



Huanglongbing disease of citrus trees

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The worst disease of citrus across much of Africa and Asia is citrus huanglongbing (HLB), which was previously known as greening disease. It is caused by a bacterium that infects only the food conducting tissues of the tree or phloem vessels, and the insects that spread it from tree to tree (the disease vectors). HLB destroys trees, has no cure, and affects all of the main types of citrus. The bacterium, following a naming convention for bacteria that cannot be cultured, is called '*Candidatus Liberibacter asiaticus*'. Its only known vector is the citrus psyllid, *Diaphorina citri* Kuwayama (Hemiptera: Psyllidae).

The name of the disease was recently changed from greening to the Chinese word, huanglongbing, because China was the country in which this disease was first discovered. Huanglongbing is Chinese for 'yellow dragon disease', a description used because infected trees go yellow, usually starting from one branch or one part of the tree, before they die — as if attacked by a 'yellow dragon'. In other parts of the world (mostly Africa) a different '*Ca. Liberibacter*' species and a different psyllid are responsible for HLB.

HLB is a major new quarantine threat to the Pacific region since '*Ca. L. asiaticus*' and the citrus psyllid appeared in the north west of the Sandaun Province in Papua New Guinea in 2002. The disease is now the subject of a quarantine containment campaign in PNG. This Pest Advisory Leaflet provides information about surveillance for the disease and its vector along with quarantine measures. It also includes some advice on disease management that could be useful in places where HLB has become established.



Fig. 2. A yellowing of only one branch or sector of the canopy or sectoral chlorosis

SYMPTOMS OF HLB

Some of the symptoms of HLB are the same as those of nutrient deficiencies, making early recognition difficult, especially when trees are not well looked after. The leaf symptoms include a blotchy mottle or diffuse yellowing; zinc deficiency symptoms, which are a green on yellow vein banding and islands of green tissue; and thin, yellow, upright new leaves. On fruits, ripening occurs at the stalk end first, though there may be no colour change in many citrus fruits in warm climates, and the central column of the fruit is curved, distorting fruit shape, and causing seeds to abort (Fig. 1).

Yellowing of only one branch or sector of the canopy that later spreads is characteristic of HLB and this can be clearly seen in an otherwise healthy tree (Fig. 2).



Fig. 1. HLB symptoms on fruits



Fig 3. Chlorotic blotching plus vein swelling of orange leaves affected by HLB

Certain combinations of leaf symptoms are also key visual guides; for example, chlorotic blotching plus swollen or corky leaf veins (Fig. 3), or leaves with a blotchy mottle plus green on yellow vein banding together on the same branch (Fig. 4).

THE INSECT THAT SPREADS HLB

The citrus psyllid is found on buds and young leaves where it sucks the sap, causing some leaf distortion and curling. Leaves may be covered with honeydew and sooty mould. Adult psyllids can live for six months and are 3-4 mm long with a yellowish-brown body and greyish-brown legs. Wings are clear and mottled with brown. Nymphs are smaller and generally yellowish-orange in colour. Psyllids are often confused with aphids, which are of similar size and are common on tender young citrus leaves. The main difference is that aphids move slowly whereas adult psyllids are active insects that jump when disturbed and may fly a short distance. Adult psyllids also hold an unusual posture on the leaf: head down, almost touching the surface, rear end pointing up at an angle of up to 30 degrees (Fig. 5). Like aphids, psyllids are often tended by ants that are attracted to the honeydew they produce.



Fig. 4. Blotchy mottle plus green on yellow vein banding

DISTRIBUTION

HLB has been common for decades in Asian countries close to the Pacific Islands, such as Malaysia, Vietnam, the Philippines and Indonesia, and is also a new arrival in South America, having been confirmed in Brazil in 2004. The disease does not occur in Australia, New Zealand or North America and, with the exception of Florida in the USA, the vector is also absent from these countries. Apart from the island of New Guinea, both HLB and the citrus psyllid are also absent from the Pacific region. A report that the disease was found in the Fiji Islands, Samoa, Tonga and Palau in the mid 1990s (Kiritani and Su 1999) is now thought to be a mistake. Generally, the arrival of the psyllid in a new region has been followed by an outbreak of the disease within a few years, as happened on the island of New Guinea.

HOSTS OF THE DISEASE AND VECTOR

Little is known about which plants other than *Citrus* spp. may be hosts for '*Ca. L. asiaticus*' except that there are reliable reports from south east Asia that mock orange (*Murraya paniculata*) is one. The citrus psyllid can feed on many plant species besides citrus. Mock orange and Chinese box (*Murraya exotica*) are the best hosts and



Fig. 5. The Asian citrus psyllid, *Diaphorina citri*



Fig. 6. Mock orange (*Murraya paniculata*)



Fig. 7. Curry leaf (*Bergera koenigii*)

curry leaf (*Bergera koenigii*) and most *Clausena* spp. are good hosts. Mock orange (Fig. 6) and curry leaf (Fig. 7) are particularly common in the Pacific Islands. The former is a favourite ornamental and the latter is often grown in backyards for use in the kitchen. Other known hosts include species within the genera *Atalantia*, *Aegle*, *Limonia* (syn. *Feronia*), *Severinia*, *Swinglea*, and *Triphasia* (Aurantieae); and *Merrillia* (Clauseneae); *Toddalia*, and *Vepris* (Toddalieae). It is likely that there are more unknown hosts including native species.

QUARANTINE PRECAUTIONS

'*Ca. L. asiaticus*' will not survive without a vector so quarantine in the Pacific should focus mostly on preventing movement of psyllids. The biggest quarantine threat is transport by people of infested citrus and other host plants, especially mock orange. HLB is not known to be transmitted in seeds.

