The Effects of (Fe3O4) Nanoparticles on the Growth, Viability, and Toxicity of Triticum aestivum L. Plants

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Iron oxide nanoparticles (IONPs) are extensively used in many applications. They spread into nature, contaminating soil and water and raising concerns about plant/human health. However, the potential genotoxic effect of IONPs on wheat is yet to be precise. This study aimed to understand the physiological, genotoxic, and growth effects of IONPs having different average sizes (15-20, 30-50, and 50-100 nm; namely NP20, NP50, and NP100, respectively) on wheat (Triticum aestivum L.), the most produced crop globally. A range of IONPs doses (from 250 to 4000 mg/L) was applied to wheat seeds/seedlings in both hydroponic and soil conditions (n=28). Photosynthetic parameters (pigments, photosynthetic efficiency) and relative expression of stress- and photosystem-related genes were quantified. Besides, microscopic analyses (light, confocal, and scanning electron microscopy) were conducted to inspect the cell/tissue structure. Randomly amplified polymorphic DNA-polymerase chain reaction (RAPD-PCR) and real-time reverse transcription-PCR (qRT-PCR) techniques were used to determine genotoxicity and expression of stress/photosystem marker genes, respectively. Results showed that NP20 and NP50 (<1000 mg/L) are helping to improve plant growth. Conversely, NP100 treatment decreases the same parameters, pointing out its toxic effect on wheat. All IONPs applications led to impairment of photosystem machinery and genotoxicity at higher doses (>1000 mg/L), as verified by RAPD-PCR and gene expression analyses. Overall, this study highlighted the importance of NP size for agricultural practices and identified a tolerable yet efficient concentration of IONPs. It appears promising to improve wheat plants' growth and development and can be used in fertilizers up to specific concentrations.

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