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APPLICATIONS OF NANOFERTILIZERS IN AGRICULTURAL AND HORTICULTURAL CROPS

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Nanofertilizers

Nanofertilizers are synthesized or modified form of traditional fertilizers, fertilizers bulk materials or extracted from different vegetative or reproductive parts of the plant by different chemical, physical, mechanical, or biological methods with the use of Nano technological tools used to improve soil fertility, productivity and quality of agricultural produces.

Applications of nanofertilizers in agriculture:

Nanofertilizers have been classified into three groups

1. Nanoformulation of micronutrients.
2. Nanoformulation of macronutrients.
3. Biofertilizers Based nanofertilizers

Macronutrient-Based Nanofertilizers

Nanofertilizer formulations and found a consistent increase in growth, yield, quality, and nutrient uptake in crop with respect to conventional urea. Nanohydroxyapatite-based fertilizer with respect to regular P fertilizers. The use of hydroxyapatite NPs led to enhanced plant growth parameters, chemical contents, and anticancer activity of leaves in comparison to different sources of P Nanofertilizers. Nano-K was most effective in increasing the leaf area, grain yield, biological yield, harvest index, potassium percentage, and chlorophyll content, disease and pest resistance, and drought tolerance owing to improved nutrient absorption.

Micronutrient-Based Nanofertilizers:

Iron chelate nanofertilizer is highly stable and provides slow release of iron in a broad pH range. Iron nanofertilizer significant increase in growth parameters, photosynthetic pigments, and total protein contents. Application of zinc nanofertilizers to plants can be accomplished by various methods such as by soil mixing, foliar spray, and/or seed-priming method. Out of these,

the seed-priming method is simple, more efficient, and cost effective. Improvement in stress tolerance in wheat was achieved with the employment of Copper nanofertilizers. A substantial increase in root length, height, fresh and dry weights of pigeon pea seedlings was noticed when treated with biogenic Cu nanofertilizers having 20 nm size. Molybdenum nanofertilizers solution as a micronutrient source of Mo for chickpea and reported that application of Mo nanofertilizers intact or in combination with microbial treatment had the potential to improve the yield, performance, and disease resistance of legume as well as other crop species **(Amin, A. M *et al.*, 2020).**

Biofertilizers-Based Nanofertilizers:

The nanoscale formulation of a biofertilizer conferring structural protection to biofertilizer nutrients and plant-growth-promoting bacteria, via nanoencapsulation-mediated coating of nanoscale polymers. The nanoencapsulation approach could be used as a dynamic mechanism to elongate the structural protection of being delivered biofertilizer, enhance its chemical shelf life and dispersion in fertilizer formulation, allowing a controlled release.

Advantages of Nanofertilizers over Conventional Chemical Fertilizers

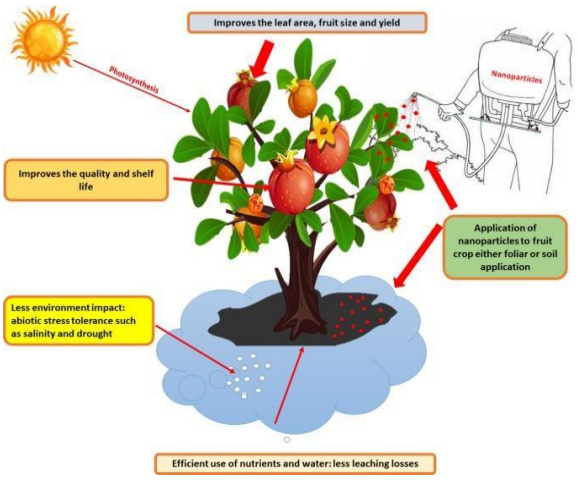
The advantages of nanofertilizers include their high nutrient concentration, slow release of nutrients, and improved plant uptake. Nanofertilizers can also enhance the physical and chemical properties of soils, and their use can help to reduce fertilizer use and the environmental impacts of agriculture **(Babu, S *et al.*, 2022).** Nanofertilizers boast high nutrient concentrations, enabling lower application rates than their traditional counterparts. As a result, fertilizer costs can be reduced, and the associated environmental impacts from production and transportation are mitigated. Slow-release nanofertilizers can provide a steady supply of nutrients to plants over an extended period, improving plant growth and yield. Improved uptake of nutrients by plants can lead to increased growth and yield and reduced nutrient losses to the environment. Nanofertilizers can help improve fertilizer efficiency, and their use can reduce the overall environmental impact.

Application of nanofertilizer in horticultural crops

Foliar spray of nanofertilizers, nano-Zn and nano-B on pomegranate (cultivar Ardestani) led to increase in pomegranate fruit yield, fruit quality, including T.S.S., maturity index, juice and deceases in total acidity. Spraying mango trees with nano-zinc at 1 mg/L before flowering improved yield and fruit quality as well as raised resistance of malformation. Maximum

proliferation was observed in 100 mg/L of enriched nano chelated iron wherein the growth of shoots, leaves and nodes increased showing that it can be used for increasing plant growth. Ca nano based fertilizers increased foliage development and chlorophyll content in vines.

Apple cultivars Red Delicious, Golden Delicious and Starking Delicious potted plants were given nano biofertilizer at 1 g/pot and dosage had greater impact on growth of apple plants. Treatment of Bitter almond seeds with nanofertilizers improved seed germination by 50 % at younger stages compared to chemical fertilizer treatment. It was observed that best yield, improved berry colouration and highest quality fruits were obtained when the vine was treated with amino mineral nanofertilizer at 0.1 %. Application of nutrients and injection of nano NPK fertilizers improved vegetative growth and increased yield of date palm **(Basavegowda, N. and Baek, K.H. 2021)**



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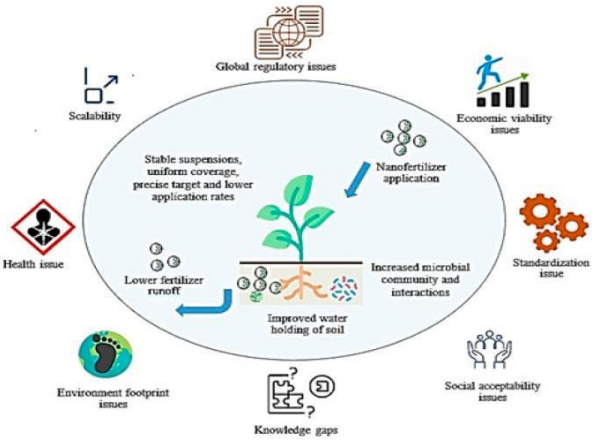

Advantages of nanofertilizer application in the field

Conclusion

The scientific essence of nano fertilizers is to boost agricultural outputs, characterized by correct selection and uniform dispersal of seeds, thorough irrigation and adequate as well as regulated use of fertilizers. Several factors determine this phenomenon, including soil type, chemical combination with other nutrients, leaching effect, and uptake efficiency of plants. Nano biofertilizers hold a great potential to boost the agricultural output at the desired rate when used in optimum concentrations while overcoming the limitations of conventional fertilizers.

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