

The Asian Citrus Psyllid, Huanglongbing, and Citrus Canker:

Exotic threats to the Australian citrus industry

CT18003: Study tour to California and Florida

March 11th – 22nd 2019



This report has been compiled by tour participants from information gained at the sixth International Research Conference on Huanglongbing, meetings with various industry groups, and observations in citrus orchards. The recommendations contained in this report reflect the participant's views of means to improve the biosecurity preparedness of the Australian citrus industry.

Tour participants



Fred Gmitter, Plant Breeder University of Florida is fourth from the right of picture. The group is standing in front of the Sugar Belle mandarin which shows HLB tolerance.

Tour participants, from the left:

Participant	Industry role	Region
Nathan Hancock	CEO, Citrus Australia Ltd.	Mildura Vic (national)
John Morris	Grower	Leeton NSW
Merryl Morris	Grower	Leeton NSW
Robert Hoddle	Grower, Gunnible Pastoral Co, Director Citrus Australia Ltd.	Gunnedah NSW
Matt Strmiska	Consultancy Lead E E Muir & Sons	Geelong Vic
Helen Newman	Biosecurity, WA Citrus	Perth WA
Ryan Arnold	Grower, Pyap Produce	Loxton SA
Adrian Chapman	Grower Services, Nutrano Produce Group	Mildura Vic
Bronwyn Walsh	Industry Development Manager, WA Citrus	Perth WA
Jeff Milne	National Citrus Surveillance Coordinator Citrus Australia Ltd.	Mildura Vic (national)

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Abbreviations & acronyms

ACP	Asian Citrus Psyllid (<i>Diaphorina citri</i>)
CCM	Californian Citrus Mutual
CDFA	Californian Department of Food and Agriculture
CHMA	Citrus Health Management Areas
CHRP	Citrus Health Response Program
CCPDPC	California Citrus Pest and Disease Prevention Committee
CRB	Citrus Research Board
CRDF	Citrus Research and Development Foundation
EPPRD	Emergency Plant Pest Response Deed
FDACS	Florida Department of Agriculture and Consumer Services
HIA	Hort Innovation Australia Limited
HLB	Huanglongbing (Citrus Greening)
IBP	Industry Biosecurity Plan
PCR	Polymerase Chain Reaction
PMA	Pest Management Areas
USDA	United States Department of Agriculture

1 Executive summary

Hort Innovation Project CT18003: *First detector network: 'United States of America (USA) Huanglongbing and Citrus Canker'* supported a study tour to California to attend the Sixth International Research Conference on Huanglongbing (IRCHLB VI), meet with growers and researchers, and understand the implications of Huanglongbing (HLB) in California and Florida, Citrus Canker in Florida, and the potential impacts of the diseases in Australia.

The tour participants had roles that influence growers such as grower liaison, industry development and pest scout, or were growers themselves. This was intended as growers are considered more likely to accept information from their peers and trusted advisors than from academics and researchers.

Attending the conference highlighted the impacts HLB has had on citrus production worldwide and the amount of research effort that has occurred without a solution being developed.

Representatives of countries where the Asian Citrus Psyllid (ACP) and HLB are now endemic commented that in hindsight, their response was too little too late, and strongly recommended that Australia prepare all the necessary controls and regulations in anticipation of the pest arriving.

The Californian visit demonstrated the difficulties and expense of urban surveillance such as finding people at home, right to access, and the need to work outside regular hours. It also showed the value of a well-run awareness campaign to gain public support.

In Florida, the orchards visited were infested with HLB and Citrus Canker, both are now considered endemic in the state. The Florida citrus industry has been impacted by other factors including freezes, hurricanes, environmental issues, and declining returns that have also contributed to the reduction in citrus production.

Propagation with pathogen free material in insect proof facilities is mandatory in Florida, California, and Brazil. Not only are all nurseries registered, but all trees are tagged and registered providing traceability all the way back to the nursery bench.

China and Brazil have strict surveillance protocols for HLB and infected trees are removed immediately and replaced with disease free nursery trees.

The tour was invaluable for building personal relationships across the US citrus industry that will facilitate sharing of information and research and potentially the opportunity for Australian researchers to study in the USA.

Short time lines, other industry events, work commitments, and the intensive itinerary deterred some participants which meant the tour group was smaller than expected.

