COMMON NAME: Huanglongbing (Citrus greening)

SCIENTIFIC NAME: Candidatus Liberobacter asiaticus Garnier [Proteobacteria]

SYNONYMS: Liberobacter asiaticus

The scientific and technical content of this document is current to the date published and all efforts were made to obtain relevant and published information on the threat. New information will be included as it comes to light, or when the document is reviewed.

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BACKGROUND

*Huanglongbing* (HLB), also known as citrus greening, is a bacterial disease. Symptoms of HLB include yellowing of leaves, dieback, and distorted and discoloured fruit. Originally it was thought that cases of HLB observed in Asia and in Africa were caused by the same pathogen, however it has since been demonstrated that two different species of bacteria are responsible. In Asia HLB is caused by the phloem-limited bacterium *Candidatus Liberibacter asiaticus*, whilst in Africa *Candidatus Liberibacter africanus* is the causal agent. HLB is the most serious impediment to citriculture in Asia and is capable of destroying orchards within five years of planting (Beattie, 2002). Both pathogens are graft-transmissible, however psyllid vectors play a large role in spread of the disease. Chemical control of the vector of *C. L. asiaticus*, particularly in Thailand, has been of limited efficacy, with 35-52 sprays applied each year in some orchards since 1980 (Beattie, 2002).

PART OF PLANT/COMMODITY AFFECTED

Leaves, stems, flowers, fruit and roots. All growth stages of the plant are affected (e.g. seedling stage, vegetative growing stage, flowering stage, and fruiting stage). (CAB International, 2002).

BIOLOGY

Symptoms

The first visible sign of HLB is usually a yellow shoot in the canopy. Progressive yellowing of the rest of the canopy follows. Affected leaves are blotchily mottled, become pale yellow, or have the appearance of foliage affected by zinc and other nutrient deficiencies. These symptoms appear together on branches. New leaves are typically thin, yellow and upright. Leaves senesce early. The most characteristic symptom is blotchy mottle; however this symptom is not specific to HLB. The mottling reduces over time, leaving the deficiency symptoms most prominent. (CAB International, 2002).

Other circumstances causing a similar blotchy mottle pattern include water logging, use of marcots, or infection with stubborn disease (*Spiroplasma citri*), citrus tristeza closterovirus (CTV) or species of *Phytophthora*. Citrus blight also causes symptoms of zinc deficiency, however HLB affected trees do not display the wilting characteristic of blight. (CAB International, 2002).

Chronically infected trees exhibit extensive twig dieback and are sparsely foliated. Inflorescences ripen prematurely. HLB causes fruit symptoms similar to those caused by CTV. Fruits or pods are often small, contain aborted seeds, show distortion in shape, are poorly coloured and/or are abnormally patterned. Premature fruit drop can also occur. (CAB International, 2002).
Identification

Symptoms of HLB may be confused with stubborn disease, CTV infection, Phytophthora infection, citrus blight or certain nutrient deficiencies. This makes HLB difficult to identify in the field, however a yellowing canopy, blotchy mottled leaves and small lopsided fruits with aborted seeds are a good indication. Diagnosis must then be confirmed through use of EM, DNA hybridisation or PCR to identify the bacterium. The HLB bacteria are restricted to phloem sieve tubes in affected plants. They have also been observed in the haemolymph and salivary glands of the insect vectors. (CAB International, 2002).

Life history

Candidatus L. asiaticus has one known insect vector. This is the Asiatic citrus psyllid (Diaphorina citri Kuwayama [Hemiptera: Psyllidae]. The African citrus psyllid (Trioza erytreae) is the only known vector of the related pathogen Candidatus L. africanus. Each of these has proven capable of hosting either pathogen in the laboratory; however it is not known whether this occurs in nature. Multiplication of the pathogen does occur within the vector however no transovarial transmission occurs. (CAB International, 2002).

D. citri can acquire C. L. asiaticus from a 15 to 30 minute feeding period on an infected host plant. D citri then retains the pathogen for life. An incubation period of approximately 21 days is required before D. citri is able to transmit the pathogen to other plants during feeding. Fourth or fifth instar D. citri nymphs and adults are capable of HLB transmission. (CAB International, 2002).

