



April 2018

A Review of the Citrus Greening Research and Development Efforts Supported by the Citrus Research and Development Foundation: Fighting a Ravaging Disease



Credit: H. D. Catling, Bugwood.org

Huanglongbing (HLB) or citrus greening, first observed more than a hundred years ago in Asia, is the most serious disease threat to the citrus-growing industry worldwide due to its complexity, destructiveness, and incalitrance to management. The bacterium *Candidatus Liberibacter asiaticus*, which is associated with HLB, is transmitted by the Asian citrus psyllid (ACP). First detected in Florida in 2005, HLB is now widespread in the state and threatens the survival of the Florida citrus industry despite substantial allocation of research funds by Florida citrus growers and federal and state agencies. Since 2005, HLB has also been reported in six other U.S. states (Louisiana, South Carolina, Georgia, Texas, Hawaii, and California).

In Florida, HLB research is overseen by the Citrus Research and Development Foundation (CRDF), a non-profit corporation created in 2009 through the initiative of the state's citrus industry. At the request of CRDF, the National Academies of Sciences, Engineering, and Medicine conducted this review of the foundation's research portfolio, with the goal of identifying ways to reconfigure HLB research to accelerate the development of tools and strategies to abate disease impacts and prevent the collapse of the Florida citrus industry.

The review concludes that research supported by CRDF and other agencies has expanded knowledge of every aspect of HLB, yet there have been no breakthroughs in HLB management. Other than research on ACP in Florida, most of the available information on HLB prior to 2005 was based primarily on research performed outside the United States, so researchers faced a steep learning curve. The reasons for the lack of breakthroughs in HLB management, despite the investments in research, are complex. The disease itself is intractable for a variety of reasons, including the inability to culture the pathogen in a laboratory, the complexity of the pathogen, insect, and host interactions, the perennial nature of citrus, the lack of resistance in any citrus relative, and the lack of a good model system for understanding the disease.

An analysis of HLB research outcomes revealed progress and pitfalls in major research areas, and research efforts that the committee believes should be continued or initiated. The committee regards the following as critical to achieve progress toward a viable HLB solution:

- Building on knowledge generated through previous research.
- Supporting research on factors that influence adoption of management practices proven effective.
- Greater collaboration and more-frequent venues for information-sharing by scientists.

- Timely and systematic communication of research outcomes and evaluation of research progress.
- Increased research coordination by CRDF and other funders of HLB research.

Citrus growers, particularly in Florida, still need short-term solutions to sustain the industry while researchers continue to generate longer-term approaches for managing HLB. Thus, support of basic and applied, short- and long-term research is needed. Longer-term HLB solutions are likely to involve citrus variety improvement, derived primarily from new molecular techniques such as gene editing, focusing on targets that mediate molecular interactions among plant, bacteria, and vector.

Because a single breakthrough discovery for managing HLB in Florida is unlikely, funders should support the development of sets of management approaches that can be combined in different ways and optimized and validated for use in different locations and conditions. This approach, founded on the integrated pest management (IPM) strategy for long-term control of pests, would allow optimization of management for each grower.

Economic and sociological factors that impact decision-making and behaviors of growers, processors, and the public will influence the adoption and success of future HLB management efforts; hence, CRDF should consider funding these research areas and creating accessible

databases to support sociological and economic modeling of HLB-related research outcomes and application projections.

The review found inconsistency in laboratory and field experimental designs and sampling methods. Because inconsistency limits the comparison of findings across teams and institutions and the use of previous research to inform further exploration, the development of community-accepted standards to conduct, evaluate, and assess research is recommended. Improved consistency in reporting research outcomes is also needed to reduce constraints in reviewing research progress and delays in applying new information to HLB solutions. CRDF should develop a standardized format and procedure, and set a timeline for mandatory reporting of project progress and final reports, to include publications and presentations, outcomes, practical applications, and impacts.

Despite commendable efforts of multiple agencies to coordinate funding and encourage appropriate interstate, inter-agency, and inter-disciplinary collaborations, decisions about research funding priorities and allocations occur largely within the domain of each agency. CRDF and other agencies should work together to create an overarching HLB research advisory panel to develop a fresh, systems approach to HLB research prioritization and the strategic distribution of resources for research leading to effective HLB management.

COMMITTEE ON A REVIEW OF THE CITRUS GREENING RESEARCH AND DEVELOPMENT EFFORTS SUPPORTED BY THE CITRUS RESEARCH AND DEVELOPMENT FOUNDATION: FIGHTING A RAVAGING DISEASE

Jacqueline Fletcher (*Chair*), Oklahoma State University (*Emerita*); **May R. Berenbaum** (NAS), University of Illinois, Champaign; **Stewart M. Gray**, Agricultural Research Service, U.S. Department of Agriculture; **Russell L. Groves**, University of Wisconsin, Madison; **Ralph Scorza**, Ralph Scorza LLC (*retired from Agricultural Research Service, U.S. Department of Agriculture*); **Lindsay R. Triplett**, Connecticut Agricultural Experiment Station, New Haven; **John Trumble**, University of California, Riverside; **Bing Yang**, Iowa State University, Ames; **Camilla Yandoc Ables** (*Study Director*), **Jenna Briscoe** (*Research Assistant*), National Academies of Sciences, Engineering, and Medicine

For More Information . . . This Consensus Study Report Highlights was prepared by the Board on Agriculture and Natural Resources based on the Consensus Study Report *A Review of the Citrus Greening Research and Development Efforts Supported by the Citrus Research and Development Foundation: Fighting a Ravaging Disease* (2018). The study was sponsored by the Citrus Research and Development Foundation. Any opinions, findings, conclusions, or recommendations expressed in this publication do not necessarily reflect the views of any organization or agency that provided support for the project. Copies of the Consensus Study Report are available from the National Academies Press, (800) 624-6242; <http://www.nap.edu> or via the Board on Agriculture and Natural Resources web page at <http://www.nationalacademies.org/banr>.

Division on Earth and Life Studies

The National Academies of
SCIENCES • ENGINEERING • MEDICINE

The nation turns to the National Academies of Sciences, Engineering, and Medicine for independent, objective advice on issues that affect people's lives worldwide.

www.national-academies.org