

EPPO Datasheet: *Palm lethal yellowing type syndromes*

Last updated: 2024-06-27

IDENTITY

Preferred name: *Palm lethal yellowing type syndromes*

Taxonomic position: Bacteria: Tenericutes: Mollicutes:
Acholeplasmatales: Acholeplasmataceae

Other scientific names: *Coconut lethal yellowing phytoplasma*,
Palm lethal yellowing disease

Common names: Awka wilt disease, Bogia coconut syndrome, Cape St Paul wilt of coconut, Palm lethal yellowing disease, bronze leaf wilt of coconut (JM), kaincope disease of coconut, kribi disease of coconut, lethal yellowing of coconut, lethal yellowing syndromes of coconut, lethal yellowing type syndromes

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EPPO Categorization: A1 list

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EU Categorization: A1 Quarantine pest (Annex II A)

EPPO Code: PHYP56



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Notes on taxonomy and nomenclature

Lethal yellowing disease of coconut was first observed in the Caribbean in the 19th century. However, it was only in 1972 that it was confirmed to be caused by phytoplasmas (Beakbane *et al.*, 1972; Plavsic-Banjac *et al.*, 1972). The many common names cited above, often from the affected localities, have been used for diseases of coconuts which are all now considered to be caused by different phytoplasmas associated with common syndromes: Lethal Yellowing Type Syndromes. These diseases differ mainly in their geographic distributions. Their host ranges all contain plants from the Arecaceae family, including the coconut tree (*Cocos nucifera*). Many coconut diseases of unknown aetiology are described in the older literature and records of these have been appraised by Howard (1983). The name ‘bronze leaf wilt’ has been used for lethal yellowing in Jamaica but corresponds to a different disease in South America.

Because no complete genome sequences are currently available for any of these phytoplasmas, their taxonomy is based on 16S rRNA sequences, and two parallel classification systems have been developed, the 16Sr group system, based on restriction enzyme digest profiles of the 16S rDNA, and the ‘*Candidatus* Phytoplasma’ species system, in which phytoplasmas sharing less than 97.5% similarity of their 16S rRNA gene sequence may be ascribed to different ‘*Ca. Phytoplasma*’ species when they are characterised by distinctive biological, phytopathological and genetic properties (Bertaccini *et al.*, 2022, EFSA, 2017).

Phytoplasmas associated with palm lethal yellowing type syndromes are placed in the 16SrIV and 16SrXXII groups, both of which are divided in different subgroups reflecting the restriction profile of the 16SrRNA gene (Gurr *et al.*, 2016; Wei *et al.*, 2007).

In the framework of this datasheet, the following ‘*Candidatus* Phytoplasma’ species are considered to be associated with palm lethal yellowing type syndromes:

- ‘*Candidatus* Phytoplasma aculeata’
- ‘*Candidatus* Phytoplasma cocostanzaniae’
- ‘*Candidatus* Phytoplasma dypsidis’
- ‘*Candidatus* Phytoplasma hispanola’
- ‘*Candidatus* Phytoplasma noviguineense’
- ‘*Candidatus* Phytoplasma palmae’
- ‘*Candidatus* Phytoplasma palmicola’
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HOSTS

The main host is coconuts (*Cocos nucifera*) but the lethal yellowing type syndromes have also been found on many different palms (Arecaceae). The occurrence of symptoms similar to lethal yellowing together with the presence of phytoplasmas among collections of palms in affected areas in Florida (USA) indicates that more than 30 species of palms are susceptible to infection. Palm lethal yellowing type syndrome phytoplasmas have been detected in non Arecaceae plants, including different grasses in plots where palms were infested (Arocha-Rosete *et al.*, 2016; Gurr *et al.*, 2016). The relevance of these plants as potential reservoirs of the phytoplasmas is not clear (EFSA, 2017). *Ca. ‘Phytoplasma noviguineense’* also includes banana (*Musa* sp.) as another economically important host crop.

A detailed list of host plants for each phytoplasma species is available in EPPO Global Database. A global host list for all host plants of palm lethal yellowing type syndromes phytoplasmas is as follows:

