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Does silver sulfide nanoparticles (Ag₂S-NPs) possess risks in soil-plant systems?

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Silver nanoparticles (NPs) are used in more consumer products than any other nanomaterial and their release into the environment is unavoidable. Of primary concern is the wastewater stream in which they are transformed to silver sulfide NPs (Ag₂S-NPs) before being applied to agricultural soils within biosolids. Once within the soil, it is likely that various soil properties (redox status, pH, and chloride concentration) will influence the stability of these Ag₂S-NPs. In the present study, we initially examined (i) the stability and transformation of Ag₂S-NPs that actually occur in soils over time at varying redox conditions and pH, and (ii) the effects of the presence of chloride on Ag₂S transformation in soils. Given their low solubility and reactivity, it has been suggested that Ag₂S-NPs are unlikely to constitute an environmental hazard. However, the assumption in the soil-plant systems has not been tested. Therefore, we also investigated (i) the toxicity of Ag₂S-NPs during both short-term (24 h) and longer-term (two weeks) exposure to discern any nano-specific effects, and (ii) the accumulation and speciation of Ag within plant tissues. Our findings have shown that Ag₂S-NPs were found to be very stable in soils but only subject to change under high Cl conditions. In addition, Ag₂S-NPs exerted toxic effects through their direct accumulation in terrestrial plant tissues. These findings need to be considered to ensure high yield of food crops, and to avoid increasing Ag in the food chain.

Keywords

silver nanoparticles, speciation, transformation, toxicity

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