Genomic and phenotypic responses to titanium dioxide and cerium oxide nanoparticles in *Arabidopsis* germinants

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Abstract

The effects of exposure to two nanoparticles (NPs) -titanium dioxide (nano-titania) and cerium oxide (nano-ceria) at 500 mg NPs L^{-1} on gene expression and growth in *Arabidopsis thaliana* germinants were studied using microarrays and phenotype studies. After 12 days post treatment, nano-titania and nano-ceria exposure resulted in significant changes in 204 and 142 genes, respectively [expression difference > 2-fold; $p < 0.05$ (*t*-test)]. The genes induced by these NPs include mainly ontology groups annotated as stimuli responsive, including both abiotic (oxidative stress, salt stress, water transport) and biotic (respiratory burst as defense to pathogens) stimuli. Further analysis of all the differentially expressed genes revealed both NPs affect a range of metabolic processes (DNA metabolism, hormone metabolism, tetrapyrrole synthesis, and photosynthesis), which are vital for the plant growth and development. Phenotype observations revealed both NPs promoted growth (emergence of radical, hypocotyl and cotyledon, and leaves) in germinants. The data clearly indicate that although molecular mechanisms of these two NPs are distinct despite some overlap in gene expression with respect to stress response, both NPs induce suites of genes related to various developmental processes that resulted in enhanced germination and growth of germinants.

Keywords: Nanoparticles; *Arabidopsis thaliana*; transcriptome, phenotype