Abstract

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Title of Doctoral Thesis: Effect of Nanoparticles on Plant Metabolism

Along with the expansion of nanotechnologies, which are used in many disciplines, the field of nanotoxicology has recently been developed. It deals with the negative effects of engineered nanoparticles on the environment and biota. Considerable attention has already been paid to the toxicity of nanoparticles to plants, however, the mechanisms responsible for their effects are not fully understood yet. At the same time, the possible positive effect of nanoparticles on plants has been investigated in recent years.

The aim of our work was to study and evaluate the effect of nanoparticles on the growth of selected plant species and to evaluate their phytotoxicity. We focused on the study of nanoparticles in the form of metal oxides. The content of accumulated metals in germinating plants of mustard (*Sinapis alba* L.), in *in vitro* cultures of true-fox sedge (*Carex vulpina* L.) and the concentration of metal ions released into the culture media were measured by atomic absorption spectrometry (Cu, Fe, Mn, Zn). and inductively coupled plasma atomic emission spectrometry (Al, Ti). The influence of metal oxides was monitored by means of a standardized test of seed germination of mustard (Al_2O_3, CuO, Fe_3O_4, MnO, TiO_2 and ZnO), by evaluation of plant growth and morphological parameters of true-fox sedge roots and content of photosynthetically active pigments also in true-fox sedge (CuO and Fe_3O_4). At the same time, the protective effect of zinc when interacting with cadmium was evaluated on true-fox sedge.

Fe_3O_4, TiO_2, MnO_2, and Al_2O_3 nanoparticles did not adversely affect mustard germination at any of the tested concentrations. Dose-dependent germination inhibition under the influence of nanoparticles occurred only in the case of CuO and ZnO. True-fox sedge growth, as well as the morphological properties of its roots and the amount of photosynthetic pigments were significantly impaired after addition of CuO nanoparticles at a concentration of 100 mg/L. Fe_3O_4 nanoparticles did not affect any of the measured parameters. The plants were not protected against cadmium-induced toxicity when ZnO nanoparticles were used. It

manifested only in case of water-soluble zinc salt in a low concentration. However, when using bulk metal oxides, the results were similar to those obtained with nanoparticles in all cases.

Thus, our results show that the nanosize or shape of the particles does not play a crucial role in the influence of the monitored metal oxides on the plants used. Conversely, metal ions released into the culture medium and accumulated in plant tissues contribute significantly to the phytotoxicity of metal oxides.