Nanotechnology in Agriculture: The Impact of ZnO-NP on Soil Microflora in Cereal Crops

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Abstract

Nanotechnology is one of the most promising areas of development in modern agriculture, offering innovative solutions in fertilization, plant protection, and improving the efficiency of nutrient use. Among the various nanomaterials, zinc oxide nanoparticles (ZnO-NP) are particularly noteworthy, as their physicochemical properties make them a potential alternative to traditional forms of zinc fertilizers. Zinc is an essential element for proper plant growth and development, but its bioavailability in the soil is often limited. The use of ZnO-NPs as a source of this micronutrient may increase its uptake efficiency, but at the same time raises questions about the potential environmental consequences of their presence in soil ecosystems. The aim of the study was to assess the impact of soil application of ZnO-NPs on the diversity and activity of soil microorganisms in agroecosystems of commonly cultivated cereals. The results obtained provide a basis for assessing the potential effects of using nanofertilizers in cropping systems and indicate the need for further research into the mechanisms of interaction between nanoparticles and soil microorganisms. Understanding these relationships is crucial for developing principles for the safe and sustainable use of nanotechnology in agriculture, which will maximize benefits while minimizing environmental risks.

Keywords

Nanotechnology, zinc oxide nanoparticles (ZnO-NPs), nanofertilizers, Soil microorganisms, agroecosystems, cereal crops, soil biodiversity, nutrient efficiency, sustainable agriculture, environmental impact.