Agri Articles
(e-Magazine for Agricultural Articles)
Volume: 02, Issue: 02 (MAR-APR, 2022)
Available online at http://www.agriarticles.com
©Agri Articles, ISSN: 2582-9882

Nano Fertilizers: Agriculture's Future Prospect

(*Syed Muzamil[1] and Shahid Mushtaq[2])
[1]Division of Soil Science & Agricultural Chemistry, Faculty of Agriculture, SKUAST-K
[2]Division of Plant Pathology, Faculty of Agriculture, SKUAST-K, J&K, India
*syed.muzammil.0707@gmail.com

The global population is anticipated to reach 9.7 billion people by 2050. (FAO, 2018). As a result, current crop production is needed to be increased by 70% in order to satisfy future food demands. This is one of the most difficult task faced by the contemporary agriculture. This task can be accomplished by enhancing the efficiency of agricultural systems, implementing environmentally sound practices and investigating different modern technologies, all of these will provide the required boost to the nutrient use efficiency of plants. Organic and synthetic fertilizers are used in modern intensive farming systems to provide vital plant nutrients, however this has resulted in substantial ecological and environmental degradation. The loss of nitrogen as nitrous oxide and nitrate leaching, as well as the consequences of global warming and climate change, have all contributed to eutrophication. The nitrogen use efficiency (NUE) of phosphate fertilizers is lower, with estimates as low as 20%. Due to the smaller surface area of nanomaterials, which promotes nutrient-surface interaction, nanofertilizers have the potential to boost NUE. Nanofertilizers are materials with macro and micronutrients that are supplied to crops in a regulated manner on nanoscale (1–100 nanometers), in the form of nanoparticles. They are more efficient because of their exceptional properties, functionalities as well as high reactivity as a reason of their high surface area-volume ratio.

Types of Nanofertilizers (On the basis of their formulation):

1) **Nanoscale fertilizer:** These correspond to the traditional fertilizers reduced in their size, in the typical form of nano particles.
2) **Nanoscale additive fertilizer:** Basically, a regular fertilizer with a nanomaterial addition
3) **Nanoscale coated fertilizer:** It is a conventional fertilizer that has nutrients encapsulated in nanofilms or intercalated into the nanoscale pores of a host material. To control nutrient release, nanocomposite structures comprising encapsulated nutrients or nutrients held in nanopores within a carrier material such as clays have been used.

Biological Mechanism of Nanofertilizers action:

Use of Nanofertilizers results in increased nutrient use efficiency (NUE), as plant cell walls contain small pore diameters (up to 20 nm), resulting in increased nutrient uptake, hence the use of nanofertilizers have been supported. Plant roots, which serve as nutrient gateways, have been found to be much more permeable to nanoparticles than the traditional fertilizers. The use of root exudates and molecular transporters through ionic channels, as well as the development of new micro-pores, can boost nanofertilizer uptake. Nanopores and stomatal apertures in leaves have also been observed to facilitate the uptake and penetration of nanomaterials deep into leaves. Nanoparticles (43 nm) were shown to be more effective than

larger particles (more than 1.0 micrometre) at penetrating deep into the leaf interior of the faba bean (*Vicia faba*). Similarly, the leaf stomatal radii of Arabian coffee (*C. arabica*) and sour cherry (*P. cerasus*) were less than 2.5 nm and less than 100 nm, respectively, showing that nanofertilizers can boost nutrient uptake. Because of increased nutrient transport and distribution via plasmodesmata, which are nanosized (50–60 nm) channels for ion transfer between cells, nanofertilizers have been found to have a higher NUE.

Advantages of Nanofertilizers over conventional fertilizers:

1. In contrast to the quick and spontaneous release of nutrients from chemical fertilizers, nanofertilizers nourish crop plants gradually and in a controlled manner.
2. Because there are fewer losses in the form of leaching and volatilization, nanofertilizers are more effective in terms of nutrient absorption and use.
3. Due to unrestricted passage through nanoscale pores, molecular transporters, and root exudates, nanoparticles have much greater absorption. Nanoparticles also use a variety of ion channels, resulting in increased nutrient uptake by crop plants. Nanoparticles have the ability to pass through plasmodesmata within the plant, resulting in effective nutrient delivery to sink sites.
4. In comparison to synthetic fertilizers, which are utilised in higher quantities due to the huge portion of their content that is lost due to leaching and emission, nanofertilizers can be used in less quantities due to their low losses.
5. Nanofertilizers provide the greatest benefit in terms of low losses, resulting in a lesser risk of pollution.
6. Nanofertilizers outperform conventional synthetic fertilizers due to their increased solubility and diffusion.
7. Smart nanofertilizers, such as polymer coated fertilizers, avoid premature contact with soil and water due to the thin covering encapsulating nanoparticles, resulting in minimal nutritional loss. These, on the other hand, are available as soon as the plants are able to absorb the nutrients that have been released.

Practical confirmation of Nanofertilizers application for sustainable agriculture:

The findings of a field study backed up the concept that nano nitrogen fertilizers could help boost rice yields. It was concluded that nano nitrogen fertilizer has the potential to replace mineral urea and reduce environmental pollution caused by chemical fertilizers leaching, de-nitrification and volatilization. Similarly, exogenously applied nutrients in the form of nanomaterials boosted cereal vegetative development, including barley, whereas nanofertilizers used in conjunction with lower dosages of mineral fertilizers were found to be effective in improving cereal yield characteristics and grain yield. . Zinc nanofertilizer provided as ZnO was found to be beneficial in improving peanut output due to vigorous plant development, enhanced chlorophyll content of leaves, and substantially superior root growth.

Nano fertilizers in Indian Scenario:

Nanofertilizers have a tremendous scope in Indian agriculture as they can provide the required boost to the crop productivity leading to substantial increment in farmers' income. Nanofertilizers can prove highly effective in India as they are environment friendly, suitable for all soil types and crops as well as they preserve the quality of land, water bodies and air. Indian Farmers Fertilizer Cooperative (IFFCO) Nano Urea has been launched in the year 2021, it is the only nano fertilizer that has been approved by the Indian government and is listed in the Fertilizer Control Order (FCO). It was created by IFFCO and was given a patent, it is the world's first nano urea. One bottle of Nano Urea might replace at least one bag of Urea. It has been tested on over 90 crops in over 11,000 locations in India in coordination

with ICAR-KVKs, Research Institutes, State Agriculture Universities and progressive farmers. Nano urea sprayed on leaves is quickly absorbed by plant cells through stomata and other pores. It is easily transferred from source to sink inside the plant via the phloem as needed.

References

1. Iqbal, M.A., (2019). Nano-fertilizers for sustainable crop production under changing climate: a global perspective. *Sustainable crop production* **8**: 1-13.
2. Bernela, M., Rani, R., Malik, P. and Mukherjee, T.K. (2021). Nanofertilizers: Applications and Future Prospects. In *Nanotechnology: Principles and Applications* (pp. 289-332). Routledge.