Learn about HLB-fighting technologies at "Science for Citrus Health"

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Project Summary

The Science for Citrus Health web site is a collaborative effort between scientists from different universities whose goal is to describe some of the existing efforts and new technologies being developed to protect citrus from the invasive disease, huanglongbing (HLB). This web site is intended to be a source of up-to-date information about cutting-edge research written in lay language for citrus stakeholders, researchers, media and the general public.

HLB is the most destructive disease of citrus worldwide and is threatening the future of the California citrus industry (da Graça et al. 2016). Since the first detection of the HLB-associated bacterium *'Candidatus* Liberibacter asiaticus' (CLas) in California in 2012, more than 1,000 HLB-positive trees have been detected in and removed from southern California homeowners' backyards. The Asian citrus psyllid (ACP) transmits the bacterium associated with HLB. As the disease continues to spread within California, there is increasing concern that the disease will reach commercial citrus in the near future. Knowing the impact that HLB has had on citrus production in Florida and globally, scientists across the U.S. and internationally continue to coordinate efforts to find long-term solutions to the disease, as well as short-term strategies to manage its impact.

There are many research strategies being explored to solve the HLB problem, directed at the plant, the insect vector and the disease. For those outside of academia with limited access to research publications and conferences, it may be particularly challenging to stay informed about the latest approaches and understand the ever-evolving scientific language accompanying them. We saw the need for brief updates, readily accessible on a web site, written in lay language for a range of audiences, and so the Science for Citrus Health web site (*https://ucanr.edu/sites/scienceforcitrushealth/*) was born.

The web site started as the outreach component of a U.S. Department of Agriculture National Institute of Food and Agriculture grant to inform growers and the general public about some of the technologies that were being developed to manage HLB within that grant. Over the years, the scope of the web site has widened to cover any technology related to HLB, to create a resource for anyone interested in research intended to facilitate the survival of citrus production despite the threat of HLB. The web site, created in May 2015 under the umbrella of the University of California Division of Agriculture and Natural Resources (ANR), has been visited more than 4,600 times. The initial team voluntarily associated with the web site has grown from four to seven people and now includes early and senior career researchers from the University of California (Riverside, Davis and Berkeley campuses) and the University of Florida with diverse expertise in plant breeding, plant pathology, plant genetics and entomology.

New topics are added to the web site when the team learns about developing technologies at research meetings, such as the California Citrus Conference or the International Research Conference on Huanglongbing. In addition, the team actively searches for new and exciting advancements in scientific publications, industry magazines such as *Citrograph* and through research networks. Once the team learns about a new approach, they discuss whether it is sufficiently developed to be publicized. If so, the associated researcher is contacted to learn more about the technology and discuss its advantages and limitations. Then, the team collaborates with the scientist to develop a "Research Snapshot," which is a short fact sheet focusing on that new approach. If needed, a graphic designer on the team works with the researcher to find the best way to illustrate the topic. Technologies are organized in six categories:

- *early detection techniques*: methods to detect CLas/HLB early in the infection process
- *established orchards*: tactics applied to established orchards to protect against HLB
- *replants*: longer-term tactics for HLB protection that require replanting citrus
- *psyllids*: methods that affect the psyllids' ability to spread CLas
- *tools*: existing tools for managing the psyllid and HLB
- *general topics*: information on scientific approaches from the past, present and future

Each technology is thoroughly explained in a Research Snapshot, which contains all the information required to understand its characteristics and potential use. Currently, there are 26 Research Snapshots on the web site (*http://ucanr.edu/sites/scienceforcitrushealth/Research_Snapshots/*).

The goal of the team is for the web site to become the go-to resource for anyone interested in learning more about current and future HLB management tactics. In addition to the web site and associated blog (*https://ucanr.edu/sites/scienceforcitrushealth/Blog/*), the team recently created a Twitter account (*https://twitter.com/sci4citrus*) to increase diffusion of the web site contents. For more information, please visit the web site or follow us on Twitter.

