



NANO FERTILIZERS-NEW GENERATION'S FERTILIZER

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INTRODUCTION

To address the significant concern of sustainable food production and development, several great technological advances have occurred in the field of farming. Sustainable agriculture requires a minimal use of agrochemicals that can protect the ecosystem and spare biodiversity from extinction. Chemical fertilizers are expensive as well as harmful to human being and environment. Nano fertilizers (NFs) are emerging as a promising alternative to chemical fertilizers in agriculture. NFs have the potential to promote sustainable agriculture and increase overall crop productivity.

Nano particle and Nano technology:

'Nano' is a prefix used to describe 'one billionth' or 10^{-9} of something. A nanoparticle is a very small particle that ranges between 1 to 100 nanometres in size. Nano technology involves the creation and manipulation of materials at the nano meter scale, either by scaling up from single group of atoms or by refining or reducing bulk materials. Nano particles are promising candidates for implementation in agriculture. Nanoparticles can serve as 'magic bullets', containing pesticide, fertilizers etc. just to provide efficient, targeted delivery to plant system. Development of nano fertilizers is one of the focus areas of nanotechnology development in agricultural field.

Nano fertilizers:

A nano fertilizer is any product that is made with nanoparticles or uses nanotechnology to improve nutrient use efficiency. The term nano fertilizer indicates the nanomaterial which is either a plant nutrient itself (micro or macro nutrients) or the carrier of a plant nutrient. Nano fertilizers are made from conventional fertilizers, fertilizer bulk materials, or extracted from different vegetative or reproductive parts of the plant by encapsulating/coating them with nanomaterials for controlled and slow release of nutrients for the improvement of soil fertility, productivity and quality of agricultural products. The encapsulation of nutrients with nanomaterials can be done in three different ways:

- Entrapped/encapsulated within the nanomaterials
- Coated with a layer of nanomaterials
- Deliver in the form of nanoemulsions

Characteristics of Nanofertilizers:

Nano fertilizers possess certain unique characteristics, which assist in more effective nutrient

uptake. Relevant characteristics are:

- The particle size of nano fertilizers is very small (less than 100 nm), which means the penetration rate of nutrients is increased in the plant system.
- Nano fertilizer particles have greater surface area and smaller particle size than that of the roots and leaves of the plant. This increases the penetration into the plant system from the applied surfaces, resulting in improved uptake and nutrient use efficiency of nano fertilizers.
- The tiny size of the nano fertilizers makes them useful in providing sites for plant food metabolism, while having high surface area enhances their action. This results in more plant development through less consumption of essential nutrients.
- They have high solubility in different solvent such as water.
- They possess the characteristic of slow and specific release of nutrients. They control the speed and dose of encapsulated nutrients release to increase availability.
- They have high reactivity with other compounds due to higher surface area and very less size.
- They provide 10 times more stress tolerant by crops.
- Effective duration of nutrient release is high.
- They improve soil microbial activity, water holding capacity etc.
- They are environment friendly having high compatibility with soil and environment.

Uses of Nano fertilizers:

Over the years, numerous studies have shown that the use of nano fertilizers increased and advanced the crop yield and quality parameters. They are used for a variety of purposes:

- **Nano fertilizers in improving Nutrient Use Efficiency (NUE):** Different crops have different nutrient requirements, so nano fertilizers are synthesized to release nutrients which match the crop nutrient requirements. This can be achieved by coating the fertilizer particles with nano-membranes that helps in slow and steady release of nutrients. Tremendous improvement of NUE was observed in plants after application of nano fertilizers. In general, 3-4 times improvement in use efficiency was noticed for many nutrients including P, Zn, Fe and Mg nanoparticles.
- **Nano fertilizers in abiotic stress tolerance:** During the growing period, a plant needs to continually

confront some biotic and abiotic stresses. Dry spell, salinity, heat, waterlogging, cold etc. are major abiotic stresses that cause enormous crop loss. Nano fertilizers help plants survive such challenging environmental factors. For e.g. utilization of nano silicon is found to be more effective compared to regular silicon application in alleviation of salinity stress.

- **Nano fertilizers on seeds germination:** Nano fertilizers significantly influence the seed germination and seedling growth. Nano fertilizers can easily penetrate into seed and increase availability of nutrient to the growing seedling. For example, nano formulation of zinc oxide demonstrated higher germination rate and root vigour as compared to bulk zinc sulphate.

- **Nano fertilizers in increasing yield:** Nano fertilizers lead to improving crop yield. This is primarily because of increasing growth of plant parts and metabolic process such as photosynthesis which leads to higher photosynthets accumulation and translocation to the economic parts of the plant.

quality parameters of the plant such as protein, oil content, sugar content etc.

