Microneedle-Assisted Delivery of Model Therapeutics in Plant Tissue

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This project focuses on a potential treatment delivery method for the bacterial disease, Huanglongbing, or citrus greening, that has devastated Florida's 9-billion-dollar citrus industry. HLB is caused by a phloem-restricted bacterium called Candidatus Liberabactor Asiaticus, vectored by the Asian citrus psyllid (ACP). Florida growers are currently evaluating foliar-applied antibiotics as a potential tool to manage HLB, but there is a concern that it doesn't guarantee efficient delivery of antibiotics to the phloem at a desired concentration necessary to kill the bacteria. A 3D printed microneedle-based stamp was designed and fabricated using CAD software to efficiently deliver therapeutics to phloem tissue. Microneedles are a minimally invasive transdermal drug delivery system used in the biomedical industry. The hypothesis is based on the idea that if ACPs can inject bacteria to the phloem with their styluses, therapeutics should be efficiently injected with microneedles. Water soluble manganese-doped zinc sulfide quantum dots (ZnS:Mn Qdots) were used as a model for newly-emerging nanoparticle therapeutics. The procedure involves treating citrus leaves with the microneedle stamp, drop-casting Qdots on the treated surface, followed by analysis of zinc content of dried sample using atomic absorption spectroscopy. Statistical analysis shows that the control measurements are extreme outliers compared to the treatment measurements. The 95% confidence interval constructed for the mean amount of zinc absorbed using the microneedles clearly shows higher absorption rates compared to the control. Four-fold increase of zinc content per unit gram of dry leaf sample was observed in treated leaves with respect to untreated control leaves.