# Researchable Areas: ARS HLB Workshop, April 23, 2008

| **Yellow highlight: areas that are not currently being addressed fully or partially** | **Time frame[a] S-M-L** | **Priority[b] H-M-L** | **Likelihood of Success[c] H-M-L** | **Short term benefit <5 yrs** | **Sustain industry long-term 5+ yrs** |
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| **CROP IMPROVEMENT** | | | | | |
| **Plant host resistance to HLB** | **M** | **H** | **H** | **no** | **yes** |
| Transgenic/cisgenic resistant varieties and rootstocks | M | H | M | | |
| Induced resistance w/ SAR | L | L | L | | |
| Virus-based host resistance (to pathogen or vector) for screening/therapy | S | H | M | | |
| Conventional breeding rootstocks | L | H | M | | |
| Host response mechanisms Direct RNA sequencing (compare healthy vs infected plants) e.g., role of miRNAs in disease development | S | M | H | | |
| **VECTOR BIOLOGY AND MANAGEMENT** | | | | | |
| **Psyllid biology** | **S,M** | **H** | **H** | **yes** | **yes** |
| Vector biology, seasonality, environmental effects, life history, dispersal | S | H | H | | |
| Vector capacity, survival, transmission efficiency, propensity | S | H | H | | |
| Vector genomics, including expression. (underway) | S-M | H | H | | |
| **Psyllid resistance and response to the HLB pathogen** | **M-L** | **M** | U | **?** | **yes** |
| Transgenic psyllid | L | M | U | | |
| Endosymbiont targets (e.g., *Wolbachia*/virus transformation for *Liberibacter* control) | L | M | U | | |
| Strain diversity; host-compatibility groups | S-M | M | H | | |
| Histopathology of psyllid-vector relationship | S | M | H: Infection rate info needed | | |
| **Psyllid-based control** | **S/M/L** | **H** | **M** | **yes** | **yes** |
| Urban areas? Homeowner psyllid management? | S | M | M; Education needed | | |
| Area-wide program? | S | H | H; Grower coordination/ cooperation needed | | |
| Symbiont manipulation for vector control | L | M | M | | |

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| Novel pesticide development (RNAi targeted at specific psyllid genes for treatment of vector, BT library evaluation) | S-M | H | H; compare to mosquito control | | |
| Insecticide resistance management | S | H | H | | |
| Insect repellent plant development ("virtual nets") | S-M | H | H | | |
| Mating disruption by…sound/pheromones, etc. | M-L | M-H | U | | |
| Plant Volatiles (attractants–Murraya, repellents) | S | H | H | | |
| Natural enemies, esp. for unmanaged citrus, e,g., parasites, predators, fungal/viral pathogens of insect | S-M | H | M-H, if used in IPM program | | |
| Kaolin clay applications | S | H | M; should be revisited; carrier for other chemicals? | | |
| Barrier-based control (plants or netting impregnated with insecticide) | S | H | H; compare to mosquito control | | |
| Wind breaks with lures and chemical treatment (trap plant) | S | H | H | | |
| **PATHOGEN AND DISEASE BIOLOGY AND DETECTION** | | | | | |
| **Pathogen biology and detection** | **S,M,L** | **H** | **M,H** | **yes** | **yes** |
| Pathogen detection | S | H | H | | |
| Genome sequence | S | H | H | | |
| Culture organism to supplement current effort (high throughput methods) | S,M | H | U | | |
| Improved diagnostics in psyllid and plant tissue | S | H | H | | |
| Pathogen variability and diversity | S,M | H | H | | |
| ID factors critical to pathogenesis, virulence: Functional genomics, gene expression, proteomics, direct RNA sequencing | M,L | H | M | | |
| Population biology and spatial and temporal distribution *in planta* | S,M | H | H | | |
| Asymptomatic plant host range e.g., source of resistance, reservoir for inoculum | M,L | M | U | | |
| **Disease biology** | **S,M,L** | **H** | **M** | **yes** | **yes** |
| Etiology (Koch postulates for *Liberibacter*., metagenomics from phloem and psyllid endophytes) | M | H | H | | |

| | | | | | |
|---|---|---|---|---|---|
| Sources of variability in symptoms (interaction with other microbes, endophytes, stress interactions) | M | M | M | | |
| Early disease detection (non-pathogen based) | M,L | H | U | | |
| High throughput disease detection (e.g., imaging techniques, hyperspectral detection or laser or microwave detection, trained dogs) | M | H | U | | |
| Seed transmission and seed treatment | S,M | H | H | | |
| "Rescue" of infected germplasm/breeding material from field/seed | S | M | H | | |
| **EPIDEMIOLOGY AND DISEASE MANAGEMENT** | | | | | |
| **Epidemiology and Management of HLB** | **S** | **H** | **M** | **yes** | **yes** |
| Symptom remission methods (antibiotics, others? Injection methodology) | S | H | U | | |
| Intercropping for disease management (e.g., guava) | M | H? U | U | | |
| Volatile effects and identification | S.M | H? U | U | | |
| Replacement tree protection via physical/chemical barriers (e.g., slow release "virtual net") | M,L | L | U | | |
| Repellents/avoidance factors (e.g., kaolin itself and as a carrier) | S,M | H | H | | |
| Cultural methods (e.g., nutrient delivery, early production systems, flush management, open hydroponic systems) | M,L | M | M | | |
| Effect of climate on disease biology (e.g. effect on range of endemic *Liberibacter* and psyllid, grow in Northern FL?) | M,L | H | U | | |
| Fruit/juice quality and abscission (productivity and quality in infected and treated trees) | S | H | H | | |

[a]*Time frame, estimated time to reach initial research goals. S=Short, present-3 yrs; M=Mid, 3-5 yrs; L=Long, 5-10 yrs.*
[b]*Priority, based upon the team's opinion that the research would provide significant benefits enabling the industry to respond to HLB. H=high M=medium, L=low, U=unknown.*
[c]*Likelihood of success, based on the team's opinion that the research is technically feasible and would be successful in reaching stated research goals. H=high M=medium, L=low, U=unknown.*