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OVERVIEW ON METAL NANOPARTICLES IN AGRICULTURE

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ABSTRACT

Nanotechnology is a new field of science allowing fascinating research in many fields and its inventions could open up various milestones in the field of agriculture. Nano-fertilizers are being used extensively as a better option in comparison to bulk fertilizers. These help in the slow release of nutrients so that loss of nutrients can be minimized drastically and nutrients can be used judiciously. Nanotechnology refers to the branch of science regarding the study of particles whose size ranges in nanometers, hence known as nanoparticles. Various physical chemical and biological methods can be used to synthesize nanoparticles. Nowadays “green synthesis” of nanoparticles is under practice so that nanoparticles can be synthesized in an environment-friendly manner. X-ray diffraction, NMR and various electron microscopy techniques can be used to synthesize nanoparticles. Here, we have discussed the significance of copper, iron, manganese and magnesium nanoparticles and their various roles in agricultural processes.

KEYWORDS

Green synthesis, Metals, Nanoparticles and Agriculture.

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INTRODUCTION

The European commission has defined Nanotechnology as one of the six “Key Enabling Technologies” that is responsible for judicious development, productivity and rise in different fields of industrial applications¹. It is a new field of life science allowing fascinating research in many fields and its inventions could open up various new milestones in the field of agriculture². Nanotechnology administers one of the prime agricultural monitoring techniques, especially by its

nano-sized dimension. There are various significances of this type of technology such as food quality and safety can be improved, agricultural inputs can be minimized, Nanoscale nutrients absorbance capacity can be enhanced etc³. In today's world nano-fertilizers are being used extensively as a better option in comparison to bulk fertilizers and they decrease the pollution of soil and water by various agrochemicals. They help in the release of nutrients very slowly so that loss of nutrients can be minimized drastically and nutrient can be used efficiently⁴.

Description of nanoparticles

Nanotechnology refers to the branch of science regarding the study of particles whose size ranges in nanometers, hence known as nanoparticles⁵. For example liposomes, quantum dots, metal nanoparticles etc. The uses of these nano-sized particles in various biomedical and scientific processes is referred to as Nanobiotechnology⁶. It is a creation of objects or surfaces whose properties are of various uses due to their miniature dimensions. It generally refers to those objects whose size ranges between 1-100 parts of a nanometer. Nanoparticles are types of crystalline structures of various metals which are composed of few hundred to a few thousand atoms with sizes of a few nanometers⁷.

Synthesis of nanoparticles

Various technologies have been developed which are used to synthesize nanoparticles. They are broadly divided into three main methods of synthesis.

Physical methods of synthesizing nanoparticles

They include various methods such as High energy ball mixing, melt mixing etc. Evaporation-condensation and laser ablation techniques have also come into picture nowadays for different types of nanoparticles based on their properties of synthesizing them⁸.

Chemical methods of synthesizing nanoparticles

These techniques are simple and involve the use of low temperatures such as less than 350 °C. Approaches of chemical synthesis of various nanoparticles involve the fast injection of reagents

into hot surfactant solution and then followed by aging at high temperature. Mixing of certain reagents at low temperature and slow/moderate heating process under various laboratory conditions are also feasible for the synthesis of such nanoparticles⁹.

Biological methods of synthesizing nanoparticles

This method is also known as the "green" method of synthesizing nanoparticles. Nanoparticles can be synthesized from various bacterial, fungal and other living organisms with the use of low-cost techniques in an environment friendly manner involving low-energy input¹⁰.

Characterization of nanoparticles

Two main characteristics for classifying nanoparticles are size and shape. It can be classified by various techniques such as:-

X-ray diffraction techniques

Which give us a brief summary about the nature of the phase, crystalline grain size and crystalline structure of the NP¹¹.

Microscopy techniques

such as TEM and SEM update us with the inter-particle distance between the nanoparticles¹¹.

Nuclear Magnetic Resonance Spectroscopy

It gives the exact atomic structure of nanoparticles and also updates us with the interaction of ligands¹¹.

Role of various nanoparticles in agriculture

Role of Copper Nanoparticles in agriculture

Copper nanoparticles (Cu-NPs) have been proven as a potential antifungal agent which can eliminate the disease-causing fungal species found in various plants. These copper nanoparticles have been proved to have far better activity as compared to commercially available fungicide bavistin against plant pathogenic species of fungi such as *Fusarium oxysporum*, *A. alternate* and *P.destructiva*¹².

Role of Magnesium nanoparticles in agriculture

Magnesium nanoparticles have the capacity to increase solar light absorption of leaves. In plants the root length, number of tips and root biomass can be increased by the application of Magnesium nanoparticles. Hence it has the capacity to increase

crop production and therefore it acts as a boon for agricultural sector¹³.

Role of Manganese Nanoparticles in Agriculture

Manganese is an element which has significant role in photosynthesis. Studies have proven that Mn nanoparticles are less harmful than Manganese Sulphate salt which is used to enhance growth of various plants for e.g. a leguminous plant mung bean (*Vigna radiata*). Chloroplasts show better photophosphorylation capacity, water splitting by an oxygen evolving complex is also enhanced by the application of Mn-NPs to plants¹⁴.

Role of Iron Nanoparticles in Agriculture

Due to the magnetic properties of iron and iron oxide nanoparticles, it is efficient in accelerating the removal of harmful pesticides from drinking water¹⁵.

CONCLUSION

Agriculture which is the main supplier of human's nourishment that should create from transitional and last contributions with surely understood innovations. Hence, it is important to take a cutting edge information in agribusiness. In spite of being relative advantages in agriculture process, still developing countries are suffering from lack of high importance of food products. Nanotechnology is another field of science permitting intriguing exploration in numerous fields and its innovations could open up different achievements in the field of agriculture. Nano-fertilizers are being utilized widely as a superior alternative in contrast with bulk fertilizers. These assistance in the moderate arrival of supplements with the goal that loss of supplements can be limited definitely and supplements can be utilized judiciously.

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CONFLICT OF INTEREST

We declare that we have no conflict of interest.

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