2 Key Recommendations

Participants on the tour agree early detection of ACP and a rapidly implemented, detailed, nationally agreed response plan is essential to eradicate any incursion and maintain the Australian citrus industry's HLB-free status. The key recommendations are:

- Surveillance is conducted to nationally agreed protocols; risk based; and is adequately resourced.
- Surveillance in urban and peri-urban areas is prioritized.
- Surveillance at entry points is adequately resourced, with increased focus on interceptions at the border.
- Additional resources be made available to support and enhance the Northern Australia Quarantine Strategy activities both on and off shore.
- Agreed response protocols including chemical use permits, movement restrictions, host list, and diagnostic tools are in place.
- A national industry-driven Citrus Pest and Disease Prevention Committee be established to focus and coordinate efforts and attention on exotic threats to the citrus industry across government, industry, and the general public.
- Further, separate study tours be arranged to suit various audiences including Agriculture Ministers, Chief Plant Health Officers, and growers and pest scouts.
- Develop a communication plan to engage with the general public on the importance of protecting their citrus from exotic pests.
- Citrus nurseries be registered and over time move to production with certified disease free material grown in insect screened facilities, all citrus trees to be registered and traceable.
- Australian research be collaborative with and complimentary to international projects.
- Economic and social modelling be conducted to demonstrate the value of the Australian citrus industry and the social impacts the loss of the industry could create.
- International relationships be maintained and developed; continue to build relationships in Asia, from where it is most likely ACP/HLB will enter Australia.

Hort Innovation partially funded the study tour, some costs were met by Citrus Australia, and the balance by the participants.

3 Overview

Australian industry concerns

The risks to the Australian citrus industry from exotic pests and diseases are understood to varying degrees by government, researchers, industry bodies and growers and are of little interest or consequence to the general public. This contrasts with California where enormous efforts at significant expense are being made to raise public awareness and prevent ACP and HLB becoming established in the major citrus producing regions in the San Joaquin Valley, utilizing regulation, surveillance, vector control, and public awareness campaigns.

The Australian citrus industry is in excess of 26,000 hectares across five states; a third of production is exported at a value of AU\$460 million. Australia is free of many significant citrus pests, however the presence of HLB and its vector ACP to our near north are a significant threat to the citrus industry.

The industry is currently responding to an outbreak of citrus canker in NT and WA thought likely to have originated in south east Asia. The recent arrival of the Tomato Potato Psyllid (*Bactericera cockerelli*) to Australia and the rapid spread of *Xylella fastidiosa* in Europe further demonstrate current international quarantine is insufficient to prevent incursions and that industry preparedness is essential.

ACP serve as the vector of *Candidatus Liberibacter asiaticus* (CLas) bacterium, the causal agent of HLB. Originally thought to be a virus, it's now known to be caused by an unculturable phloem limiting bacteria that ultimately blocks the phloem and starves the tree of water. Evidence in other regions of the world suggests ACP multiply quickly and are difficult to eradicate if not treated immediately. HLB is spread by the ACP or through grafting; in the absence of ACP, HLB cannot spread and will simply kill the infected tree.

Australian native citrus and citrus relatives are potential hosts for ACP and carriers of HLB.

Decades of research and hundreds of millions of dollars have been invested in R&D in countries such as Brazil, China, and the United States yet there is currently no cure for HLB. Although some treatments may reduce the impact of the disease, production and fruit quality are reduced significantly and input costs increase dramatically.

Despite previous HLB study tours in 2010 and 2014, there continues to be a low recognition in Australia of the threats and preventative measures that could be taken by growers and nurseries.

Previous tours had involved researchers and government departments. It was believed growers would be more receptive to information from peers such as grower liaison staff, pest scouts, industry development officers, and other growers.

Biosecurity is a high priority for Citrus Australia; the 2019 Citrus Technical forum focused heavily on awareness of the threats and their impacts. Evidence suggests that government policy has moved toward responding to incursions at the expense of preventing incursions. Response to incursions is expensive, for the public and industry and often unsuccessful because the incursion may not have been detected for months or years, allowing the pest to establish to the point where eradication it is not technically or financially feasible.

HLB and ACP in California

ACP was first detected in southern California in August 2008 and shortly thereafter in Los Angeles (LA). Subsequent trapping and surveys indicated ACP was widespread and had been present for some time.

