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Nanotechnological Applications in Enhancing Use Efficiency of Micronutrients

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Abstract

The use efficiency of applied micronutrients through conventional sources is around 2% due to the lack of synchronization between crop demand and nutrient release. An option before us is to evaluate and use nanotechnology for enhancing the use efficiency of micronutrients. Nanomaterials (NMs) are the reduced size materials with at least one dimensions less than 100 nanometers (nm). Accordingly, nanofertilizers are the formulations in nanoscale to supply nutrients directly to plants or the carriers of conventional fertilizers with controlled release properties which increases the efficiency of conventional fertilizers.

Introduction

According to the United State, Environmental Protection Agency (EPA) nanotechnology is defined as "the creation and use of structures, devices, and systems that have novel properties and functions because of their small size." Two terms are used at the nanoscale, *i.e.*, nanomaterials (NM) that have one of its dimensions below 100 nm and nanoparticles (NPs) with 2 dimensions at this scale. Nanotechnology is the new interdisciplinary science which has range of applicability in the field of engineering, medicine, food science and agriculture *etc*. Properties of high specific surface area and moisture holding capacity NMs have potential to be used as nanofertilizer and agrochemicals. The NMs are synthesized from organic as well as inorganic sources thus vary in their compassions. The application of nanoparticles in different fields is very much dependent on their composition and thus their physicochemical properties (Kaushik, 2021). The controlled release property of polymer-coated nanoparticles makes them suitable for use as carriers of agrochemicals and fertilizers.

Uptake of Nanoparticles by Plants

The uptake, translocation, and accumulation of nanoparticles depend on 4 important factors (i) type of plant species, the age of the plant; (ii) growth environment: (ii) physicochemical properties, functionalization, and stability of NPs; and (iv) mode of delivery of NPs. The pore diameter of the cell wall is 5-20 nm; hence, NP or NP aggregates smaller than the pore size could easily pass through the cell wall. Functionalized NPs enhance the uptake of NPs by enlargement of pore size or formation of new cell wall pore. The uptake of NPs into plant cells is also facilitated by carrier proteins such as aquaporin, ion channels, or endocytosis. Nanomaterials undergo various physical, chemical, and biological transformations in the environment and in biological systems, which greatly determine the behavior of nanomaterials (Lowry *et al.*, 2012).

Nanofertilizers

Nanofertilizers are the NMs that can provide nutrients to the plants or assist in augmenting the activities of conventional fertilizers. Nanofertilizers release the nutrients into the soil steady and in a controlled way, thus increasing the nutrient use efficiency and preventing water pollution. Different micronutrient nanofertilizers such as Fe-NPs, Mn-NPs, CuO-NPs, and ZnO-NPs were evaluated in different parts of the world for their efficiency and safety on different crop plants under controlled conditions as well as in field conditions. Delfani *et al.* (2014) tested the foliar application of Fe-NPs (500 mg L^{-1}) to black-eyed peas and observed significant increase in the Fe content in leaves (by 34%), and chlorophyll content (by 10%) over the controls. Tarafdar *et al.* (2014) applied ZnO-NPs on pearl millet and found significant improvement in growth of pearl millet and increase in the enzyme activities of acid phosphatase (76.9%), alkaline phosphatase (61.7%), phytase (322.2%), and dehydrogenase (21%) over control in 6 weeks old plants. Watson *et al.* (2015) studied the effect of soil properties on the effect of ZnO-NPs on wheat growth. In the acidic soil, the ZnO-NPs caused dose-dependent phytotoxicity, observed as the inhibition of elongation of roots of wheat.

NM's micro-encapsulation process produces microcapsules (*i.e.*, µm in diameter) that have several nutritional benefits: (1) improved surface area for absorption, resulting in increased bioavailability; (2) low production cost, and (3) biodegradability and biocompatibility with the environment. Different coating polymeric materials have been used, depending on the target molecule, tissue or organism, type of active ingredient and environmental conditions. Examples of these polymers include ethylene vinyl acetate, alginate, chitosan, lignosulfonate, pectin, and starch.

Nanoclays have also been used to make nanoclay polymer composites (NCPC), which have excellent water retention capacity and are biodegradable under natural environment condition. Nanoclay Polymer Composites (NCPC) have been synthesized and used as intelligent delivery systems for plant nutrients such as N, P, and Zn in recent times.

Conclusion

Nanoscale or nanostructured materials as controlled release carriers can improve nutrient utilization efficiency and reduce environmental pollution. Nanofertilizers can precisely release their active ingredients in response to environmental triggers and biological needs. However, the absorption, translocation, and fate of nanoparticles in plant systems are largely unknown, leading to the rise of various ethical and safety issues. Systematic and thorough quantitative analysis regarding potential health impacts, environmental cleanup and safe handling of nanomaterials can lead to improvements in the design of fertilizer inputs.

References

Delfani, M., Baradarn Firouzabadi, M., Farrokhi, N., Makarian, H., 2014. Some physiological responses of black-eyed pea to iron and magnesium nanofertilizers. *Communications in Soil Science and Plant Analysis* 45(4), 530-540.

Kaushik, S., 2021. Polymeric and Ceramic Nanoparticles: Possible Role in Biomedical Applications. In: *Handbook of Polymer and Ceramic Nanotechnology*, Springer, Cham. pp. 1293-1308.

Lowry, G.V., Gregory, K.B., Apte, S.C., Lead, J.R. 2012. Transformations of nanomaterials in the environment. *Environmental Science and Technology* 46(13), 6893-6899.

Tarafdar, J.C., Raliya, R., Mahawar, H., Rathore, I., 2014. Development of zinc nanofertilizer to enhance crop production in pearl millet (*Pennisetum americanum*). *Agricultural Research* 3, 257-262.

Watson, J.L., Fang, T., Dimkpa, C.O., Britt, D.W., McLean, J.E., Jacobson, A., Anderson, A.J., 2015. The phytotoxicity of ZnO nanoparticles on wheat varies with soil properties. *Biometals* 28(1), 101-112.