# 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* | Canker Pathology | 1/14/10 |

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

Copper loaded silica nanoparticle/nanogel - a new generation of nanobiocide for the prevention of citrus canker disease

**TITLE and CONTACT INFORMATION**

*Proposal Title* Development of nanoparticle/nanogel formulation for the prevention of citrus canker disease


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| *Phone* 407-882-2848 | *Project Duration (years)* 1 *Year of Project* 1 |
| *Organization* University of Central Florida | *Total Direct Funds (current year)* 90,000 |


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

During this reporting period we have accomplished the following.

Task 1 (CuSiNP/NG design, synthesis, characterization and protocol optimization):
(A) Completed additional CuSiNG characterization as summarized below: (i) CuSiNG synthesis protocol has been optimized; (ii) CuSiNG synthesis in 110 mL (laboratory scale) and 4.5 gallon (large scale) has been successfully tested; (iii) Metallic Cu loading in CuSiNG was about 33 wt% as determined by the atomic absorption spectroscopy (AAS); (iv) X-Ray electron diffraction (XRD) data showed that CuSiNG is amorphous within the sensitivity limit of the technique. However, high-resolution transmission electron microscopy (HRTEM) images confirmed that CuSiNG is loaded with numerous Cu oxide nanocrystals (< 5 nm size) throughout the nanogel matrix; (v) HRTEM elementary mapping confirmed presence of silicon (most abundant), oxygen (most abundant), copper (abundant), and sulfur (least abundant). Presence of sulfur indicates that trapping of sulfate ions occurred within the nanogel matrix along with ionic copper.

(B) Performed CuSiNP synthesis and characterization as summarized below: (i) CuSiNP synthesis protocol has been optimized with respect to Cu loading; (ii) AAS study estimates metallic Cu content to be ~45 wt%; (iii) HRTEM data confirmed formation of Cu oxide nanocrystals (2 nm – 10 nm size range) that remain uniformly distributed throughout the matrix; Optimized CuSiNP formulation showed significant gel like morphology under HRTEM; (iv) Elementary mapping confirmed presence of silicon (most abundant), oxygen (most abundant), copper (abundant), and sulfur (abundant). Presence of sulfur indicates that trapping of sulfate ions occurred within the matrix along with ionic copper; (v) Like CuSiNG material, CuSiNP demonstrated extremely strong adherence property to citrus leaf surface.
Future Plan: We have completed optimization of CuSiNP and CuSiNG synthesis protocols as proposed. Further materials characterization of CuSiNP is in progress. Cu release study is also in progress.

Task 2 (Assessment of the antimicrobial activity of the CuSiNP/NG nanoformulation): We have systematically performed disk-diffusion assay (DDA) to evaluate the anti-bacterial efficacy of several CuSiNG as well as CuSiNP samples. CuSiNG material exhibited improved anti-bacterial properties in comparison to CuSiNP as well as Kocide 3000 and Cu-sulfate controls. Antibacterial efficacy of CuSiNG is improved by 2 times over Kocide 3000 when tested against Xanthomonas Alfalfae (canker surrogate). We have performed appropriate statistical analysis. We also have observed that CuSiNG material has the ability to spread out on agar.
Future Plan: Efficacy of CuSiNP against E. coli is in progress. We will also perform preliminary studies to evaluate direct interaction of CuSiNG material with the bacteria to better understand improved Cu bioavailability.

Task 3 (Develop large-scale nanoformulation production set-up): We have synthesized and characterized a few 4.5 gallon batches of CuSiNG as well as CuSiNP materials. Characterization data showed no difference in the quality when compared to the data of 110 mL laboratory scale preparation.