Citrus is widely grown in residential LA, the California Department of Food and Agriculture (CDFA) estimates 60% of the households in the LA basin (17 million people) have residential dooryard citrus and of these households the average is approximately two trees per household. With approximately 20.4 million trees located in the residential area alone, the threat is being taken seriously in the region.

An extensive surveillance program for ACP detection, and subsequent sampling/testing of trees where ACP is present for HLB is being conducted throughout the greater LA region. Trees confirmed to be infected with HLB by PCR are removed.

ACP was first detected in commercial citrus in the San Joaquin Valley in 2013 and has now been detected in at least 22 counties as far north as Sacramento, beyond commercial citrus production regions. As an outcome of response activities to date, populations of ACP have not been able to establish in growing regions in the San Joaquin Valley, however detection is becoming more frequent. No ACP found in the San Joaquin Valley have carried the CLAs.

HLB has been detected in backyard citrus in several locations in LA, Orange, and Riverside counties but not confirmed in commercial citrus plantings around Riverside. Nor has HLB been confirmed in the San Joaquin Valley, the major citrus producing region in the state with 262,000 acres at risk. Most we spoke to in California consider it only a matter of time until it is detected and is likely already present without expressing symptoms.



Bulk Citrus Regional Quarantine

- Zone 1
- Zone 2
- Zone 3
- Zone 4
- Zone 5
- Zone 6
- Zone 7

Zone 1: counties with no ACP infestation and where HLB has not been detected

Zones 2, 3, & 7: counties that are partially infested with ACP and HLB has not been detected

Zones 4 & 5: counties that are generally infested with ACP and HLB has not been detected

Zone 6: counties or portions of counties that are generally infested with ACP and HLB has been detected in some areas

Californian citrus quarantine zones stretching nearly 1000km

HLB, ACP, and Citrus Canker in Florida

Citrus Canker outbreaks had been eradicated until the mid-1990s. In the mid-2000s during an eradication response multiple Citrus Canker outbreaks occurred following several hurricanes. The number of outbreaks combined with legal challenges to residential tree removal schemes resulted in eradication attempts being discontinued and Citrus Canker is now fully established throughout Florida.

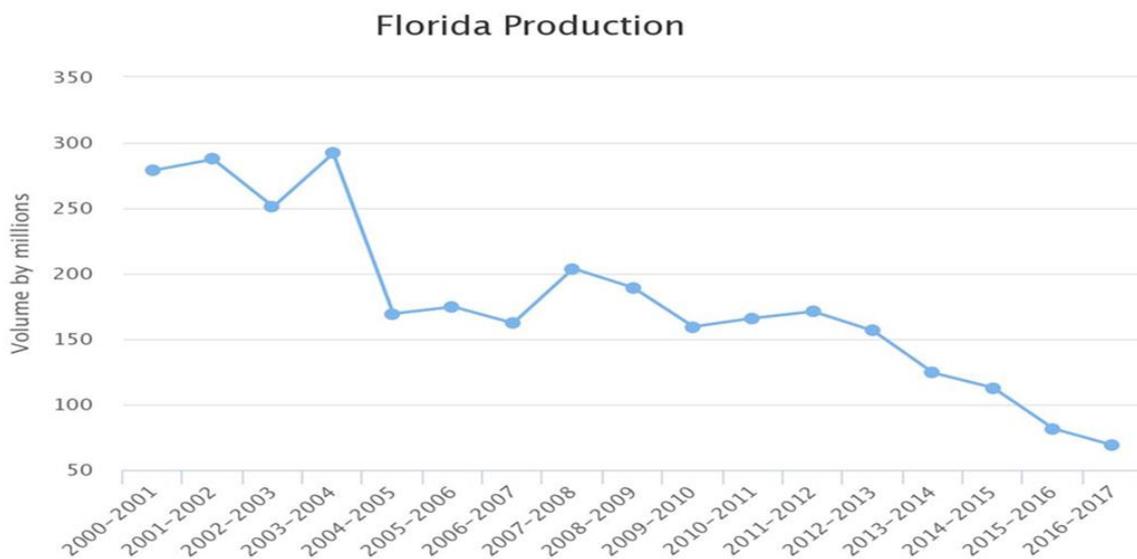
Many credit the downfall of the Florida citrus industry to the failure to keep the public sector engaged. During the canker response in the 2000s an attempt to eradicate citrus leaf miner caused public concern. Citrus leaf miner was later shown not to be a vector of canker. When ACP was first detected in Florida in 1998 a decision was made not to eradicate it as it had low impact on citrus and HLB was not present. Then in 2005 the USDA confirmed HLB infection in 404 citrus trees from 268 locations across Florida and within ten years every commercial grove was infected with HLB because ACP had gone untreated and was now impossible to eradicate.

