



Supremacy of Nano Fertilizers in Farming

(*Vimal Chandar, M. and Dr. N. Elakiya)

JKK Munirajah College of Agricultural Sciences, Gobichettipalayam, Erode

*Corresponding Author's email: elakiya.nandu@gmail.com

Farmers worldwide are grappling with the daunting task of nourishing an ever-growing global population, all while contending with diminishing arable lands due to rapid urbanization. This issue has led to widespread food insecurity and famine, particularly in remote corners of the world. In response to the challenge of insufficient food production, the "green revolution" emerged as a transformative force in agriculture, boosting both productivity and population well-being.

Central to achieving high crop yields is the imperative of enriching the soil with ample fertilization. This practice, though beneficial, can sometimes have adverse repercussions on ecosystems and diminish the overall efficacy of fertilizers. While nano-fertilizers, offer a promising solution characterized by minimal application yet maximal utilization. The integration of nano-fertilizers presents a potential game-changer, addressing these limitations and ensuring sustainable agricultural practices with enhanced efficiency. Nano fertilizers have the ability to optimize nutrient usage while minimizing environmental impact, are poised to reshape the trajectory of the sector.

Nano technology in agriculture

Nano-science has a potential to revolutionize the agricultural and food industry with new tools of molecular treatment for disease enhancing the ability of plants to observe nutrients etc. Smart delivery systems help the agriculture combat from virus and pathogens, then nanostructure catalysed will be available in future which will increase the efficiency of pesticides and herbicides this allows to use in low dosages. The developing goal is energy conversion and storage and water treatment the minimum goal and achieve is agriculture productivity enhancement also protects the environment directly through the usage of alternatives from nano-science. In future the nano-scale devices with novel properties could be used to make agriculture systems smart, currently the nano-science applied in agriculture is nano-fertilizer. These are in nano-scale size which are used efficiently and allows to use low dosage which reduce the toxicity in biosphere

Nano-fertilizers

Nano-materials which can supply one or more nutrients to the plants when are fortified with nutrients. The synthesis of nano-fertilizers is done by fortification of nutrients with nano-dimension singly or in combination on to various adsorbent materials. Nano-fertilizer can be defined as nanoparticles encapsulated materials which slowly delivers nutrients to crops. Different kinds of encapsulation methods include: (a) encapsulation of nutrients with nano-materials like nanotubes or nanoporous materials, (b) coating of nutrients with a thin protective layer of polymer and (c) formulations which can deliver nutrients as particles or emulsions of nanoscale dimensions.

Unique properties of nanoparticles

- Smaller size, Larger surface area
- Increased surface area to volume ratio
- Nanoparticles are so small in size that they can even pass through the plant and animal cells
- Slow release
- Specific release

Nutrient loading

Nanoparticles have higher efficiency to deliver nutrients to specific target sites in living systems. Nutrient loading on the nanoparticles is generally carried out by

- Attachment of nutrients on nanoparticles
- Adsorption of nutrients mediated by ligands on nanoparticles
- Encapsulation of nutrients with nano-particulate polymeric shell
- Entrapment of polymeric nanoparticles
- Synthesis of nutrient nanoparticles

Methods, uptake and movement of nanoparticles

Nano-fertilisers can be applied by either foliar application or soil application. Nanoparticles can enter the plant system through different pathways root, shoot or leaf tissues (e.g., cuticles, trichomes, stomata, stigma, and hydathodes), even through wounds and root junctions also. Thus nanoparticles or nanoparticle aggregates with lesser diameter than the pore size of plant cell wall could easily enter through the cell wall and reach up to the plasma membrane.

Merits of nano-fertilizers

- Increased nutrient use efficiency
- Extended fertilizer release period
- Reduce the usage of chemical fertilizers by 50%
- Nutrient mobilization increased by 30%

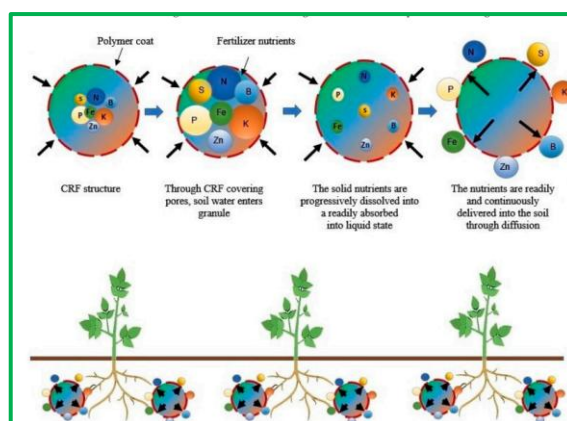


Fig. 1. Mechanism of action of controlled nutrient release nano-fertilizers in the field

