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Potential uptake of nanoparticles by different plants

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Nanotechnology has emerged as one of the most important scientific and technological developments in the last decades, and has also raised increasing concern regarding potential bioaccumulation of nanoparticles (NPs) in the environment. The release of NPs into soil-water environments and understanding of their interactions with biological systems is thus a critical area of research. Plants, as the main source of food and feed, represent an important component of the food chain. In this framework, elucidation of the fate of NPs in plants and their impact on plant growth, metabolism and yield is essential for the beneficial and safe use of NPs. To achieve this goal, selected plants (Arabidopsis thaliana, Solanum lycopersicum, Phragmites australis) were exposed to isotopically labeled Ag-NPs, Cu-NPs and ZnO-NPs – synthesized and characterized in the laboratory – which allow us to trace the origin of the respective metals that may also be naturally present in plants. We determine the fate and behavior of these NPs under realistic environmental conditions, and their bioaccumulation in plants. Concentration of respective metals in plants exposed to the selected NPs was measured with ICP-MS. For all of the plants exposed to NPs in our experiments, the concentration of each metal was much higher in roots as compared to shoots. Comparing among different states of metal (bulk, ionic and nanoparticle), it was found that Ag and Cu were taken up to shoots more when supplied in the bulk state than in nanoparticle or ionic state, while ZnO-NPs translocated more than other forms to the shoots. For roots, uptake of NPs is much more significant than uptake in any other state, for all cases studied. Scanning electron micrographs and EDS of roots, in all plants, show similar behavior of accumulation of AgNPs, whereas Cu-NPs and ZnO-NPs could not be traced in the roots despite very high concentrations of the respective isotopically labeled Cu and Zn in roots. Thus, fate and uptake of NPs depend more on the type of nanoparticles and less on the type of plant to which they are exposed.