Abandoned orchards survive in Florida's climate, providing uncontrolled sources of ACP habitat and HLB infection and citrus canker.

Production in Florida has declined dramatically, dropping from 297 million 90-pound (41kg) boxes in 2004-5 to 50 million in 2017-8. Hurricane Irma caused orchard losses of 30-70% in 2017-8, production is predicted to rise to 87 million boxes in 2018-9.

The area of citrus in Florida peaked at 971,577 acres (393,350 Ha) in 1997 and has declined to 400,900 acres (162,300 Ha) in 2018.

Factors other than HLB/ACP and Citrus Canker such as freezes, hurricanes, poor juice prices, urban expansion and environmental campaigns have also contributed to the decline in production.



Annual Florida citrus production in millions of boxes (US 41kg box)

Due to HLB, a 2014 study estimated that production costs have increased by \$US 468 per acre and yields decreased by 40%. Indicated losses to the state of Florida were over \$10 billion and 9,300 jobs since 2005 and this figure continues to rise.

HLB/ACP have been detected in all southern USA border states except New Mexico and in Georgia on Florida's northern boundary.

4 Tour details

Itinerary

Date	Location	Activities
11 th March	Travel	Arrive California
12 th March	Riverside	CCPDPC - Jim Gorden, chair; Victoria Hornbaker, secretariat Observers at CCPDPC meeting Lunch with committee members Presentations on canine detection and ACP spread modeling
13 th March	Riverside	IRCHLBVI conference
14 th March	Riverside	IRCHLBVI conference Gless Ranch field visit John Gless, owner & CCPDPC member
15 th March	Riverside	IRCHLBVI conference
16 th March	San Gabriel	CDFA urban surveillance, Tina Galindo environmental program manager
17 th March	Travel	Arrive Florida
18 th March	Winterhaven	Noble Citrus (WG Roe & Sons) Bill Roe, owner Orchard visit, disease observation, industry history and future
19 th March	Lake Alfred	UFAS Citrus Research and Education Centre Dr. Michael Rogers, centre director, entomology Dr. Megan Dewdney, citrus pathologist Dr. Lauren Diepenbrock, entomology Dr. Fred Gmitter, horticulture/citrus breeding Dr. Jude Grosser, horticulture/citrus breeding Dr. Evan Johnson, plant pathology Dr. Davie M. Kadyampakeni, soil and water sciences Dr. Arnold Schumann, soil and water science Dr. Tripti Vashisth, horticulture
20 th March	Lake Panasoffkee	Brite Leaf Nursery, Nate Jameson, owner
	Depart Orlando	
21 st March	Travel	
22 nd March	Arrive Australia	

California

California Citrus Pest & Disease Prevention Committee (CCPDPC) meeting on March 12th prior to the conference (see Item 6 below).

IRCHLB VI conference from March 13th to 15th with concurrent sessions for much of the program to allow participants to select the sessions of most interest to them (see Item 6 below).

In addition to the conference program there were 174 posters on display and many contacts were made either at the posters, during breaks, or through the conference social program.

Field trip to a nearby Riverside citrus grove, Gless Ranch, was arranged through members of the CCPDPC.

Residential surveillance procedures by the CDFA were observed; four participants joined a surveillance team and observed two backyards being inspected for psyllids and sampled for HLB.

Florida

The first day in Florida was spent with Bill Roe, from long-established citrus growing and marketing business WG Roe and Sons - Noble Citrus. The visit showed the impacts of HLB/ACP, what is being done and an insight into future strategies from a grower's perspective. ACP, HLB, and Citrus Canker were observed in the field, the first time for many of the participants.

Day two was at the University of Florida Experimental Centre in Lake Alfred, established in 1917 in response to a severe freeze and Citrus Canker outbreak. The group met with key research and extension staff, viewed a number of trials and held detailed discussions that generated opportunities for further collaboration and information sharing.

