantines against LY. Arizona and Nevada maintain State Exterior Quarantines against select counties in Florida and Texas for LY and prohibit the entry of susceptible palm species, as well as sedges and grasses that could support the vector. Texas has a State Exterior Quarantine against Florida, Puerto Rico, and Guam for select palms and various species of sod grass. Louisiana has a quarantine against palms from the entire State of Florida. Hawaii has an exterior quarantine for coconut palms (all states and countries regulated) separate from a broad palm quarantine against all palm species from Florida, Texas, Puerto Rico, Guam, and many foreign countries because of LY, cadang-cadang, Guam disease, and “other similar” diseases of palms. (https://nationalplantboard.org/laws-and-regulations/).

California Distribution: Lethal yellowing of palm phytoplasma Is not known to be present in California.

California Interceptions: There have been no interceptions of Lethal yellowing of palm phytoplasma in California.

The risk Lethal yellowing of palms caused by *Ca.* Phytoplasma palmae subgroup (16SrIV-A) would pose to California is evaluated below:

Consequences of Introduction:

1) Climate/Host Interaction: It is likely that Lethal yellowing of palm can establish a distribution in the climates of California wherever the susceptible palms are cultivated

Evaluate if the pest would have suitable hosts and climate to establish in California.

Score: 3

– **Low (1)** Not likely to establish in California; or likely to establish in very limited areas.
– **Medium (2)** may be able to establish in a larger but limited part of California.
– High (3) likely to establish a widespread distribution in California.

2) Known Pest Host Range: Lethal yellowing of palms has a large host range of 41 known types of palms as well as screwpine

Evaluate the host range of the pest.

Score: 2

– Low (1) has a very limited host range.
– Medium (2) has a moderate host range.
– High (3) has a wide host range.

3) Pest Dispersal Potential: Lethal yellowing of palm is transmitted from plant to plant by the American palm cixiid, *Haplaxus crudus*, which is asap sucking insect. The pathogen is also spread by moving LY infected nursery stock, and grasses and sedges infested with the insect vectors.

Evaluate the natural and artificial dispersal potential of the pest.
Score: 3

– Low (1) does not have high reproductive or dispersal potential.
– Medium (2) has either high reproductive or dispersal potential.
– High (3) has both high reproduction and dispersal potential.

4) Economic Impact: Lethal yellowing of palms could impact trees used for agricultural fruit and nut production and, ornamental palms in nurseries and landscapes. These perennial plants take years to reach maturity and the loss of even individual specimens could be devastating to property owners and residents. Antibiotic treatment of individual palms, or insecticide treatment for vectors, would result in increased costs of management and production.

Evaluate the economic impact of the pest to California using the criteria below.

Economic Impact: A, B, C, D, E.

A. The pest could lower crop yield.
B. The pest could lower crop value (includes increasing crop production costs).
C. The pest could trigger the loss of markets (includes quarantines).
D. The pest could negatively change normal cultural practices.
E. The pest can vector, or is vectored, by another pestiferous organism.
F. The organism is injurious or poisonous to agriculturally important animals.
G. The organism can interfere with the delivery or supply of water for agricultural uses.

– Low (1) causes 0 or 1 of these impacts.
– Medium (2) causes 2 of these impacts.
– High (3) causes 3 or more of these impacts.

5) Environmental Impact: A, D, E

A. The pest could have a significant environmental impact such as lowering biodiversity, disrupting natural communities, or changing ecosystem processes.
B. The pest could directly affect threatened or endangered species.
C. The pest could impact threatened or endangered species by disrupting critical habitats.
D. The pest could trigger additional official or private treatment programs.
E. The pest significantly impacts cultural practices, home/urban gardening or ornamental plantings.

Score the pest for Environmental Impact. **Score: 3**

- **– Low (1)** causes none of the above to occur.
- **– Medium (2)** causes one of the above to occur.
- **– High (3) causes two or more of the above to occur.**

Consequences of Introduction to California for Lethal Yellowing of Palms:
Total points obtained on evaluation of consequences of introduction of Lethal yellowing of palm phytoplasma to California **= (14)**

- **– Low** = 5-8 points
- **– Medium** = 9-12 points
- **– High = 13-15 points**

6) Post Entry Distribution and Survey Information: Evaluate the known distribution in California. Only official records identified by a taxonomic expert and supported by voucher specimens deposited in natural history collections should be considered. Pest incursions that have been eradicated, are under eradication, or have been delimited with no further detections should not be included.

Score: 0

- **– Not established (0) Pest never detected in California or known only from incursions.**
- **– Low (-1)** Pest has a localized distribution in California or is established in one suitable climate/host area (region).
- **– Medium (-2)** Pest is widespread in California but not fully established in the endangered area, or pest established in two contiguous suitable climate/host areas.
- **– High (-3)** Pest has fully established in the endangered area, or pest is reported in more than two contiguous or non-contiguous suitable climate/host areas.

Final Score:

7) The final score is the consequences of introduction score minus the post entry distribution and survey information score

Final Score: *Score of Consequences of Introduction – Score of Post Entry Distribution and Survey Information =* ***14****.*

Uncertainty:

The taxonomy of Lethal yellowing of palm caused by *Ca*. Phytoplasma palmae in 16S rDNA RFLP group 16SrIV is under continual review as diagnostics improve. The potential for other phloem-feeding insects to act as vectors of LY, and for native and non-native grasses and sedges to support those vectors, is not known. California has a native palm, *Washingtonia filifera,* and it is not known if it could be infected by LY.

Conclusion and Rating Justification:

Based on the evidence provided above **the proposed rating for** *Ca.* Phytoplasma palmae 16SrIV-A (Lethal yellowing of palm phytoplasma) is **A**

CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE

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Responsible Party:

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* Comment Period: 6/6/2019 through 7/21/2019

*NOTE:

You must be registered and logged in to post a comment. If you have registered and have not received the registration confirmation, please contact us at plant.health[@]cdfa.ca.gov.

Comment Format:

- Comments should refer to the appropriate California Pest Rating Proposal Form subsection(s) being commented on, as shown below.

Example Comment:

Consequences of Introduction: 1. Climate/Host Interaction: [Your comment that relates to "Climate/Host Interaction" here.]

- Posted comments will not be able to be viewed immediately.

- Comments may not be posted if they:

    Contain inappropriate language which is not germane to the pest rating proposal;

Contains defamatory, false, inaccurate, abusive, obscene, pornographic, sexually oriented, threatening, racially offensive, discriminatory or illegal material;

Violates agency regulations prohibiting sexual harassment or other forms of discrimination;

Violates agency regulations prohibiting workplace violence, including threats.

- Comments may be edited prior to posting to ensure they are entirely germane.

- Posted comments shall be those which have been approved in content and posted to the website to be viewed, not just submitted.

Proposed Pest Rating: A