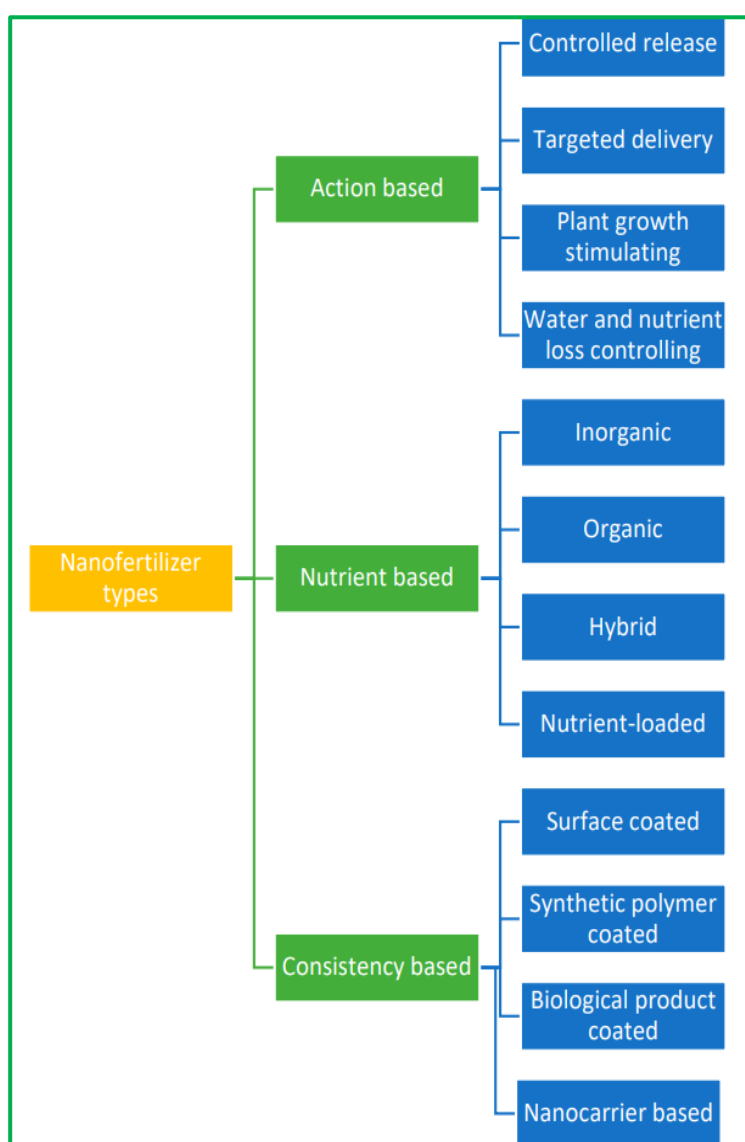


Fig 2. Classification of nano-fertilizers

- Increase in crop yield by 15-30%
- Reduced soil toxicity
- Reduces frequency of application
- Minimise the effect of over dosage

Effect of Nano scale fertilisers on agriculture

Nano ZnO recorded higher peanut seeds germination % and root growth compare to bulk ZnSO₄. Positive effective of nano-scale SiO₂ and TiO₂ on germination was reported in soya bean. Zeolites are commonly used for a substrate for plant-based products which are 3D crystalline structure adsorbing the positively charged ions and releases when necessary. All nutrients like macro (NPK), micro and secondary nutrients have nano-avatar. Unlike conventional fertilizers, nano urea losses can be decreased using zeolites as additives. Addition to that mixing in organic matter, it continued to prolong the preservation of exchangeable NH₄ and supply of NO₃. Nano fertilizer could last for 1200 hours while convectional fertilizer would be able to last for 300 hours only. Same as in phosphorus nano fertilizer, the effect of zeolites increases the nutrient retention, nutrient loss and reduce the requirement.

Demerits of nanofertilizers

- Reactivity and variability is different under different conditions. This raises safety concerns for farm workers who may become exposed to xenobiotics during their application
- Inhalation of nanoparticles during application caused chronic lung effects and exposure to metal based nanoparticles caused skin irritation, rashes, headaches. These include not only those exposed to nano-fertilizer manufacturing but also nanofertilizer application in the field
- The accumulation of nanoparticles in plants and potential health concern
- Phytotoxic effect of nanoparticles due to bioaccumulation

Conclusion

Nano nutrients are more efficient and economical than conventional ones. Application of different types of nano-fertilizers has a major impact on yield of crops, the protection of natural resources and the reduction of fertilizer cost for crop production. With the use of nano-fertilizers in agriculture fields, nutrient use quality will be increased. With optimizing dosing for different nano-fertilisers in different crops, in near future, the farmers could get more productivity being eco-friendly.