Day three visited Nate Jameson's Brite Leaf Citrus Nursery, a state-of-the-art fully enclosed facility that demonstrates "best practice" and is said to produce the best trees in Florida. Nate is an articulate and passionate believer in biosecurity who spoke at the 2019 Australian Citrus Technical Forum.

5 The California Citrus Pest & Disease Prevention Committee

The CCPDPC was created to advise the CDFA secretary and the citrus industry about efforts to combat serious pests and diseases that threaten the California's citrus crop.

The CCPDPC is appointed by the CDFA secretary and consists of fourteen citrus producer representatives, two citrus nursery representatives, and a representative from the general public.

Other appropriate individuals such as the CDFA secretary, county agricultural commissioners, pest control advisors, chairperson of the CRB, and representatives of the University of California and California State University systems are non-voting ex-officio members of the committee.

Meetings are open and growers and other interested parties are encouraged to attend. Typically, a meeting has around twelve CDFA staff plus others associated with programs and around twenty observers. Meetings are broadcast as webinars.

The CCPDPC oversaw US\$39m in activities in the 2017-18 year and is funded by State and Federal grants and grower levies.

6 The IRCHLB VI conference

The joint conference of the International Organization of Citrus Virologists and the International Research Conference on Huanglongbing VI was held March 10th to 15th 2019 in Riverside California.

Prior to the conference it was announced New South Wales DPI citrus pathologist Dr Nerida Donovan was the incoming chair elect of the IOCV, a wonderful accolade for a dedicated and tireless worker for the citrus industry.

The HLB sessions from 13th to 15th attracted over 600 delegates, with 104 presentations over 10 sessions with panel discussions at the end of each session. 84 presentations were concurrent allowing delegates to select sessions, and there were six keynote speakers during conference meals.

7 Citrus Canker

Citrus Canker *Xanthomonas citri* subsp. *citri*. is a bacterium that infects the plant through wounds and natural openings on leaves, stems, thorns and fruit causing lesions or cankers at infection sites. Fruit quality and yield are affected and the unsightly lesions mean fruit is not acceptable for fresh markets.

Efforts to eradicate canker from Florida have ceased as canker is considered endemic and disinfection procedures no longer followed on farm.

Windbreaks are believed to reduce its spread through wind driven rain; fruit can be protected by copper sprays; and leaf miner control reduces the damaged sites Citrus Canker can enter the plant.

Susceptibility varies with variety. Grapefruit and navel oranges are highly susceptible with Hamlins and tangelos less so, but still can be severely damaged. Mandarins, Valencia, and some hybrids such as Murcotts are more tolerant.

There are several University of Florida bred canker resistant varieties close to commercialization.

8 Tour learnings

The following sections detail the learnings of the group across all tour activities

8.1 HLB worldwide

Citrus Huanglongbing (HLB, citrus greening, or yellow shoot disease) has been recorded in the world's major citrus producing regions, Africa (1928), Asia (China since at least the 1930s), South America (Brazil 2004), the USA (Florida 2005).

In 1956, Professor Kung Hsiang Lin demonstrated disease transmission by graft inoculation in China.

The African citrus psyllid (*Trioza erytreae*) was reported as the vector in South Africa in 1965 and the Asian citrus psyllid (*Diaphorina citri*) as the vector in India and Philippines in 1967.

Phloem restricting bacterium are distributed by the vectors feeding on infected host plants, *Candidatus Liberibacter africanus* (LAF), *Candidatus Liberibacter asiaticus* (LAS), and *Candidatus Liberibacter americanus* (LAM).

California has the ACP vector present in at least 22 counties, but HLB infection has only been confirmed in greater Los Angeles, Orange, and Riverside counties.