List of Research Snapshots

Early Detection Techniques

Davis *UC Davis*	Using volatile changes in citrus for early detection of HLB
Leveau *UC Davis*	Changes in microbial communities on citrus leaves can help detect HLB
Ma *UC Riverside*	Using antibodies for early detection of HLB infection
McRoberts *UC Davis*	The value of early detection technologies (EDTs) for HLB management
Pourezza *UC Davis*	Starch accumulation sensor for early detection of HLB
Slupsky *UC Davis*	Metabolite changes in the tree can help us detect Huanglongbing

Established Orchards

Bonning *University of Florida*	A new, Bt toxin-based strategy for suppression of the Asian citrus psyllid vector of HLB
Dawson & Pelz-Stelinski *University of Florida*	Using tristeza virus to provide citrus with anti-microbial or insecticidal protection
Falk *UC Davis*	Using insect viruses to combat the Asian citrus psyllid
Ferrarezi *University of Florida*	Growing citrus under enclosures
Heck *USDA-ARS, and Boyce Thompson Institute*	Controlling psyllid gut cell death to prevent Huanglongbing
Shatters *USDA-ARS, Fort Pierce, FL*	Using peptides as a preventive approach to target the psyllid and the pathogen
Stelinski & Killiny *University of Florida*	Using interference RNA to manage Asian citrus psyllids

General Topics

Lemaux & Grafton-Cardwell *UC Berkeley & UC Riverside*	Genes, Genomes and Genetic Engineering in Citrus
Lemaux, Mackelprang & Grafton-Cardwell *UC Berkeley & UC Riverside*	New genome editing technologies - CRISPR

Psyllid

Falk *UC Davis*	Using insect viruses to combat the Asian citrus psyllid
Pelz-Stelinski *University of Florida*	Altering the Asian citrus psyllid's beneficial bacteria to stop HLB spread
Shatters *USDA-ARS, Fort Pierce, FL*	Using peptides as a preventive approach to target the psyllid and the pathogen
Stelinski *University of Florida*	Attractants and traps for ACP management

Replants

Bonning *University of Florida*	A new, Bt toxin-based strategy for suppression of the Asian citrus psyllid vector of HLB
Dutt & Grosser *University of Florida*	Disease resistance in citrus with addition of plant defense genes
Hall *USDA-ARS, Fort Pierce, FL*	HLB control: capitalizing on resistance in *Poncirus trifoliata* to Asian citrus psyllid
Ma, Coaker, Wang, Ancona & Vidalakis *UC Riverside*	Using genome editing to develop HLB-resistant or -tolerant citrus
Shatters *USDA-ARS, Fort Pierce, FL*	Using peptides as a preventive approach to target the psyllid and the pathogen
Thomson *USDA-ARS, Albany, CA*	Founder lines used to improve HLB tolerance

Tools

Grafton-Cardwell *UC Riverside*	Area-wide management of ACP to limit the spread of HLB in California
Hoddle *UC Riverside*	Biological control of Asian citrus psyllid in California
Lemaux & Grafton-Cardwell *UC Berkeley & UC Riverside*	Genes, Genomes and Genetic Engineering in Citrus
Lemaux, Mackelprang & Grafton-Cardwell *UC Berkeley & UC Riverside*	New genome editing technologies - CRISPR
McCollum *USDA-ARS, Fort Pierce, FL*	How is the HLB-associated bacterium detected in citrus trees and Asian citrus psyllids?
Stansly & Croxton *University of Florida*	Reducing Asian citrus psyllid Infestation and disease incidence with reflective mulches
Stover *USDA-ARS, Fort Pierce, FL*	Progress toward HLB-tolerant citrus from conventional plant breeding

References

da Graça, J.V.; Douhan, G.W.; Halbert, S.E.; Keremane, M.L.; Lee, R.F.; Vidalakis, G.; Zhao, H. 2016. Huanglongbing: An overview of a complex pathosystem ravaging the world's citrus. *Journal of Integrative Plant Biology* 58(4):373–387. https://doi.org/10.1111/jipb.12437

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