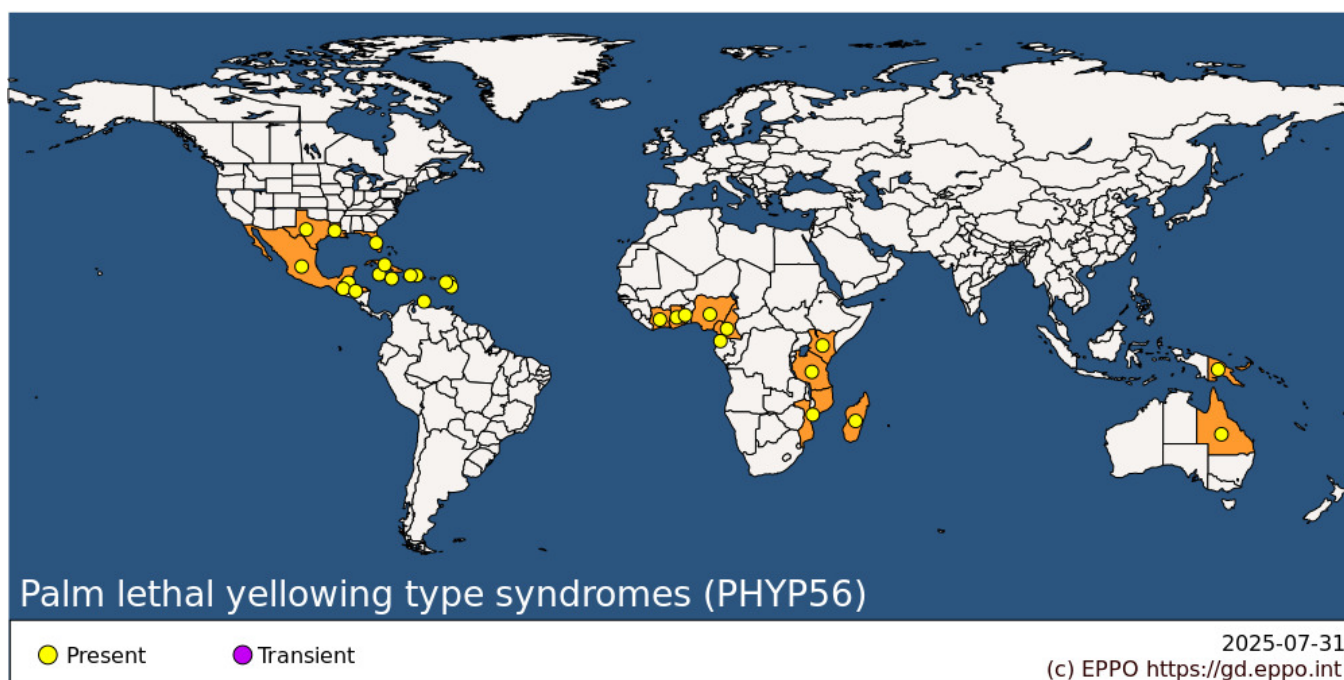
Host list: *Acrocomia aculeata*, *Adonidia merrillii*, *Aiphanes horrida*, *Aiphanes minima*, *Allagoptera arenaria*, *Areca catechu*, *Arecaceae*, *Arenga engleri*, *Arenga pinnata*, *Arenga*, *Attalea butyracea*, *Bismarckia nobilis*, *Borassus flabellifer*, *Brahea brandegeei*, *Butia odorata*, *Carludovica palmata*, *Carpentaria acuminata*, *Caryota mitis*, *Caryota rumphiana*, *Caryota urens*, *Chelyocarpus chuco*, *Chrysalidocarpus cabadae*, *Chrysalidocarpus decaryi*, *Chrysalidocarpus leptoscheilos*, *Chrysalidocarpus lutescens*, *Cleome ruidosperma*, *Cocos nucifera*, *Cocos*, *Corypha umbraculifera*, *Corypha utan*, *Corypha*, *Cryosophila warszewiczii*, *Cyanthillium cinereum*, *Dictyosperma album*, *Dictyosperma*, *Elaeis guineensis*, *Gaussia attenuata*, *Gaussia*, *Howea belmoreana*, *Howea forsteriana*, *Hyophorbe verschaffeltii*, *Hyophorbe*, *Latania lontaroides*, *Livistona australis*, *Livistona chinensis*, *Macroptilium lathyroides*, *Nannorrhops ritchieana*, *Phoenix canariensis*, *Phoenix dactylifera*, *Phoenix reclinata*, *Phoenix roebelenii*, *Phoenix sylvestris*, *Phoenix*, *Pritchardia pacifica*, *Pritchardia thurstonii*, *Pseudophoenix sargentii*, *Ravenea rivularis*

, *Roystonea regia*, *Sabal mexicana*, *Sabal palmetto*, *Saribus rotundifolius*, *Stachytarpheta jamaicensis*, *Syagrus romanzoffiana*, *Syagrus schizophylla*, *Syagrus* sp., *Synedrella nodiflora*, *Trachycarpus fortunei*, *Veitchia arecina*, *Washingtonia robusta*

GEOGRAPHICAL DISTRIBUTION

Lethal yellowing type syndromes are widely distributed in the intertropical zone. They are present in North and Central America and the Caribbean ('*Ca. Phytoplasma palmae*' and '*Ca. Phytoplasma aculeata*' and '*Ca. Phytoplasma hispanola*'), in Africa ('*Ca. Phytoplasma palmicola*' and '*Ca. Phytoplasma cocostanzaniae*' and in Oceania ('*Ca. Phytoplasma novoguineense*', and '*Ca. Phytoplasma dypsidis*').