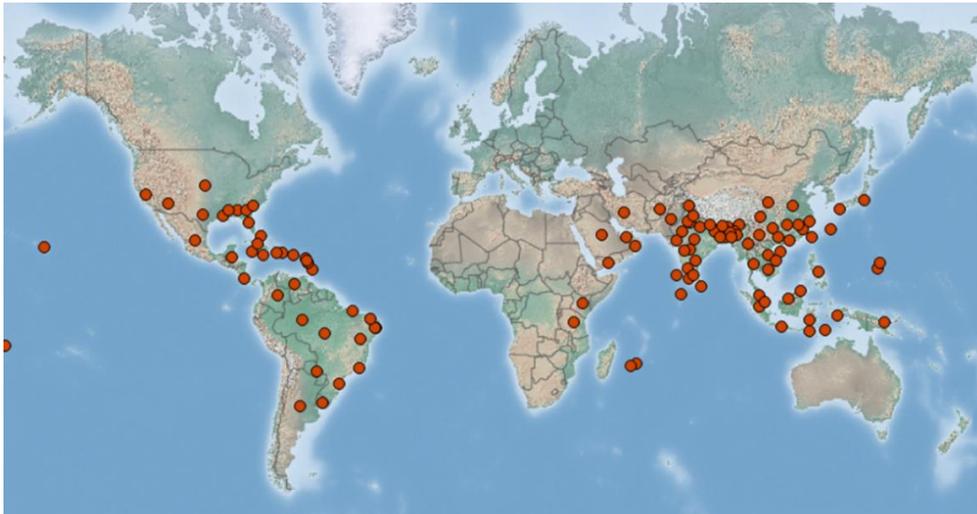
The Mediterranean is free of HLB, but the African psyllid is in Portugal and Spain. Iran has HLB and the ACP vector. Saudi Arabia and Yemen have both Asian and African HLB and its psyllid vectors.

The ACP and associated LAS are more heat-tolerant and have a greater impact than the African psyllid and LAF or LAM. LAS has displaced LAM in Brazil and Florida.

ACP is established in Ecuador and is threatening northern Peru; ACP is spreading through other parts of Central and South America where land borders are difficult to defend.

The ACP was collected in the Northern Territory in 1915, but is believed to have been eradicated along with citrus canker in 1922.

Australia and New Zealand have the opportunity to remain free of HLB and its psyllid vectors. Both must be well prepared for an incursion and successful eradication of the vector before the disease is established.



Diaphorina citri (Asian citrus psyllid) distribution



Invasive species compendium

8.2 Research

- Diagnosis
 - Trees can be CLas infected and pass the pathogen to the ACP vector but not display visual symptoms of HLB for up to three years.
 - Symptom expression varies seasonally and within the plant.
 - Visual symptoms are easily confused with nutrient deficiencies and other disorders. Experienced field staff are able to identify HLB easily.

- Polymerase Chain Reaction (PCR) analysis is being refined continuously, but there is debate about timing and locations to sample. The processing time between observation in the field and confirmation by PCR can be months.
 - Detector dogs have been shown to detect CLAs before visual symptoms exist; this has potential as an early detection tool. However, not all growers or researchers are convinced they are accurate detectors. Understandably there is reluctance to remove potentially large numbers of ‘healthy and productive trees’ in California based on this technology without further confirmation.
- Vector control
 - Insecticide dependence leads to resistance, loss of beneficials, and increased chemical residues.
 - Attract and kill devices are being researched.
 - Photonic fencing; identifying psyllids, tracking, and killing with lasers.
 - Genetically modified ACP without ability to carry HLB; CRISPR gene editing the ACP to not be able to ingest/transfer CLAs.
 - Production of sterile males in rearing factories.
 - Biological control with predatory wasp; *Tamarixia* is useful in residential settings for suppression but not sufficient to control in orchards as populations never reach zero.
 - Disruption pheromones and reflective tarping in orchard.
 - Kaolin or oil sprays to prevent feeding and/or egg laying.
 - Failure of Area Wide Management; area wide management (a collaborative effort by grower groups to spray ACP in a coordinated manner) was successful in the early stages of infection but has lost supporters over time for reasons such as it was not effective in reducing ACP numbers, not all growers were participating hence the ACP could reinfest quickly from those blocks, and the expense made production unprofitable.
 - “Trap crops”, like *Murraya*, discussed but considered by many to enhance ACP breeding.
 - Citrus Under Protective Structures and Individual Protective Covers are used in Florida to exclude the vector but create conditions favouring other pests and diseases.
 - Pathogen control
 - Oxytetracycline and streptomycin antibiotics as tree sprays and soil drench assist CLAs control, but concerns over widespread use are creating a public backlash.
 - Peptides derived from the Australian finger lime are cost-effective, stable at high temperatures, easy to synthesize, and claimed to be safe and better than antibiotics.
 - Peptides also control potato zebra chip.
 - High micronutrient levels, particularly Zn, Mn, and Cu are claimed to “cure” trees.
 - Using nano capsules ingested by ACP to deliver bacterial control agents and anti-microbials to the tree to control HLB in the infected tree.
 - Stringent nursery protocols on use of budwood material and insect proof growing conditions to ensure new nursery stock are HLB free.

