SILVER NANOPARTICLES STABILIZED WITH HUMIC SUBSTANCES CAUSE ENHANCED TOXICITY TOWARDS WHEAT PLANTS AND ALGAE

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Silver ions are widely known for their antimicrobial activity. As a result, the growing tendency exists in application of silver nanoparticles (AgNP) for crop protection purposes, in particular, as prospective antifungal agents. At the same time, little is known about effects of stabilizing agents on silver toxicity and the same is true for the fate of AgNPs entering the soil environment. For characterizing behavior of AgNPs in the environment including their toxicity, it is necessary to study their interaction with humic substances (HS) which is a major component of soil organic matter and influence behavior of all xenobiotics in soil. The aim of our study was to estimate effect of HS on both AgNP toxicity and on their behavior in soil. For reaching this goal, AgNP and HS-stabilized AgNPs (HS-AgNPs) were synthesized. Leonardite HS were used for the study. Seedlings wheat Triticum aestivum L. (8-day old) were transferred in the treatment solutions containing AgNP (200 μM Ag), HS-AgNP (200 μM Ag) or HS (50 mg/L). Distilled water was used as control. After 6 days, the plant biomass was estimated. ζ-potential of nanoparticles studied was measured before exposition with the plants and after. Addition of AgNP led to a slight decrease in both roots (8%) and shoots (5%) of biomass. HS alone caused slightly stimulating effect. However, addition of HS-AgNPs resulted in a significant decrease in both root (13%) and shoot (15%) biomass. The same effect was observed for photosynthetic activity of algae (Chlorella Vulgaris). A decrease in colloidal stability of AgNPs in the presence of HS was suggested, which might have caused precipitation of AgNPs onto the plant roots and algae surface. It was supported by ζ-potential measurements revealing a drop in ζ-potential of AgNPs from –40 to –16 mV in the presence of HS. The data show that the presence of HS might increase toxicity of AgNP upon their applications on field crops. Substantial changes in soil organic matter were also detected in sorption experiments of AgNPs in soil.
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