C. L. asiaticus and C. L. africanus differ in heat tolerance. Symptoms are not displayed above 25-30°C for the African species, whereas the Asian pathogen is more tolerant to high temperatures (symptoms displayed above 30°C). In South Africa, Kenya, Ethiopia, Madagascar and Yemen HLB (caused by C. L. africanus) is only found in cool climatic conditions and at elevations over 600-1000m. These conditions are unlikely to occur in the Australian citrus growing regions. In the Indian Subcontinent, Asia and Saudi Arabia, where C. L. asiaticus is the causal agent, the disease also occurs at low elevations with a hot climate. (CAB International, 2002).

Dispersal

HLB can be transferred via movement of infected tissue including bark, fruits, inflorescences, leaves, seedlings, micropropagated plants, roots, stems and wood. The pathogen can also survive and be transported between sites in growing media. (CAB International, 2002).

In the field both pathogens can be transmitted by dodder (Cuscuta campestris ) from affected citrus trees to the alternative host Catharanthus roseus. The liberobacters reach higher titres in this host than in citrus. Transmission from C. roseus to C. roseus occurs via graft inoculation. Transfer of C.L. asiaticus from C. roseus to tobacco (Nicotiana tabacum var. xanthi NC) has also been demonstrated.
Severe symptoms are displayed by infected tobacco plants even though the liberobacter titre is relatively low. (CAB International, 2002).

Spread also occurs via movement of insect vectors. As *C. L. asiaticus* and *D. citri* have spread through eastern Indonesia there is a high risk that they could spread to Australia, either by natural means or by unintentional human-assisted introduction on host material (Beattie, 2002).

**HOST RANGE AND DISTRIBUTION**

HLB affects most commercial citrus types, particularly sweet oranges, tangelo and mandarins. Limes, pomelos and trifoliates are less strongly affected. A range of other rutaceous plants including ornamentals and wild species are susceptible to infection; however the severity of symptoms displayed varies. In South Africa *Candidatus L. africanus* has been found in *Toddalia lanceolata*, a wild rutaceous species, and in *Calodendrum capense*, an ornamental rutaceous tree. In Asia, *Murraya paniculata*, an ornamental rutaceous shrub, is a preferred host of *D. citri*. (CAB International, 2002).

**Primary host range**


**Other hosts**

Rutaceae: *Citrus aurantiifolia* (lime), *Poncirus, Fortunella, Murraya, Toddalia*, *Calodendrum capense, Severinia buxifolia, Limonia acidissima*. Apocynaceae: *Catharanthus roseus* (Madagascar periwinkle). (NB: These are hosts of HLB. *C. L. asiaticus* and *C. L. africanus* are not differentiated here).

**Distribution**

HLB caused by *C. L. asiaticus* is found in many countries throughout Asia, and is spreading in Indonesia. *C. L. africanus* occurs in numerous countries in Africa and is also spreading. HLB and its vectors have not been detected in Australia.

The following countries are listed as having HLB by CAB International (2002); however the two pathogen species are not differentiated.

**List of countries**

**Asia**

- Bangladesh: present, no further details (Catling et al., 1978)
- Cambodia: present, no further details (Garnier & Bové, 1998)
- **China**
  - Fujian: present, no further details (Lin & Lin, 1956)
  - Guangdong: present, no further details (Lin & Lin, 1956)
  - Guangxi: present, no further details (Lin & Lin, 1956)
  - Hainan: present, no further details (Lin & Lin, 1956)
  - Jiangxi: present, no further details (Lin & Lin, 1956)
  - Taiwan: widespread (Matsumoto et al., 1961)
  - Zhejiang: present, no further details (Lin & Lin, 1956)
- **India**
  - Andhra Pradesh: present, no further details (Bové et al., 1993)
  - Assam: present, no further details (Ahlawat, 1997)
  - Delhi: present, no further details (Bové et al., 1993)
  - Indian Punjab: present, no further details (Ahlawat, 1997)
  - Karnataka: present, no further details (Bové et al., 1993)
  - Maharashtra: present, no further details (Bové et al., 1993)
  - Orissa: present, no further details (Bové et al., 1993)
  - Rajasthan: present, no further details (Bové et al., 1993)
  - Uttar Pradesh: present, no further details (Bové et al., 1993)
- **Indonesia**
  - Java: present, no further details (Aubert et al., 1985)
  - Kalimantan: present, no further details (Aubert et al., 1985)
  - Lesser Sunda Islands: widespread (Bové et al., 1998)
  - Sulawesi: present, no further details (Aubert et al., 1985)
  - Sumatra: present, no further details (Aubert et al., 1985)
- **Japan**
  - Ryukyu Archipelago: present, no further details (Miyakawa & Tsuno, 1989)
- **Laos**: present, no further details (Garnier & Bové, 1998)
- **Malaysia**
  - Peninsular Malaysia: present, no further details (Garnier & Bové, 1996)
  - Sarawak: present, no further details (Bové et al., 1993)
- **Myanmar**: present, no further details (Garnier & Bové, 1998)
- **Nepal**: widespread (Regmi et al., 1996)
- **Pakistan**: present, no further details (Garnier & Bové, 1996)
- **Philippines**: widespread (Garnier & Bové, 1996)
- **Saudi Arabia**: restricted distribution (Bové & Garnier, 1984)
- **Thailand**: present, no further details (Promintara, 1990)
- **Vietnam**: restricted distribution (Bové et al., 1996)
- **Yemen**: restricted distribution (Bové & Garnier, 1984)

