Influence of soil texture on TiO2 nanoparticle fate in wheat crop

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Abstract

Nanotechnology is the new industrial revolution of our century. Its development leads to an increasing use of nanoparticles (NPs) in the industry and thus to their dissemination. Their fate in the environment is of great concern and especially their possible transfer in trophic chains might be an issue for food safety.
In this study we investigate the fate of titanium dioxide (TiO2) NPs in wheat (Triticum aestivum) seedlings exposed on soil. In addition, the influence of soil texture was assessed by growing plants on four different types of soils: sand, silty sand, loamy sand and clayey loam.

After two weeks, plants were harvested. Ti distribution and speciation in wheat roots were investigated by synchrotron based micro X-ray fluorescence (μXRF) and micro X-ray absorption spectroscopy (μXAS) respectively. Ti concentration in roots was evaluated by micro particle induced X-ray emission coupled to Rutherford backscattered spectroscopy (μPIXE/RBS) to permit to distinguish adsorbed vs. absorbed Ti. With this technique we were also able to identify an eventual impact of NP exposure on root ionome. Ti concentration in wheat leaves, soils and leachates was measured using inductively coupled plasma-atomic emission spectroscopy (ICP-AES). Toxicity was assessed using classical parameters such as plant biomass, plant height and photosynthetic pigment concentrations.

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Results showed that it is mandatory to take the soil texture into account in such study. Indeed, NP contamination in sand will lead to a higher transfer of Ti into the leachates (mimicking here the water table) and in plants. However, if the contamination occurs over a clayey soil, Ti will mainly remain in the soil and have a very low bioavailability for plants. No major change of speciation was detected for Ti either after two weeks in the soil or once taken up by plants. Likewise, no major phytotoxicity symptoms were identified.

Keywords: nanoparticle, TiO2, plant