Florida Citrus Advanced Technology Program

QUARTERLY & FINAL REPORTS: Control of Citrus Greening, Canker & Emerging Diseases of Citrus

Instructions Complete the fields based on your project specs. When finished, save the form to your local disk using a unique name. Then, go to **http://research.fcprac.com**, and log in with your user name and password using Researcher Login in the lower left. Find this project title and click on **Submit a Report**. Update your profile information if needed, then upload this report as directed.

2009-2010 REPORT	CATEGORY (drop-down)	TODAY'S DATE (m/d/yr)
○ *Quarterly Report* ◉ *Annual Report* ○ *Final*	Management	4/8/10

WHAT IS THE "HEADLINE" FOR THIS REPORT (e.g. a one-sentence "newspaper headline" describing what you accomplished)

Potential sensing techniques for HLB detection in citrus orchards.

TITLE and CONTACT INFORMATION

Proposal Title Detecting citrus greening (HLB) using multiple sensors and sensor fusion approach

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Organization Citrus Research and Education Center	*Total Direct Funds (current year)* $ 290,000

REPORT UPDATE (650 words; provide details about your headline)

Several sensors and sensor aiding tools such as four-band sensor, five-band sensor (with GPS and self-incident light correction), volatile collection device holders (for volatile organic compound- VOC sampling), and moving sensor platform with retractable mast (for holding multiple sensors) were developed during the first year of this project.

During the last quarter of this project period, significant progress was made in the application of mid-infrared spectroscopy (5.15-10.72 µm) for HLB detection. The healthy, nutrient-deficient, and HLB-infected leaf samples were analyzed using a portable mid-infrared spectrometer. The k-nearest neighbor (kNN)-based statistical algorithm yielded a healthy and diseased class average classification accuracy of 91% and 96%, respectively after data preprocessing (baseline correction, narrow waveband, principal component analysis-PCA). In addition, greenhouse experiments indicated that the visible-near infrared reflectance data (350-2500 nm) from a spectroradiometer could be used to identify HLB-infected plants with a classification accuracy of > 60% and > 90% for Hamlin and Valencia varieties, respectively (using quadratic discriminant analysis based algorithm). Aerial images were collected across 2,000 acres (Southern Gardens) during previous years to develop a spectral library. Forty-four critical wavebands (of 128 bands) were selected using image processing algorithm, which enhanced the average overall classification accuracy from 45% to 65% in 150 acres blocks. These bands also decreased the false positives by 60%. On December 9, 2009, a new set of georeferenced aerial hyperspectral imagery was acquired from a new citrus grove. Healthy and infected spectral data for ground measurement showed a clear separation in the two wavelength ranges: 500-800 nm and 1500-2000 nm.

Studies on VOC profiling for HLB detection were performed in the greenhouse. These experiments were conducted to identify volatile biomarkers. Volatile samples were collected from two varieties (Valencia and Hamlin) of healthy and HLB-infected samples. After data pre-processing (baseline correction, computation of auto-regression coefficients), PCA and PC regression with leave-one-out validation were applied for HLB diagnosis. The corresponding systematical accuracy, false positive rate and false negative rate are: 80.7%, 10.0%, and 36.4% for Valencia; 76.0%, 16.7%, and 30.1% for Hamlin; and 70.0%, 18.8%, 45.8% for the varietal independent case. With these results, the next step will be to eliminate background variations between sampling batches and varietals. In regard to the application of fluorescence-based HLB detection, a subcontract was signed between University of Florida and Embrapa Agricultural Instrumentation to allow partnership. However, the process could not be completed due to some complications resulting from the change in rules by the Brazilian Government. Embrapa is making efforts to resolve this issue to receive funding for this project. For HLB detection, a sensor prototype PHOTONCITRUS was developed. In the laboratory, the accuracy for detecting HLB-infected citrus leaves and healthy leaves using the calibrated system increased to 95% and 80%, respectively. The sensor will be further evaluated to detect HLB-infected trees under field conditions. The work done in Brazil will be joint and partially moved to Florida to avoid funding transfer problems. In summary, progress has been made in the developing sampling protocols, establishing experimental protocols, evaluating multiple sensors under laboratory and field conditions, as well as developing data analysis algorithms and improving their performances for accurately detecting HLB-infected citrus trees. In the second year, we will further expand our research to validate the current findings on a larger dataset under field experiments and further refine the sensing techniques and classification accuracies.