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NANO-FERTILIZERS -SMART NUTRIENT DELIVERY SYSTEM TO INCREASE THE NUTRIENT EFFICIENCY

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The first Green Revolution during the 1970s targeted to the four basic elements of production system which are high yielding varieties of rice and wheat, extensive use of irrigation, fertilizers and agro-chemicals as a resulted in a tremendous increase in the agricultural production but present agriculture is generally chemical-intensive by using more doses of chemicals for insect, disease, weeds and nutrient management for getting maximization of production per unit area without concern of natural resources and ecosystems therefore resultant, adversely impact our soil health (Soil –physical, chemical, biological property) indirectly in our ecology. In the past 50 years, the fertilizer consumption exponentially increased from 0.5 (1960's) to 24 million tonnes (2013). That is commensurate with a four-fold increase in food grain output (254 million tonnes)but also observed that yields of many crops have begun to stagnate due to imbalanced of fertilization and decline in organic matter content of soils. We are well vast about the optimal NPK fertilizer ratio of 4:2:1 is ideal for crop productivity while the current ratio is being maintained at 10: 2.7: 1 in India.So it is our crucial concern to reduce the huge amount of application of fertilizer whereas increase the higher yield with increasing the nutrient use efficiency, therefore, Nanotechnology is the novel approach for optimization of targeted yield with its higher nutrient use efficiency along with the concern of soil health.

Nano-fertilizers -Smart nutrient delivery system

Nano-fertilizers are also termed as "Smart Fertilizers". Nano-fertilizers are synthesized or modified form of traditional fertilizers, bulk materials or extracted from different vegetative or reproductive parts of the plant with different chemical, physical, mechanical or biological methods along with the help of nanotechnology used to improve soil fertility, productivity and quality of agricultural produce (Tarafdar J. C, et al., 2012). A

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nanoparticle (nanopowder or nanocluster or nanocrystal) is a small particle with at least one dimension less than 100 nm where 1 Manometer = 10-9 m = 1 billionth of a meter. Nanosized particles can even pass through the cell wall in plants and animals having with this property Nanotechnologists are used this property to deliver at the cellular level that is more effective than the conventional method because of high surface energy and spatial confinement. Example like Rock phosphate if use as nano form it may increase the availability of phosphorus to the plant because of the direct application of rock phosphate, nanoparticles on the crop may prevent fixation in the soil. As a result, there is no silicic acid, iron and calcium for fixation of the phosphorus, increase phosphorus availability to the crop plants.

Classes of Nanofertilizers

Three classes of nano-fertilizers have been proposed

1. Nanoscale fertilizers (nanoparticles which contain nutrients),
2. Nanoscale additives (traditional fertilizers with nanoscale additives)
3. Nanoscale coating (traditional fertilizers coated or loaded with nanoscale).

Nonmaterial coatings (such as a nanomembrane) may slow the release of nutrients, or a porous nano fertilizer may include a network of channels that retain nutrient solubility. The use of nanotechnology for fertilizers is still in the budding stage but is already adopted for medical and engineering applications

Types of nanofertilizer designs

i. **Slow-release:** The nano-capsules release nutrients over a specific period of time (slow delivery of a substance in the body).

ii. **Quick-release:** The nanoparticle shells break upon contact with a surface (such as a shrinking leaf).

iii. **Specific release:** The shell breaks upon when it encounters a specific chemical or enzyme.

iv. **Moisture release:** The nanoparticle degrades and releases nutrients in the presence of water.

v. **Heat release:** The nanoparticle releases nutrients when the temperature reaches a set limit.

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vi. **pH release:** The nanoparticle releases nutrients only at specified acid or alkaline conditions.

vii. **Ultra-sound release:** The nanoparticle is ruptured by an external ultra-sound frequency.

viii. **Magnetic release:** A magnetic nanoparticle ruptures when exposed to a magnetic field.

Advantages of nanofertilizers over conventional fertilizers:

Nanaofertilizers have a higher surface area, which makes them easier to for the absorption by crops and have better solubility and retention capacity in soil thus making more available for the crops uptake.

DESIRABLE PROPERTIES	EXAMPLES OF NANO-FERTILIZERS ENABLED TECHNOLOGIES
Controlled release formulation	So-called smart fertilizers might become a reality through a transformed formulation of conventional products using nanotechnology. The nanostructured formulation might permit fertilizer intelligently control the release sped of nutrients to match the uptake pattern of crop.
Solubility and dispersion for mineral micronutrients	Nanosized formulations of mineral micronutrients may improve the solubility and dispersion of insoluble nutrients in soil, reduce the absorption, fixation and increase the bio-availability to the crops.
Nurient uptake efficiency	Nanostructured formulations might increase fertilizer use efficiency and uptake ratio of the soil nutrients in crop production and save fertilizer resource.
Controlled release modes	Both release rate and release patterns of nutrients for water-soluble fertilizers might be precisely controlled through encapsulation in envelop forms of semi-permeable membranes coated by resin polymers, wax and sulphur.
Effective duration of nutrient release	Nanostructured formulation can extend increase the effective duration of nutrient supply of fertilizers into the soil.
The loss rate of fertilizer nutrients	Nanostructured formulations can reduce the loss rate of fertilizer nutrients into the soil by leaching or leaking.

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Conclusion

Application of nanotechnology in agriculture is still in its budding stage, but it has the potential to revolutionize agricultural systems particularly where the issues on fertilizer applications are concerned through reduce the cost of fertilizer for crop production and minimize the pollution hazard. It has the ability to more soluble or more reactive that can improve penetration through the cuticle and also performs to controlled release and targeted delivery. Meanwhile, there is awareness created on the risks of consuming and performing few operations rather than the benefits and effectiveness of the technology, and also the Governments across the world should form common and strict norms before commercialization and bulk use of these nanomaterials.

References

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