A Novel Synthesis of Manganese Nanoparticles Using Microfluidic Devices to Study Stress Tolerance in Raphanus sativus

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Abiotic stresses induce oxidative stress in crops. Oxidative stress is when a plant produces more reactive oxygen species (ROS) than the antioxidant defense system can counteract, which leads to necrosis. Nanoparticles have recently been applied to agricultural studies as a preventative measure against necrosis. Nanoparticles are highly reactive because the size of the particle is smaller than the mean free path of an electron. This makes it easier for nanoparticles to react with molecules in the plant. In this project, an attempt to synthesize manganese nanoparticles (MnNPs) was conducted using a microfluidic device. Manganese acetate was used as an ion, sodium dithionite was used as a reducing agent, and oleic acid was used as a capping ligand. The attempted manganese nanoparticles were characterized by way of fluorescence spectroscopy. The results from the spectroscopy analysis supported the hypothesis that the synthesized particles were in the nanoscale size range. Furthermore, the observed bright orange color also provided supporting evidence for this hypothesis. The manganese nanoparticles were formed into a foliar spray that was used to study the nanoparticles' ability to mitigate drought stress in Raphanus sativus. Plant stress tolerance was measured using chlorophyll content. The results from the chlorophyll content showed that the foliar spray increased stress tolerance several days after application. The foliar spray also showed to increase plant growth of the Raphanus sativus, and the plants treated with the foliar spray visually appeared to be healthier. This data supports the hypothesis that manganese nanoparticles have the ability to alleviate stress in crops.

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