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Role of Nanoscale nutrients in Crop production

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Abstract

Materials with a particle size less than 100 nm in at least one dimension are generally classified as nanomaterials. Revealing biological effects of nanoscale materials, especially in plants, is an important research area in bio-nanotechnology. Evaluation of the effects of nanoscale materials on agricultural crops is currently under exploitation. Manufacturing advancements have led to the fabrication of nanomaterials of different sizes and shapes. As size dependent properties are evident at nanoscale, initiation of evaluation of size dependent effects of nanoscale materials on the crop plants is one of the prioritized research areas in agricultural sciences. Preliminary studies show the potential of nanomaterials in improving seed germination and growth, plant protection, pathogen detection, and pesticide/herbicide residue detection. Nano-fertilizers are new generation of the synthetic fertilizers which contain readily available nutrients in nano scale range. Nano fertilizers are preferred largely due to their efficiency and environment friendly nature compared to conventional chemical fertilizers.

Introduction

Nanotechnology

"Nanotechnology is the art and science of manipulating matter at the nanoscale (1 to 100 nm) to create new and unique materials and products with enormous potential to change society."

- Nanotechnology is the study of manipulating matter on an atomic scale.
- It is emerging as the sixth revolutionary technology in the current era.

Nano scale

From the Greek *nanos* - meaning "*dwarf*", this prefix is used in the metric system to mean

1 nm = 1 billionth 10^{-9} of a meters

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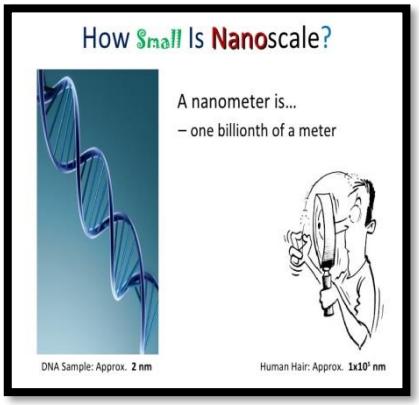
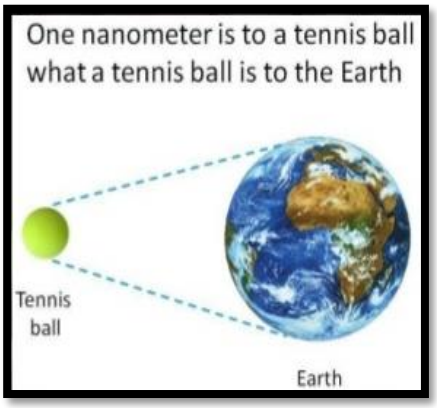
Things about nanomaterials

- Synthesis
- Characterization
- Application





Synthesis of nanoparticles

- Top-down
- Bottom-up

Top-down approach

Creating Nano-scale materials by physically or chemically breaking down larger materials

Bottom-up approach

Assembling Nano materials atom-by-atom or molecule-by molecule (self-assembling)

Nanofertilizers

- "Molecular modified or synthesized materials with the help of nanotechnology, used to improve the fertility of soil for a better crop yield and quality ".
- These are synthesised in order to regulate the release of nutrients depending on the requirements of the crops.

Advantages of nano-fertilizers

Properties	Nano-fertilizers-enabled technologies	Conventional technology
Solubility and availability of nutrients	Nano-sized formulation improves solubility and dispersion of insoluble nutrients in soil, reduce soil absorption, fixation and increase the bioavailability	Less bioavailability to plants due to large particle size
Nutrient uptake efficiency	Nanostructured formulation might increase fertilizer efficiency and uptake ratio of the soil nutrients in crop production and save fertilizer resource	Bulk composite is not available for roots and decrease efficiency
Controlled release modes	Both release rate and release pattern of nutrients were controlled by encapsulation in envelope forms of semipermeable membranes coated by resin-polymer, waxes, and sulphur	Excess release of fertilizers may produce toxicity and destroy ecological balance of soil
Effective duration of nutrient release	Nanostructured formulation can extend effective duration of nutrient supply of fertilizers into soil	Used by the plants at the time of delivery, the rest is converted into insoluble salts in the soil
Loss of nutrients	Nanostructured formulation can reduce loss of nutrients into soil by leaching and/or leaking	High losses by leaching, run off and drift

- Yields: Nano-fertilizers increases yields by an average of 20% and for some crops even more. For example: in some experiments sunflower grain yield increased by 50% and in cucumber trials yield increased upto 25%.
- Nutritional value: Some experimental results showed 10 % increase in both protein and sugar content when nanofertilizers applied.
- Health: Overall health of the plant is improved, making it more resistant to severe extreme environmental conditions and to fight against disease and prevent infections.

Conclusions

- Nanofertilizers permit the nutrient release by controlling their release rate to match uptake pattern of the crop

- Nanosized formulations may improve the solubility and dispersion of insoluble nutrients in soil, reduces soil absorption and fixation there by increases the bioavailability.
- Nanostructured formulations improve the efficiency of fertilizer, uptake ratio there by enhancing crop yield and also saves fertilizer resources.
- These nanofertilizers minimize the cost of production, maximize the profit and also helps in reduction of pollution.

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