- **Nano fertilizers in improving plant health:** Some nutrient elements improve the resistance of the plants to diseases. Due to the more availability of nano nutrient to the plant, it prevents from diseases and other nutritional disorders. It indicates that nano fertilizers enhance overall health of the plant.

Merits of Nano fertilizers:

- Three times increase in nutrient use efficiency
- Extend fertilizer release period
- Nutrient mobilization increased by 30%
- Reduce the usage of chemical fertilizers by 50%
- Increase the crop yield by 15-30%
- Improve soil water holding capacity and microbial activity
- Reduce soil toxicity
- Reduce frequency of application
- Minimize the effect of over dosage
- Contribution to precision farming.

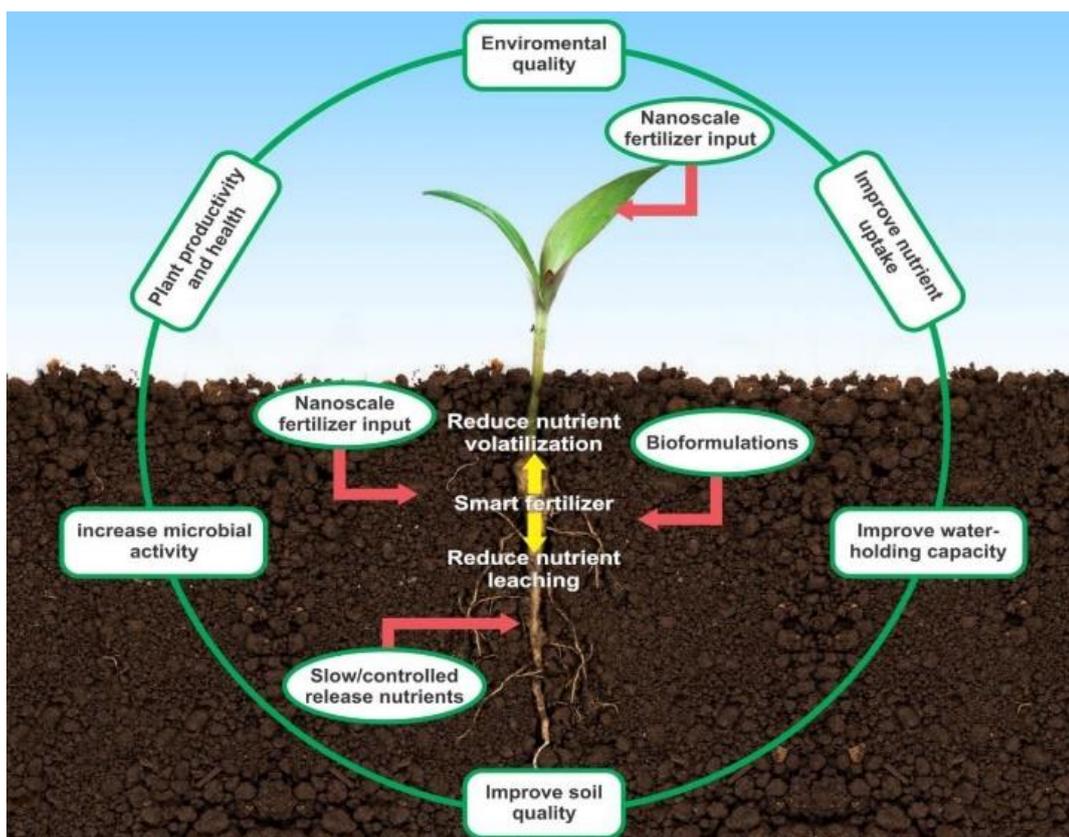


Fig: Potential smart fertilizer- Nano fertilizer effects in the soil system

- **Nano fertilizers in improvement of nutritional value:** Nano fertilizers can improve nutritional value of crops. Nano fertilizers provide more surface area and more availability of nutrient to the crop which help to enhance the rate of reaction or synthesis process in the plant system. This leads to increase

Demerits of Nano fertilizers:

- Reactivity and variability is different under different conditions
- This raises safety concerns for workers who may become exposed during manufacturing and application in the field

- Inhalation of nanoparticles during application may cause chronic lung effects and exposure to metal based nanoparticles causes skin irritation, headaches
- Can accumulate in food parts and when consumed may cause human health problems
- Some studies have reported phytotoxic effect of nanoparticles due to bioaccumulation

CONCLUSION

Application of different nano fertilizers has greater role in enhancing crop production which will overcome the limitations of conventional fertilizers. Nutrient use efficiency in crop production can be enhanced with effective use of nano fertilizers. The application of nano fertilizers in agriculture should have a greater concern to society. Nano fertilizers improve crop growth and yield up to optimum applied doses and concentration, but they also have inhibitory effect on crop growth if concentration is more than the optimum. So, with optimum dosing of nano fertilizers, the agricultural system will be highly productive and eco-friendly in near future.

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