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Recent Advances of Nanotechnology in Agro-Production by Mitigating Abiotic Stress, Boosting Fertilizer and Pesticide Efficacy: A Review

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Abstract: This paper explores the role of nanotechnology in modern agriculture, particularly in addressing abiotic stress and improving the effectiveness of fertilizers and pesticides. Nanotechnology involves the creation and use of materials with nanoscale dimensions (<100 nm). It has applications in agriculture, biotechnology, and plant sciences, offering innovative tools to improve plant growth and productivity. Nanoparticles (NPs) can enhance plant metabolism, improve stress tolerance, and boost yields. They can be used in nanoformulations, nanosensors, and genetic modification techniques for crop improvement. NPs help plants withstand extreme environmental conditions such as drought, salinity, and temperature fluctuations. Certain nanoparticles aid in nutrient absorption and water retention, thereby improving plant resilience. Nano-based fertilizers ensure a slow and controlled release of nutrients, minimizing waste and environmental pollution. Nanopesticides improve pest control by enhancing the efficacy of active ingredients and reducing harmful side effects. NPs exist naturally (e.g., volcanic ash, dust storms, ocean spray, and microbial activity). They can also be artificially synthesized using physical, chemical, and biological methods. Nanotechnology has significant potential to revolutionize agricultural production by improving plant health, increasing crop yields, and reducing environmental impact. Further research is needed to fully understand the interactions between nanoparticles and plants, as well as to ensure their safe and sustainable use in agriculture

Keywords: Nanoparticles, Nanofertilizer, Nanopesticides

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