Surveillance for the vector

Psyllid numbers generally go down after heavy rain and populations will be at their highest after the first growth flushes of the new wet season following dry weather. Look for psyllid adults and nymphs on under surfaces of new growth flushes of host plants, especially on the lower part of the canopy on the shady side of the tree. Sample with a sweep net, collect psyllids from the net using an aspirator and place them in 70% alcohol.

Surveillance for the disease

As the symptoms of HLB look like those of other problems, the disease can be difficult to survey for when trees are stressed. Chlorotic blotching and swollen or corky leaf veins are two key visual guides, especially when they are both found on the same leaf (Fig. 3). The pathogen can only be properly diagnosed using biotechnology (DNA testing). If

HLB is suspected, leaves showing symptoms, including leaf stalks, should be sent under quarantine security to a suitable laboratory (contact SPC for details). Disease symptoms are not seasonal.

WHAT TO DO IF THE DISEASE IS PRESENT

The only cost effective action is to eliminate HLB inoculum, that is, infected plant tissues. Once established in a region, this means removing trees or parts of trees as the best way to limit local spread. On a country-wide scale, this means preventing infection of trees in new areas by using internal quarantine precautions.

Eradication of small outbreaks

Diseased trees occur in clusters in citrus orchards, reaching sizes of up to around 25 m across. In the backyards of Vanimo town in PNG where HLB first appeared, diseased trees were also grouped together, but these clusters expanded in size only very slowly. Therefore, the destruction of infected trees plus all surrounding citrus and psyllid host trees within at least 50 m of an infected tree should give a good chance of eradicating the disease. It is essential to carry out a spray programme to kill all psyllids infesting these and other host trees before felling the trees. This is because short-distance spread of HLB mostly occurs when psyllids are disturbed and react by jumping and flying a short distance before landing. They can travel longer distances if they rise up above the tree canopy and are carried in the wind. Ensuring rapid death of psyllids is also very important. Psyllids can be killed before trees are felled by using a foliar spray (dimethoate or diazanon) of higher than normal strength. Systemic insecticides applied to tree trunks can do the same job if applied correctly, and this method would minimise contamination of the environment. Imidacloprid (Confidor) could be painted on to the trunk and this chemical or the cheaper alternative, dimethoate, could be injected into trunks or simply poured into holes drilled in trunks. Another alternative, even less toxic to the public would be a spray of 2% white oil at very high volume, literally

soaking the tree. However, this would need sophisticated spraying equipment with an agitator, capable of spraying 60-100 litres for a 6 m high tree. These are drastic measures, which would incur great expense and environmental impact. Before attempting eradication of a new outbreak, the likelihood of further incursions occurring needs to be taken into account.

Disease containment

The rate of natural spread of HLB in north-west PNG was found to be very low, implying that successful containment within a limited region of a large island is possible. This can be achieved with a campaign of public awareness and legislation to prevent movement of citrus and *Murraya* planting material from the region.

Disease management

Once HLB becomes established in an area, inoculum reduction is again the best control strategy. In South Africa, control measures are based on ongoing removal of infected plant parts, combined with chemical controls to keep psyllid populations at a minimum.

HLB inoculum reduction Individual branches affected by HLB will not bear good fruit and do not recover. As the bacterium spreads only slowly through infected trees, removing only the parts of the tree showing symptoms can be useful, depending on the age of the tree and the infection level. This practice is summarised in Table 1. Tree destruction or pruning must be done when psyllid populations are at a minimum, otherwise the disturbance will increase tree to tree spread of both psyllids and disease. In many Pacific Islands, it may be possible to carry out activities to reduce inoculum when psyllid populations are naturally low, simply by timing the work carefully. This would avoid the environmental impact and costs of killing psyllids prior to working on trees.

If a distinct wet season occurs, psyllid numbers will be at their lowest towards the end of it, making this the ideal time to get rid of HLB infected branches and trees. Replacement trees must be known to be HLB free, and should be obtained either from disease indexed nursery stock, or from disease free areas.

Table 1. HLB management as practised in South African orchards, when combined with chemical treatments to minimise psyllid populations.

Age of trees	Amount of canopy with symptoms	Treatment
<5 years	Any symptoms	Destroy tree
6-10 years	<75%	Remove only affected branches
6-10 years	>75%	Destroy tree
> 10 years	<40%	Remove only affected branches
>10 years	>40%	Destroy tree

Minimising psyllid populations Contact and systemic insecticides will not prevent introduction of HLB to individual trees or orchards, but they can help reduce HLB spread by reducing psyllid populations. In Asia, a range of insecticides, mostly organophosphates and pyrethroids, are used in very intensive spray programs to kill nymphs and eggs on flush growth. Horticultural and agricultural mineral oils are now being developed as alternative treatments. These are much less damaging to the environment and less disruptive to biocontrol of other pests. In South Africa, applying systemic insecticides aimed specifically at psyllids to tree trunks has been most effective. If HLB becomes a problem in large scale commercial citrus production in the Pacific in the future, seek the latest advice on the most suitable practices.

Reference

Kiritani, K. and Su H.-J. 1999. Papaya ring spot, banana bunchy top, and citrus greening in the Asia and Pacific region: occurrence and control strategy. *Japan Agricultural Research Quarterly* 33: 22-30.

This leaflet was prepared by Richard Davis, Tony Gunua, Glenn Bellis^a and Judy Grimshaw^a. Further information can be obtained from Land Resources Division, SPC, or PNG National Agricultural Quarantine and Inspection Authority (NAQIA) Andrew Beattie, University of Western Sydney, Australia, is thanked for advice on psyllid control and host trees, and for providing Fig. 5.

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^aNAQS Program, AQIS, Australia

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