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Coconut Risk Management and Mitigation Manual for the Pacific Region

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5. PHYTOPLASMA DISEASES

By R. Davis, F. Pilet, M. A. M. Gruber, S. B. Woruba and T. McKenzie

Description

Phytoplasmas are insect-vectored bacteria that cause disease in a wide range of plant species. They are responsible for various forms of Coconut Lethal Yellowing-Like Diseases (LYLDs). Numerous outbreaks of LYLDs of coconut have been recorded in Central America, the Caribbean and Africa since the late nineteenth century and have caused the death of millions of coconut palms. The risk is that these diseases invade the Pacific region and kill many coconut palms.

The only LYLD presently found in the Pacific region is the Bogia Coconut Syndrome (BCS) in Papua New Guinea (PNG). This phytoplasma is not considered as such a worrying problem as the *Oryctes rhinoceros* CRB-G biotype, given its present localized distribution, but rather it does have the potential to become a major disease. In addition, palm death caused by phytoplasmas can provide breeding sites and exacerbate the *Oryctes rhinoceros* problem.

LYLDs are caused by several different, but related, phytoplasmas in different places around the world. Phytoplasmas can survive only inside the plants that host them and the insects that spread them from plant to plant. The LYDL phytoplasmas cannot be cultured *in vitro* and can only be studied using the tools of molecular biology. Because of this they have complex grouping and naming conventions.

Four different, but closely related phytoplasmas are responsible for LYLDs around the world. The phytoplasma in the Caribbean, Central America and Florida, was the first to be found and it is named '*Candidatus* Phytoplasma palmae'. The LYLD phytoplasmas in Africa are '*Candidatus* Phytoplasma palmicola' in West Africa and Mozambique and '*Candidatus* Phytoplasma cocostanzaniae' in Kenya and Tanzania in East Africa. A new phytoplasma recently discovered in PNG is the most immediate threat to the Pacific Islands. It has been given the name '*Candidatus* Phytoplasma noviguineense', Included reference below. Less severe phytoplasma diseases of coconut palms caused by phytoplasmas that are not closely related to the LYLD phytoplasmas occur in Malaysia, Sri Lanka and Indonesia.

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Plate 8. Female adult of *Zophiuma pupillata*

Bogia Coconut Syndrome LYLD was identified in 2008 near Madang, in PNG. The causal phytoplasma, '*Candidatus* Phytoplasma noviguineense', is related to but different from those threatening Africa and America. It may be that the BCS phytoplasma was not recently introduced and is endemic to PNG. In studies on BCS in PNG, several sap feeding insects found in the country are very strongly suspected to be vectors of the phytoplasma. One of the most important and widespread is the planthopper *Zophiuma pupillata* (see Plate 8), which breeds on coconut palms

The symptoms of BCS are quite similar to those of other LYLDs and shows a very well-defined sequence that helps identify the disease. The disease progress has five distinct stages, which happen very rapidly (within around four months):

1. The outer fronds of the crown will droop and have a pale to distinctly bright yellow colouring.
2. Premature dropping of nuts of all ages progressively follows, whether they are ripe or not.
3. Fronds then turn brown and hang down the stem, like a skirt.
4. A dry rot develops in the newly expanding spear, progressing downwards to the growing point.
5. Complete necrosis - death of the palm. Finally, all fronds fall, leaving only dead stems.

An early symptom may also include rotting of male and female inflorescences (to see this it is necessary to climb the palm and open the inflorescences manually).

Although each of these symptoms can be caused by other things, the sequence of symptom development, and its rapid speed, is unique to BCS. Similar symptoms have been observed in more than 50 other palm species that suffer from LYLD.

A common mistake is to confuse the symptoms of LYLDs with the damage caused by lightning, which can kill ten or so coconut palms in one fell swoop. In the case of lightning, the trunks of the coconut trees very often bear black elongated marks from burning, with exudates of sap.

Occurrence and severity

Bogia Coconut Syndrome is a major concern as coconut is an important food and trade source in PNG. The Bogia Coconut Syndrome phytoplasma also attacks some varieties of cooking bananas, betelnut, and other palms. In the area of PNG affected by BCS many palms have died and plantations have been abandoned. The loss of plantations from the disease can cause serious problems for social and economic security. However, the disease is currently highly localised and subject to strict biosecurity measures to ensure containment

Another phytoplasma was recently found in diseased cooking banana plants, close to the border of PNG (Bougainville, Magusaiai Island). DNA analysis showed it was closely related to the BCS phytoplasma. This phytoplasma, known as Banana Wilt Associated Phytoplasma (BWAP), is found in some areas in PNG. Only bananas are affected but coconuts are not. Unpublished phylogenetic data seems to differentiate the coconut and banana phytoplasmas from Madang Province from banana phytoplasmas from Western Province and the Solomon Islands archipelago. It seems there is genetic variation within the closely related group of phytoplasmas in the Pacific region. This however does not dismiss the potential for a wider spread by BCS given the distribution patterns of other related phytoplasmas in the Pacific.

