Development of an Industrially Viable Oxytetracycline Nano-Carrier and Microneedle-Based Detection System (OXYCHECK2) for Citrus and Stone Fruit Disease Management: Year 4

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Citrus greening (Huanglongbing, HLB) is the most devastating citrus disease, causing a 75% production decline and billions in losses. Oxytetracycline (OTC), the only approved antibiotic, is phytotoxic and degrades rapidly. This project develops a stable, neutral-pH OTC treatment using a multifunctional phytochemical nanoparticle carrier (OTC-PC) for foliar spray or trunk injection, compatible with novel sensing technologies. Microscopy shows OTC-PC forms a uniform film on leaf surfaces, where the diverse phytochemicals improve adhesion and rainfastness. Antioxidant analysis (~4500 GAE) and molecular modeling confirm OTC encapsulation via hydrogen bonding and p-p interactions, stabilizing it against oxidative degradation. The formulation remains stable in pH, particle size, and other key properties when combined with common essential oils, nutrients, and hormones for industrial integration. Greenhouse seedling trials demonstrated reduced acute toxicity and improved chlorophyll and disease metrics compared to untreated and standard treatments. Large-scale Florida field trials showed statistically significant ($p < 0.05$) reductions in citrus canker and greening symptoms in grapefruit and oranges. Synergistic antibacterial effects were observed versus OTC alone, including against resistant field isolates of Xanthomonas arboricola pv. pruni. Complementary sensing tools were developed for treatment monitoring: a paper sensor, originally detecting OTC fluorescence to 11 PPM, now provides clear colorimetric readout for growers, while a GMAC-coated microneedle patch extracts leaf sap for quantitative fluorescence analysis by researchers. Together, this dual treatment and detection platform shows promise for scalable disease management in citrus and stone fruits.

Awards Won:

First Award of $6,000

EU Contest for Young Scientists Award