- Management
 - Improved nutrition and irrigation management has improved yields, but only to around 70% of pre-HLB in Florida.
 - Symptoms are masked with improved tree health, but the tree is still an infection source.
 - High-density plantings and earlier production are being targeted.
 - Cover crops may improve soil conditions for root development and help sustain ACP predators.
 - China and Brazil routinely monitor for and remove symptomatic trees and replace with a 2-year-old HLB free re-plant tree to minimize time out of production.

- Plant breeding
 - GMO and conventional breeding of both rootstocks and scions with exposure to HLB pressure to develop new tolerant varieties such as the Sugar Belle Tangelo developed at UCF.
 - CRISPR Cas9; using the Cas9 enzyme to target and snip specific area of the citrus trees' DNA chain to induce a mutation during repair or to insert healthy DNA to create a resistant plant to the CLas bacteria.
 - Concerns over market acceptance of new varieties and GMOs even if only the rootstock.
 - Resistance traits of Australian native citrus.
 - Fast Track program allows growers to plant promising experimental citrus selections for trial and reduce the evaluation time.

8.3 Surveillance

- California
 - Orchard and residential area surveillance for ACP and HLB like any surveillance program is intensive, can be expensive and very time-consuming.
 - ACP detections have spread from the south and are now as far north as Sacramento, beyond commercial citrus plantings.
 - Detections usually occur along major transport routes and then spread out from there to orchards and residential areas.

- Florida
 - Has ceased surveillance, all citrus is considered infected and ACP is endemic.
 - Nurseries are inspected monthly to ensure the integrity of their insect exclusion netting.

8.4 Regulation

- California
 - Mandatory removal of HLB positive trees (1135 removed to date of the conference mainly in Los Angeles and Riverside).
 - ACP control zone for 400m radius for any ACP detection.

- Quarantine and movement controls with field disinfection and covered loads, nursery regulations.
- Nurseries must be registered with CDFA, insect proof, use propagation material from the California Citrus Clonal Protection Program or mother and increase trees that are regularly tested.
- All trees are registered and tagged.
- Florida
 - No intra state movement restrictions, uncovered loads of bulk and binned citrus were observed.
 - Nurseries have similar requirements to California.

8.5 Awareness

- Both states have extensive awareness programs in each state using a range of media targeted at different groups and in multiple languages.

9 Study tour recommendations

9.1 Surveillance

ACP and HLB are present to our near north. Potential to enter Australia illegally through commercial airlines is extremely high, therefore comprehensive surveillance is critical. Our recommendations are:

- National protocols for surveillance and diagnostics (including training, data collection and management, and alternative hosts) be developed and adopted.
- Risk modelling be used to prioritise surveillance activities with an emphasis on urban, peri-urban and potential entry points. Significant industry surveillance at an orchard level already occurs to meet export protocols.
- Improve collaboration between agencies, the citrus industry, and other industries to optimise surveillance outcomes.
- Boost surveillance on and off shore. (e.g. through the Northern Australia Quarantine Strategy)
- Additional citrus industry biosecurity levy funds be collected.

9.2 Response

Preparedness to respond rapidly to any exotic pest detection was stressed by all we spoke with on the tour. We recommend:

- Movement protocols for trees and fruit be agreed and be able to be enacted in a timely, uniform manner.
- Chemical use permits for exotic pests be ready for immediate issue.
- Tamarixia and other beneficial insects that parasitise ACP be able to be bred in production facilities to allow repeated releases in urban areas where psyllids detected.