Mitigation and adaptation

Little is known about how BCS or other LYLDs are spread, and there are limited control methods. There is not economically viable chemical nor organic treatment against LYLDs in the agricultural context. Phytoplasma can be controlled by injection of tetracycline-type antibiotics into the coconut trunk. This requires a bi-weekly systemic treatment on a four-monthly schedule which is not affordable for agricultural production but is sometimes used for ornamental purposes in tourist sites and hotels. The use of antibiotics in agriculture is banned in some countries, and we do not know, for instance, if the coconut water is contaminated by the antibiotic. We do know that misuse of antibiotics can result in antibiotic-

resistant pathogens. Such issues will need to consider the ISO standards on safe residue levels of pesticides and other chemical treatments.

Successful integrated pest management (IPM) against LYLD is through:

- Biosecurity measures, which should include, prohibition of movement of palms (and other known hosts such as banana) out of the affected areas, strict quarantine and disease surveillance;
- Prompt detection followed by immediate removal and destruction of LYLD infected trees;
- Proper weeding of alternative plant hosts that may allow the vector to undergo part of its life cycle;
- Replanting with resistant varieties, and;
- Control of the insect vector.

In Ghana, the treatment of infected farms with insecticide by hot fogging followed by felling diseased and contact palms, immediately upon detection, has slowed down the disease and in some cases completely holds the disease in check for few years. Intercropping coconut with other crops has failed to lower the disease incidence but has provided an alternative source of income as insurance against the disease in Ghana.

Plate 7. Coconut plantation destroyed by a Lethal Yellowing Disease caused by a phytoplasma in Ghana.

In Jamaica, the Michael Black farm, totalling 62,000 palms, is in a diseased zone. Thanks to meticulous monitoring of the disease (including culling and systematic early producing hybrid replantation), only 915 palms or 1.5% were lost because of LYLD within the period 2002- 2013.

Some varieties and hybrids of coconut palm are known to be less susceptible to LYLD, but none are completely resistant. Varieties that better tolerate the diseases are different, depending upon which phytoplasma is involved. Information is not yet available about tolerant varieties in the case of BCS, although it is thought that diverse coconut plantations may limit effects of disease. Research conducted in Ghana has revealed that the Sri Lanka Green Dwarf was the most tolerant variety to the local form of LYLD, although LYLD are not present in Sri Lanka. In Jamaica, the most tolerant variety was the Malayan Yellow Dwarf, then the phytoplasma evolved, and also started to kill this variety.

From a research perspective, it is very important to test for tolerance and resistance to BCS of different coconut varieties as this has worked for similar diseases elsewhere in the world and would provide the best control of all. Having diverse coconut plantations may be important to limiting the effects of the disease.

Good biosecurity is the only way to prevent LYLDs from developing in new locations. The BCS phytoplasma has been found in betelnut palms and banana plants. Restricting the movement

of live coconut, betelnut and banana planting material out of the Madang Province is vital and this will slow its spread. Young plants, including symptomless banana suckers, can carry the phytoplasma to new places. Whilst the dangers posed by coconuts and betelnuts for planting are not fully understood yet, it would be safest to include these in the restrictions. Research into BCS is identifying other host plants, and as these hosts are found, they will also need to be targeted. Where vector insects are known, their movement should also be tightly controlled.

Actions to undertake

- In Papua New Guinea, search for tolerant varieties in local and international coconut germplasm. For instance, it would be useful to introduce the Sri Lanka Green Dwarf, which is tolerant to LYLD in Ghana.
- From 2014 to 2017 Australian Aid funded an ACIAR project in PNG on developing biological knowledge and a risk management strategy for BCS and related phytoplasma syndromes. Results from this and further projects may help to contain or control the disease.
- Maintain strong biosecurity and set up early detection systems. If an outbreak of the disease occurs in the Pacific region, the Ghanaian method should be applied: insecticide treatment by hot fogging (only practical on smaller palms) followed by felling diseased and contact palms.
- Biosecurity should include surveillance for potential host insects. For example, BCS requires the presence of both the phytoplasma and *Zophiuma*, the insect that is one of the vectors of the phytoplasma. It is also important to identify the full range of insects that can transmit the phytoplasma.

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