Distribution maps for each phytoplasma species is available in EPPO Global Database. The global distribution of lethal yellowing type syndromes of palms is as follows:



Africa: Cameroon, Cote d'Ivoire, Equatorial Guinea, Ghana, Kenya, Madagascar, Mozambique, Nigeria, Tanzania, United Republic of, Togo

North America: Mexico, United States of America (Florida, Louisiana, Texas)

Central America and Caribbean: Antigua and Barbuda, Belize, Cayman Islands, Cuba, Dominican Republic, Guadeloupe, Guatemala, Haiti, Honduras, Jamaica, Netherlands Antilles, Saint Kitts and Nevis

Oceania: Australia (Queensland), Papua New Guinea

BIOLOGY

Palm lethal yellowing type syndromes are associated with phytoplasmas. Mycoplasma-like particles have been found in the sieve-tube elements of the phloem of coconut and other palms exhibiting characteristic symptoms (Beakbane *et al.*, 1972; Plavsic-Banjac *et al.*, 1972). Oxytetracycline treatment causes remission of disease symptoms (McCoy, 1975). Since then, the techniques of molecular biology and DNA sequencing have made it possible to show the association of phytoplasmas with these syndromes (Gurr *et al.*, 2016; Jones *et al.*, 2021; Miyazaki *et al.*, 2018; Soto *et al.*, 2021).

Marked differences in susceptibility to the phytoplasmas are reported in different varieties of coconut palms as well as between other palm species. Susceptibility also varies with the phytoplasma species involved (Howard *et al.*, 1979; Gurr *et al.*, 2016; Palma-Cancino *et al.*, 2023).

To date, the only insect identified as a vector of a palm lethal yellowing type syndromes -associated phytoplasma is *Haplaxius crudus* in the Caribbean. *H. crudus* feeds abundantly on coconut leaves and population densities of *H. crudus* were observed to be up to 40 times higher in areas affected by palm lethal yellowing type syndromes than unaffected ones (Howard, 1980; Howard *et al.*, 1983). Since then, evidence for *H. crudus* carrying phytoplasmas has been demonstrated (Dzido *et al.*, 2020; Mou *et al.*, 2022a; EPPO, 2024). The geographical distribution of *H. crudus* in the Americas more or less coincides with the known distribution of the phytoplasmas (Howard, 1983). In areas other than the Americas, no vector has been positively identified. Other species of insects have been suggested as potential vectors (Brown *et al.*, 2006; Bila *et al.*, 2017; Fernández-Barrera *et al.*, 2022; Kwadjo *et al.*, 2018; Lu *et al.*, 2016; Mpunami *et al.*, 2000; Ramos Hernández *et al.*, 2020).

Purcell (1985) noted that *H. crudus* is a very inefficient vector of lethal yellowing, but can be so abundant that a very low transmission rate is sufficient to spread the disease.

Oropeza *et al.* (2017) demonstrated the transmission of lethal yellowing phytoplasmas from coconut embryos to plantlets. However the relevance of seed transmission for disease spread is not clear.

DETECTION AND IDENTIFICATION

Symptoms

In general, an early symptom is the drying up of developing inflorescences, and the premature drop of most or all fruits or seeds within a few days. In coconut palms the spathes enclosing the flowers become discoloured and the tips blacken. The youngest leaves next to the buds show water-soaked streaks which spread until there is a terminal rot of the growing point. Following the first symptoms there is progressive leaf discoloration, beginning with the older leaves and spreading rapidly to the younger ones. The foliage turns light-yellow and eventually orange-yellow. This symptom coincides with the death of root tips. Death occurs in *C. nucifera* about 4 months after the initial symptoms appear.

Morphology

Typical phytoplasma particles were found in sieve tubes of infected plants. They were ovoid, elongated and filamentous in shape and were bounded by a triple-layered structure comprising two electron-dense layers with a transparent layer between them (Plavsic-Banjac *et al.*, 1972).

Detection and inspection methods

Several molecular methods exist to detect lethal yellowing type syndrome associated phytoplasmas both in plants and in vectors (Bahder *et al.*, 2018; Bahder *et al.*, 2019; Christensen *et al.*, 2004; Córdova *et al.*, 2014; Hodgetts *et al.*, 2009; Lu *et al.*, 2016; Pilet, 2021). LAMP detection systems have also been developed to rapidly detect the phytoplasmas in the field (Dickinson, 2015; Tropicsafe, 2021a; Yu *et al.*, 2023).

