METALLIC Ag NANOPARTICLES AFFECT GROWTH, PHOTOSYNTHESIS, REDOX AND CALCIUM BALANCE IN *ARABIDOPSIS THALIANA* PLANTS

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Metallic silver nanoparticles (Ag NPs) are the most widely used nanomaterial (25–30% of all products containing nanoparticles, 2012). Studies conducted over last two decades have shown that levels of engineered Ag NPs in US soils reached 1–8 mg L^{-1}. This shows that Ag NPs have become an important environmental contaminant. Here, we have examined mechanisms of Ag-NP-induced toxic action on flora using model plants of *Arabidopsis thaliana*. Ag NPs (d = 40±5 nm; 50-10000 mg L^{-1}) inhibited root and leaf elongation and leaf growth as measured in standardised tests of sterile whole plant culture. Ag NPs induced transient elevation of cytosolic free Ca^{2+} (major stress signalling second messenger) and generation of reactive oxygen species (ROS, measured by Amplex Red system). Ag NPs inhibited photosynthetic efficiency and caused accumulation of Ag in plant tissues up to 1 g kg^{-1} fresh weight. In all tests, NPs showed stronger effect than bulk. Using electron paramagnetic resonance spectroscopy, we have found that Ag NPs can interact with L-ascorbic acid (major plant antioxidant). This reaction probably leads to ROS accumulation and oxidative stress. Overall, these data show that Ag NPs are toxic to higher plants and their emission to the biosphere should be controlled.