9.3 Capacity building

Despite the devastation and expense ACP/HLP has caused in other countries there is a lack of urgency in Australia's preparation. The perceived shift of government strategy from prevention to eradication of incursions will not serve the citrus industry as HLB has no known cure. Australia has unique geographic biosecurity advantages. We recommend that we capitalize on these through initiatives such as:

- **High level delegations of Agriculture Ministers and department secretaries to California and Florida to see the costs of ACP and HLB**, not only to citrus growers, but to governments and regional economies.
- Broaden the focus for engagement by reaching out to other citrus industries such as Brazil and South Africa to develop networks and observations of their programs.
- The citrus industry establish a Citrus Pest & Disease Prevention Committee to coordinate and recommend actions (similar to US example).
- Liaise closely with the CCPDPC and run parallel programs where appropriate such as variety evaluation and citrus breeding with Australian native varieties.
- Collaboration and exchanges with international researchers not only in the US, but also projects in Asia which has the biotypes most likely to arrive in Australia.
- Support an Australian PhD student on an HLB/ACP related project in Florida; this is particularly urgent in entomology field with psyllids a focus (in broader horticulture too).
- Audience specific training and awareness programs for industry, nursery, agency staff, home gardeners, and the general public.

9.4 Propagation

Nursery controls and systems must be adequate to allow full traceability of product from commercial operations. The risk for pest and disease spread from "backyard" propagation is of grave concern to industry. This report recommends:

- Registered nursery production including insect proof propagation and nursery facilities, mandatory approved budwood and full traceability scheme implemented overtime.
- Citrus tree registration.
- Public awareness of risks involved in the propagation of backyard citrus and how to access clean budwood.
- The approved budwood system to include non-commercial but culturally significant citrus varieties.

9.5 Further research

Enormous efforts have been directed to research in countries such as the US, China, and Brazil amongst others. Australian research should be complimentary and where possible in collaboration with international activities. Research priorities should include:

- Improved trapping for ACP.
- Remote sensing/detection of HLB.
- Evaluation of HLB tolerant rootstocks and scions in Australian regions.
- Non-chemical controls of HLB and or ACP.
- Impact of Tamarixia on Australian native species of psyllids.
- Identify potential Australian native vectors and hosts.
- Breeding for tolerance or resistance to HLB, particularly with Australian native citrus.
- Canine detection suitability for Australian conditions.
- Social research be used to assist in the development of public awareness campaigns for industry, backyard citrus producers, and the general public.

9.6 Economic modelling

The citrus industry is a major employer in regional and rural Australia and contributes in excess of AU\$800 million in farm gate value to the gross domestic product. Added to this is the allied businesses that provide goods and services to the citrus industry and the retail, processing and food service sectors that value add or on sell the product. The citrus industry is one of the largest fresh produce export industries. These facts are not well known in the community or by government, this report recommends investment is made to:

- Demonstrate the value of the citrus industry to the regional and national economy and the impact of HLB across all sectors.
- Note the social impacts of HLB as the number of family farms in Florida has dramatically reduced.

9.7 International relationships

Learning from international experience is essential both economically and for timeliness and this requires the development and maintenance of international relationships.

- Maintain relationships developed and seek to develop similar ties in other regions with ACP/HLB, including citrus producers close to Australia.
- Increase the public awareness activities of the Northern Australia Quarantine Strategy in neighboring countries that have ACP/HLB.
- To see HLB/ACP and the impact on citrus production in Florida themselves was invaluable to the tour participants and further tours should be conducted to raise the citrus industry's understanding of HLB and to see the symptoms and vector.
- Future study tours should consider the target audience and structure the tour accordingly with additional orchard time, a large field day or trade fair, and potential to extend the tour.

10 Tour photographs

IRCHLB VI conference



Dr Nerida Donovan presenting



Conference venue

California surveillance



Residential surveillance



Tree labelling



Sample collection

HLB & ACP observations



Asian Citrus Psyllid



Asian Citrus Psyllid nymphs



Beat sampling



Notched leaves and asymmetric blotchy mottle



Typical "twiggy" shoot dieback, Florida



Misshapen fruit

Citrus Canker



Leaf lesions (NSW DPI photos)
UFAS Citrus Research and Education Centre



Variety collection impacted by HLB Dr. Fred Gmitter
Nursery controls: Brite Leaf Citrus Nursery, Florida

Citrus Under Protective Structures Dr. Arnold Schumann



Decontamination prior to entry

Insect proof production, all trees tagged

Florida



Good



Bad



Ugly



Optimistic



Utilises superheros



Has other hazards