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Evaluation of the potential toxicity of metal oxide nanoparticles in plants using Allium cepa as a model system.

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The increasing production of nanoparticles (NPs) associated with their use in commercial products is attracting great concern due to their inevitable release into the environment, raising many uncertainties about the environmental toxicity of these materials. In this context, the present study aimed to evaluate the environmental toxicity of metal oxide nanoparticles (CuONPs, Fe2O3NPs, TiO2NPs, and ZnONPs) using the Allium cepa test; Firstly, NPs were characterized using transmission electron microscopy (TEM), scanning electron microscopy (SEM), dynamic light scattering (DLS) and zeta potential (ZP), from which their sizes, shapes, hydrodynamic radius, and surface charges were obtained. For the bioassays, seeds of Allium cepa were placed to germinate when submitted to an aqueous solution of NPs in a fixed concentration of 100 ppm. After that, germination percentage and root elongation were determined. Additionally, the cell division phenomenon was analyzed in its different phases: prophase, metaphase, anaphase, and telophase. 5,000 cells were analyzed to determine the mitotic, chromosomal, and mutagenicity indices. Finally, the T-Student statistical test (p? 0.05) was applied to assess the significance of the observed variations. The results revealed that ZnONPs and TiO2NPs presented cytotoxic, genotoxic, and mutagenic effects. Fe2O3NPs only indicated a small tendency of genotoxic and mutagenic potential, while CuONPs were not toxic. Our results also suggest that the mechanisms of cytotoxicity and genotoxicity are related to the production of reactive oxygen species (ROS), in which the ROS generation became much more noticeable under illumination. In summary, our study revealed that metal oxide NPs can promote toxic effect on roots´ meristematic cells of Allium cepa, which the toxicity was dependent on the size and chemical composition of the NPs and their ability to generate ROS.