Overview of Horticultural Presentations at 2011 HLB Conference

3 full days, 400 participants from 20 countries, 75 oral presentations, 96 posters, (20 pages of notes)

- Urgency of HLB as a threat to citrus production and the engine of substantial grower investment has fully engaged numerous researchers to find solutions
- In two years of this effort, there are SOME new ideas or mature recommendations ready for implementation
- Tools & knowledge are being assembled for much greater future progress and I assume growers want a glimpse…..
- In this meeting, researchers shared ideas and data and many came away with a piece of the puzzle that will plug in to advance their efforts or established collaborations that will accelerate progress
- MANY of these “aha” moments occur over dinner or during breaks, and so these summaries can only tell a part of the story

Urgency of need to save existing trees has compelled strong interest in developing therapeutics to lesson effect of HLB

- Nutritional treatments are contreversial, seem to provide a benefit in some situations- great talk by Irey to suggest threshold of 4-5% tree loss per year as transition point from Scouting/Roguing to Nutritional Life Support for infected trees
- Antibiotic treatments Zhang et al. (UF-IRREC and ARS) have provided marked benefits in pilot studies in the greenhouse and initial field studies….may face tough sledding for deregulation and likely require cheaper delivery (sprays rather than injections) for commercial delivery
- Jim Graham Irey and Miele- Injection of Cu compounds (Magna Bon) reported to reduce CLas.

More therapeutics to save existing trees:

- Ping Duan (ARS- Ft Pierce) reported that in initial field trials, a form of therapy, appears to have eliminated HLB symptoms …. Stay tuned
- RNAi for psyllid control (Falk/Hunter/Borovsky et al)- Biopesticide today/transgenic tomorrow?
- Bill Dawson CREC- provided update on the CTV expression vector. Best greatly suppress HLB and have developed variants that can infect CTV+ trees and likely will protect 80% of trees for 10+ years. BIG regulatory hurdles, but in field trials.
- Dean Gabriel UF –Gainesville Plant Path, reported discovery that a virus embedded in the CLas DNA may provide seeds of Clas destruction. Signal that causes the virus to replicate would kill CLas cells. Possible therapeutic, transgenic?

New Understanding of HLB/citrus biology with relevance to citrus industry?

- The question as to whether HLB can be seed-transmitted continues to compel new work
- Two studies reported that seed from HLB-infected highly symptomatic fruit did not result in plants with HLB. One study reported CLas transmitted often, but likely not causing HLB
- In a study reported by Mark Hilf USDA/ARS Ft Pierce, he showed that CLas is often present in vascular bundles of seed coats which may explain the reports of early PCR+ seedlings
- In our breeding program we remove seed coats before planting seeds from infected fruit

Citrus Breeding Programs throughout US and the World are Squarely Focused on HLB

- Developing tools that will open up cutting edge technologies which make this “a golden age for biology”. Steve Lindow noted that “HLB is a tough nut to crack, and you are lucky you didn’t get it even a few years ago”
- Exploring genes related to resistance/susceptibility
- Assessing resistance in conventional breeding/ scions/ rootstocks
- Developing transgenics

Loading the tool box!

- Tremendous progress in genomics of host, pathogen, and vector- FINALLY we will have the full wiring diagram to fix "what's broken"
  - Citrus: Gmitter (CREC- leading international consortium) Full genome (DNA sequence) of Haploid Clementine and Ridge Pineapple Orange
  - ACP: Hunter and Shatters (ARS Ft Pierce)- ACP genome will provide RNAi targets etc.
  - Liberibacter: Gabriel and Wulff (Brazil) CLam & CLas comparison; Hong Lin (ARS Parlier) strains of CLas ; Duan; Hartung…. Understanding differences reveals weaknesses to exploit
- Antibodies to CLas!!!! Like shining a spotlight at night

Exploring resistance and susceptibility genes

- Identifying genes that may confer resistance, better understanding of HLB biology and gene expression in resistant and susceptible Citrus. Targets for action!
  - Understanding of Citrus defense systems and HLB. E.g. Some SA response to HLB (Moore UF-Gainesville); but shuts down some SAR systems (Dandekar UCD); turns up JA (Machado; Brazil); produces antimicrobials (Albrecht & Bowman);
  - Identified CLas "virulence" genes that cause plant disease response (Wang -CREC)
  - Better understanding of HLB source/sink metabolism etc. for therapeutics or transgenics (Chen et al CREC; He et al IRREC)
  - Understanding of phloem plugging (Albrigo)

Existing Resistance? Not ready for prime time….

- No strong HLB resistance has been identified in cultivated Citrus scion varieties
  - But evidence that there are differences in susceptibility, seemingly even between sweet oranges, which may have economic value (Stuchi et al., Brazil)
  - Some specialty types (e.g. ‘Temple’) with much lower CLas than sweet orange (Stover et al.)
  - Stronger resistance in more distant varieties that may be used in conventional breeding or in “cisgenics” (Bowman, Stover, Stuchi)
  - Evidence that some rootstocks may enhance HLB-tolerance of scions (Grosser; Stuchi)

Transgenics

- Exploring antimicrobial peptides and other transgenes that will enhance plant resistance (many labs reported)
- Comparing promoters that direct where genes are “turned on” (ARS- Ft Pierce; CREC)
- Tomato & LSol as a model system for testing transgenics (Manjunath and Lee ARS-Riverside)
- Improved methods for resistance screening of transgenics (Grosser-CREC)
- Many transgenics being tested by many labs
- Most advanced is GE citrus with virus gene that kills bacteria, looks excellent in GH, and now in field trials (Jiang et al., Gabriel lab UF)

Take home?

- If knowledge is power……..
  - Our knowledge of HLB, Liberibacter, ACP and their interaction with Citrus has expanded many fold over the last two years
  - The assembled understanding is reaching a critical mass that will soon reveal outstanding tools for living with HLB
  - And a series of ever-better solutions will emerge over the coming years