CITRUS
HUANGLONGBING (HLB) DISEASE

CURRENT USDA-ARS RESEARCH

Edwin L. Civerolo
USDA-Agricultural Research Service
San Joaquin Valley Agricultural Sciences Center
Parlier, California

ARS HLB RESEARCH

- **Broad in scope**
- **Basic / Discovery**
- **Applied / Development**

Locations

- **Ft. Pierce, FL**
- **Winter Haven, FL**
- **Beltsville, MD**
- **Frederick, MD**
- **Parlier, CA**
- **Riverside, CA**
- **Weslaco, TX**

Multidisciplinary

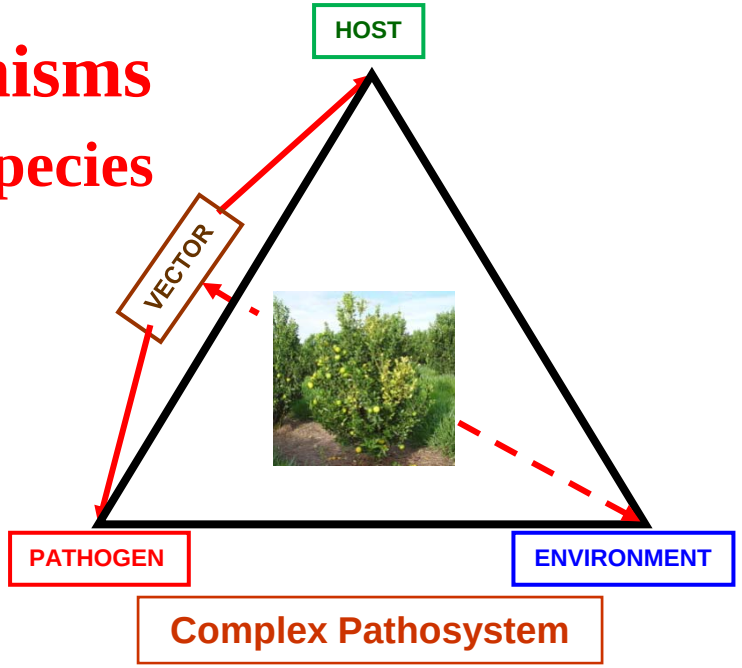
- **Plant Pathology**
- **Entomology**
- **Microbiology**
- **Plant Physiology**
- **Plant Biochemistry**
- **Molecular biology**
- **Genetics**
- **Omics/Bioinformatics**

Collaborative

ARS HLB RESEARCH

Primary Components of Complex Pathosystem to Identify Potential Targets to Mitigate Disease

- **Host**
  - Responses to infection
  - Resistance
- **HLB-associated microorganisms**
  - "*Candidatus* Liberibacter" species
  - Phytoplasmas
  - Other?
- **Insect vector(s)**
  - Citrus psyllids



BROAD RESEARCH AREAS

- **Disease detection – pre-symptomatic**
- **Disease diagnosis – symptomatic**
  - **clinical samples (plant tissue)**
- **Candidate pathogen(s) - detection & identification**
  - **plant tissue; insect vector**

- **Etiology**
- **Epidemiology**

- **Disease Management / Mitigation**

DISEASE DIAGNOSIS / PATHOGEN(S) DETECTION & IDENTIFICATION

- **PCR**
  - **protocols**
  - **primers**
- **Serological assays**
- **Detection arrays**
- **Novel platforms**

- **HLB-associated microorganisms/candidate pathogens (e.g., liberibacters)**
- **Host response(s) to infection**

ETIOLOGY

- **Identification of etiological agent(s) of HLB**
  - **(candidate) pathogens associated with HLB**
    - **"*Candidatus* Liberibacter" species**
    - **Phytoplasmas**
    - **Other?**
- **Cultivation HLB-associated microorganisms *in vitro***
- **Fulfillment of Koch's postulates**

EPIDEMIOLOGY

- **Diversity of HLB-associated microorganisms**
  (e.g., Las)
- **Population dynamics of HLB-associated microorganisms in citrus**
- **Endophytic microbial community in citrus:**
  - **Characterization (qualitative; quantitative)**
  - ***in planta* & *in insecta* dynamics & interactions**
  - **Potential role in HLB**
- **Insect vector biology / ecology**

INTERACTIONS BETWEEN HOST and HLB-ASSOCIATED MICROORGANISM(S)

- ***In planta*** **distribution of HLB-associated microorganism(s) interactions**
- **Biochemical & physiological responses in HLB-affected citrus**
- **Gene expression in HLB-affected citrus plants**
  - **Identification of genes whose expression is altered in HLB-affected plants compared to that in non-diseased plants**
- **Effect(s) of HLB on citrus fruit juice quality**

INTERACTIONS BETWEEN INSECT VECTOR and HLB-ASSOCIATED MICROORGANISM(S)

- **Acquisition & transmission parameters**
- **Factors that affect**
  - **Acquisition & transmission of HLB-AM**
  - **Vector specificity**
  - **Vector competence**
- **Localization of HLB-associated liberibacter in various insect vector tissues**

DISEASE MANAGEMENT

- **Host resistance**
  - **Screen citrus genomic resources to identify new, potential sources of resistance/tolerance to HLB**
  - **New citrus scion & rootstock germplasm & cultivars with enhanced resistance/tolerance to HLB**
  - **Induced resistance (pathogenesis-related proteins)**
  - **Transgenics**
    - **antimicrobial peptides/proteins**
    - **other (chimeric proteins, plant defensins)**

DISEASE MANAGEMENT

- **Cultural practices**
- **Therapeutic treatments**
  - **Heat treatment of budwood**
  - **New antibiotics**
  - **New antimicrobial chemicals/compounds**
  - **Other**

DISEASE MANAGEMENT

- **Novel strategies to manipulate gene expression to:**
  - **Enhance innate citrus host plant resistance/tolerance to HLB**
  - **Disrupt normal biological pathways involved in:**
    - **Disease development**
    - **Insect vector behavior**

DISEASE MANAGEMENT

- **Insect vector management**
  - **Improved ACP sampling**
  - **Chemical insecticides**
  - **Biological control**
    - **Parasitoids**
    - **Other**
  - **Volatiles**
    - **Repellents or attractants**
  - **Cultural practices**
  - **Area-wide psyllid management**

OMICS

- **Sequencing, assembly & annotation of the genomes of HLB-associated "*Candidatus* Liberibacter species" (i.e., Las, Lam)**

Genomics

DISEASE MANAGEMENT

- **Omics**

- **HLB-associated *"Ca.* Liberibacter species"**
- **Host responses to infection & psyllid**
- **Microbial community associated with HLB**
  - ***in planta***
  - ***in insecta***
- **Gene expression**
  - **Citrus host**
  - **Insect vector (e.g., ACP)**
  - **HLB-candidate pathogens**

Transciptomics
Proteomics
Metabolomics
Metagenomics
Bioinformatics