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## EXPLORING SEED-NANOPARTICLE INTERACTIONS AND THEIR PROMISING APPLICATIONS IN NANOPRIMING

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Nanomaterials (NM) hold promise for the development of revolutionary products in agriculture, including cutting-edge pesticides, fertilizers, biostimulants and nucleic acid delivery systems. Nevertheless, the application of MNs is hindered by a lack of fundamental knowledge regarding the mechanisms of MN uptake and their unpredictable biological effects on both plants and the environment. One of the most fascinating applications of nanotechnology in agriculture might be in seed priming. Seed priming involves subjecting seeds to controlled mild stress during a pre-treatment phase, which induces specific physiological and molecular changes, leading to optimal germination, early seedling establishment, improved stress tolerance, and ultimately higher yield, even in unfavorable environmental conditions.

The main objective of this study was to investigate the effects and underlying molecular mechanisms of seed priming using iron oxide nanoparticles (MNPs) in plants. Specifically, a comprehensive multidisciplinary approach was employed to explore the intricate interactions between MNPs and seeds in pepper (Capsicum annuum), one of the most economically important crops worldwide. Advanced imaging techniques were employed to map MNP distribution in seeds. Phenotypic and

physiological analysis conducted on both seeds and young plants showed that the application of MNPs has beneficial effects on the root and vegetative growth of pepper plants. RNA-seq analysis revealed over 2200 differentially expressed genes in nanoprimed seeds, primarily associated with plant defense mechanisms and potentially contributing to the establishment of a seed memory capable of enhancing the plant's resilience against various stress conditions. Ongoing tests are being conducted to assess the tolerance of nanoprimed plants to biotic stress.