NANOSCALE NUTRIENTS TO SUPPRESS DISEASE AND INCREASE CROP PRODUCTION

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Increasing global food insecurity requires that novel solutions be developed to sustainably increase food production. Plant pathogens reduce crop yields from 15-20% and novel management strategies are needed. The use of nanotechnology to suppress crop disease has recently gained significant interest in agriculture. This presentation will look at two case studies where material properties were tuned to responsively deliver micronutrients to suppress disease. First, a biodegradable, tunable, biopolymer-based nanoplatform was developed as seed coating to enhance copper (Cu) delivery and seedling (tomato, lettuce) development. The various Cu-release nanofiber coatings promoted seed germination, particularly in the diseased media conditions, and increased seedling biomass by 12-29%. Importantly, the developed nanofiber seed coating significantly improved germination and seedling biomass compared to conventional film coating approaches utilized by the industry, owing to its unique nanofibrous structure and controlled release kinetics. In a second study, copper sulfide nanoparticles (CuS NPs) were synthesized at 1:1 and 1:4 ratios of Cu and S and antifungal efficacy was evaluated against *Gibberella fujikuroi* (Bakanae disease) in rice. The dissolution of Cu from CuS (1:1) and CuS (1:4) NPs over 7 days was 9.5% and 7.8%, respectively, which were several-fold higher than CuO NPs (0.7%). Rice seedlings were treated with 50 mg/L Cu-based NPs via seed or foliar application. In the seed treatment, both CuS NPs significantly decreased disease by 35.1-45.9%. CuO NPs achieved only 8.1% disease reduction and the commercial Cu-based pesticide Kocide 3000 had no impact. For foliar application, CuO NPs and CuS (1:1) NPs decreased disease incidence by 30.0 and 32.5%, respectively, which outperformed CuS (1:4) NPs (15%) and Kocide 3000 (12.5%). CuS (1:4) NPs uniquely modulated the production of two important phytohormones important to plant defense; salicylic acid and jasmonic acid, providing important mechanistic insights into the mode of action. These two studies and others from our group have demonstrated that nanoscale micronutrients may be used to uniquely stimulate plant immunity and importantly, the magnitude of disease suppression can be directly controlled by tuning material properties such as dissolution, composition, morphology and size.

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Dr. White has expertise on the use of nanotechnology in agriculture (nano-enabled agriculture); specifically, on the use of nanoscale micronutrients to suppress crop disease and enhance food production. He also has expertise in the accumulation and toxicity of nanomaterials to crop species, as well as the fate and disposition of engineered nanomaterials in the environment. Dr. White has additional experience in the detection of pesticides, toxins, poisons and heavy metals in food. He also has expertise in the phytoremediation of persistent organic pollutants in soil, as well as more generally on the fate of organic contaminants in soils, sediments, and waters.

Awards and Achievements:
European Science Foundation (ESF) College of Experts
Immediate Past President, International Phytotechnology Society (IPS)
Managing Editor, *International Journal of Phytoremediation*
Editorial Advisory Board, *Environmental Science and Technology*
Editorial Advisory Board, *Environmental Science and Technology Letters*
Editorial Board, *Environmental Pollution*
Editorial Board, *NanoImpact*