Metal oxide nanoparticles in hybrid nanocomposites as a green solution for crop resilience

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Water scarcity and excessive metal presence in soils significantly hinder crop yield, posing serious challenges to food production. Current solutions fail to effectively mitigate these abiotic stresses, which become more prominent due to climate change and soil degradation. Further, massive use of conventional fertilizers is contributing to increase soil toxicity and waste. We propose green nanomaterials as innovative fertilizers to enhance plant tolerance to environmental constraints. Metal oxide nanoparticles, such as cerium and iron oxide, are proposed as nutrients in promoting plant growth and in enhancing plant resistance/tolerance against salinity stress and metal toxicity. The loading in biopolymeric shell was also developed not only as carrier but also to guarantee a smart release of nutrients to plants. Advanced structural and chemical properties of nanocomposites will be discussed, revealing the success of preparation in terms of nanometric sizes, metal oxide loading and solution stability. Moreover, their validation on plants under stress conditions will be discussed. Treatments by foliar-spray of the proposed nanofertilizers, dispersed in a water solution, were tested. Results demonstrated effective mitigation of damage caused by salinity stress or cadmium pollution, depending by the metal oxide used, with improved plant health and productivity. This study was performed in the framework of PNRR Samothrace Project.