**Africa**

- **Burundi**: present, no further details (Aubert et al., 1988)
- **Cameroon**: present, no further details (Aubert et al., 1988)
- **Central African Republic**: present, no further details (Aubert et al., 1988)
- **Ethiopia**: present, no further details (Aubert et al., 1988)
- **Kenya**: present, no further details (Garnier & Bové, 1996)
- **Madagascar**: present, no further details (Bové & Garnier, 1994)
- **Malawi**: present, no further details (Aubert et al., 1988)
• Mauritius: present, no further details (Garnier et al., 1996)
• Rwanda: present, no further details (Aubert et al., 1988)
• Réunion: present, no further details (Etienne & Aubert, 1980)
• Somalia: present, no further details (Bové, 1995)
• South Africa: restricted distribution (Korsten et al., 1996)
• Swaziland: present, no further details (Bové & Garnier, 1994)
• Tanzania: restricted distribution (Bové & Garnier, 1994)
• Zimbabwe: restricted distribution (Garnier & Bové, 1996)

Potential distribution in Australia

CSIRO CLIMEX model predictions indicate that Asiatic citrus psyllid would survive in more than 50 per cent of the area covered by Australia’s citrus-growing regions (Beattie, 2002).

The following risk analysis for HLB is based on the methodology in Biosecurity Australia’s guidelines on Import Risk Analysis for Plants and Plant Products (2001).

ENTRY POTENTIAL

Entry potential: Rating = High

There is a high risk of *C. L. asiaticus* and *D. citri* being introduced, particularly by natural or unintentional human-assisted spread through Indonesia and Papua New Guinea, on either known or unknown hosts.

ESTABLISHMENT POTENTIAL

Establishment potential: Rating = High

CSIRO CLIMEX model predictions indicate that Asiatic citrus psyllid would survive in at least half of Australia’s citrus-growing regions (Beattie, 2002).

SPREAD POTENTIAL FOLLOWING ESTABLISHMENT

Spread potential following establishment: Rating = High

For *C. L. asiaticus* with its psyllid vector.

ECONOMIC IMPACT

Economic impact: Rating = High

The trends in south east Asia indicate that in the presence of the insect vector, and without effective control, *C. L. asiaticus* would cause a significant and potentially unrecoverable decline in the Australian citrus industry over 10 to 20 years. The effects of the disease on productivity are often severe, particularly for sweet oranges, mandarins and tangelos.
With effective control, increased production costs may still significantly reduce the viability of the industry. Impacts on the industry are likely to be far greater than the potential loss of export income. (Beattie, 2002).

**ENVIRONMENTAL IMPACT**

**Environmental impact: Rating = Unavailable** (pending further research)

This disease has the potential to infect native rutaceous species.

**CONCLUSIONS**

**Overall risk: Rating = Unavailable** (pending finalisation of environmental impact rating)

**REFERENCES**


*The following references relate to the CAB International (2002) HLB geographic distribution list:*


Conference of the International Organization of Citrus Virologists. IOCV University of California, Riverside, USA.