Sampling is most reliable when done in immature leaves taken from around the apical meristem, or inflorescences, which are rich in phloem (Harrison *et al.*, 1999). However, once plants are symptomatic, PCR testing of the phloem from the palm trunk (by drilling a hole 10–15 cm into the trunk and collecting sawdust) is a non-destructive method of successful phytoplasma detection (Harrison *et al.*, 2002). The drill should be sterilised (e.g. in 70% ethanol) prior to each sample collection.

PATHWAYS FOR MOVEMENT

Natural spread results from the movement of the known vector *H. crudus*, as well as of yet unknown vectors. Infected plants for planting, including ornamental species, can carry the pathogen in international trade. They can also carry infectious vectors, such as adults of *Haplaxius crudus* that are known to remain within palm foliage when plants are uprooted and transported to new localities. Ogle and Harries (2005) considered that the most likely means of transmission of the disease between Caribbean islands has been by the unintentional introduction of infected

vectors on pasture grasses or animal fodder. Nymphs of *H. crudus* could also be moved in soil accompanying plants for planting or turf, but nymphs are not infected by the phytoplasmas.

PEST SIGNIFICANCE

Economic impact

Palm lethal yellowing phytoplasmas are a serious economic threat for coconut, causing their premature decline and death. Experience in Jamaica suggests that almost total destruction of a population of susceptible palms can occur: by 1979, an estimated 4 million coconut palms had been killed by palm lethal yellowing disease on the island. In Florida, out of an estimated 1-1.5 million *C. nucifera* on the mainland, 300 000 had died by 1983. In the case of Florida, not a coconut-producing area, the socio-economic loss has been as a result of a destruction of an important and valuable feature of the amenity vegetation. The disease is still causing a large impact nowadays in the Caribbean and Central America (Gurr *et al.*, 2016; Mou *et al.*, 2022b), as well as in Africa (Bertaccini *et al.*, 2023; Tropicsafe 2021b; Mpunami *et al.*, 1999) and Papua New Guinea (Miyazaki *et al.*, 2018).

Control

Management of the disease relies on several steps: early identification of infected plants (based on symptoms and ideally confirmed by testing), removal of infected plants, control of the vectors, planting of healthy plants, weed control.

Research is being conducted to identify resistant genotypes (Gurr *et al.*, 2016; Tropicsafe, 2021c).

Control of the vector *H. crudus* with insecticides by spraying or trunk injection is used in some crops but has not been economically successful in coconut plantations (Gurr *et al.*, 2016). Management of the grass populations in coconut plantations has also been suggested as a means of control, since some grass species are hosts for the nymphs of *H. crudus* (although they are relatively poor hosts) (Howard, 1990).

Treatment of infected plants by injection into the trunk of antibiotics (e.g. oxytetracycline) had been shown to suppress the symptoms of lethal yellowing (McCoy, 1975) but was not considered sustainable as it should be applied at 4-monthly intervals and the use of antibiotics in agriculture is banned in many countries worldwide.

Phytosanitary risk

In the EPPO region, the most important economic crop at risk are date palms (*Phoenix dactylifera*) that are widely cultivated in Algeria, Morocco and Tunisia for fruit production. In addition, many palm species are used as ornamental trees in the entire EPPO region (indoor and outdoor). Movement of ornamental palms from infested areas could be just as hazardous to date-growing countries as the movement of date palms themselves, because of the possibility of spread from ornamental to date palms by existing auchenorrhynchan insects that may become local vectors.

The disease introduction into the EPPO region could also impact ornamental palms of considerable amenity value grown outside in the southern EPPO region and as well as valuable collections of palms under glass in botanic gardens, etc. In addition, palms are of great significance in nearly all modern indoor landscape plantings and their value to the horticultural trade is considerable in particular for mature plants.

PHYTOSANITARY MEASURES

In order to prevent the introduction of the disease to the EPPO region, the importation of host plants for planting, originating from areas where the disease occurs should be prohibited. Alternatively, measures such as pest-free areas may be appropriate, as is the case for similar pests, as well as pest-free production sites or pest-free places of production with conditions also ensuring the absence of vectors. Healthy planting material of host plants can be produced in the framework of a certification scheme. Post-entry quarantine (including testing) could be used in special cases.

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Datasheet history

This datasheet was first published in the EPPO Bulletin in 1986 and revised in the two editions of 'Quarantine Pests for Europe' in 1992 and 1997. It is now maintained in an electronic format in the EPPO Global Database. The sections on 'Identity', 'Hosts', and 'Geographical distribution' are automatically updated from the database. For other sections, the date of last revision is indicated on the right.

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