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Introduction of Nanoparticles in Agriculture

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Abstract

Nanotechnology is a branch of science which manipulates the properties of particles keeping in size range of 1-100 nm. The particles come between 1-100 nm is called nanoparticles. The nanoparticles have proven excellent physical, chemical and other properties than bulk particles. This advantage has been used in almost all fields including agriculture. The research associated with nanoparticles in agriculture is still rudimentary. The existing findings proven that fertilizer use efficiency of nanoparticles are very high compared to conventional fertilizers. They act as smart delivery fertilizer units. Nano herbicides also have proven advantages than bulk. Nano particles can serve as smart sensors in hi-tech agriculture. But the fixation of optimum dose of nano particles in agriculture is still struggling. It was seen that even small doses of nanoparticles cause toxic impacts on crops. So, there is need of detailed research about nanoparticles in agriculture to bring nanoscience from "lab to field".

Introduction

Nanotechnology is the study of manipulating matter on an atomic scale. Nanotechnology refers to the engineering of the functional system at atomic level. A nanometer is one billionth of a meter, roughly the width of three or four atoms. The average human hair is about 25,000 nm wide. The first ever concept of nanotechnology was in 1959 by the famous professor of physics Dr. Richard P Feynman. The term "Nano technology" had been coined by Norio Taniguchi in 1974. The early 2000's also saw the beginnings of commercial application of nanotechnology. Silver nano platform as anti-bacterial agent, nanoparticles based transparent sunscreens and carbon nanotubes for stain resistant textiles are typical examples for commercialization of nano particles.

Nanoparticles are solid colloidal particles ranging from 1-100 nm in size; they consist of macromolecular materials in which the active ingredients are dissolved, entrapped, encapsulated or adsorbed. Nanoparticles can be of two types. They are nanospheres and nano capsules. The different methods using for nanoparticles preparation are emulsion polymerization, dispersion polymerization, inter facial polymerization and interfacial complexation. The basis of the 100-nanometer limit is the fact that novel properties that differentiate particles from the bulk material typically develop at a critical length scale under 100 nm. Nanoparticles and nanoclusters are not the same particles. Nanoparticles have nanoscale dimension in all three axes but nanoclusters have nanoscale dimension at minimum of one axis. The term colloid particles and nanoparticles are not interchangeable. The term colloid applies when particle size ranging from nanometer to micrometer and capable of showing Brownian movement, nanoparticles can exist colloid as well as non-colloid particles (Kandasamy and Prema, 2015).

Nanoparticles in Agriculture

As Food Preservative

Agricultural systems can make excellent use of nanotech-enabled "smart" devices that can perform multiple roles of being a preventive and early warning systems and as a supplier for nutrients at proper time and dosage (Mosanna *et al.,* 2015). Smart food packaging system can be developed using nanotechnology that in turn increases the shelf life of food products. Durethan KU2-2601 is a packaging film made of silicate nano particle, which protect drying of food content and protect the food content from oxygen and moisture, thereby increase the shelf life of the product.

As Nano-Fertilizers

The nutrient use efficiencies of conventional fertilizer hardly exceed 30-35%, 15-20% and 50-60% for N, P and K for past several decades. Nanofertilizers are synthesized by fortifying the nutrients singly or in combination onto the adsorbents with nano dimension. Nanofertilizers are designed to deliver nutrient slowly and steadily for more than 30 days which may assist in improving the nutrient use efficiency without associated ill effects. When nanoparticles applied as foliar spray, its efficiency goes around 80%.

As Nano-Herbicide

Nano structured compounds are able to eliminate the harmful compounds from agricultural ecosystem. Nanoparticles can serve as "magic bullet" containing herbicide, chemicals or genes which target particular plant parts to release their content. Nano capsules can enable effective penetration of herbicide through cuticle and tissues, allowing slow and constant release of the active substances.

Nano-Biotechnology

The convergence of technology with biology of nano level is called nano biotechnology. Nanotechnology can be a part of Controlled Environmental Agriculture (CEA). CEA is an advanced and intense form of hydroponic based agriculture. CEA technology as it exists today provides an excellent platform for introduction of nanotechnology to agriculture. Precision farming has been a long-desired goal to maximize the output, can also help to reduce agricultural waste and thus keep environmental pollution to a minimum. These nano sensors could be distributed throughout the field where they can monitor soil condition and crop growth. The use of nano sensors helps to increase sensitivity, allowing an earlier response to environment chemistry.

As a result of their unique properties, nanoparticles may influence metabolic activities of the plant at different degrees compared to conventional material and have the potential to mobilize native nutrient such as phosphorous in the rhizosphere (Laware and Raskar, 2014). The fate of large portion of applied fertilizer is lost to the atmosphere

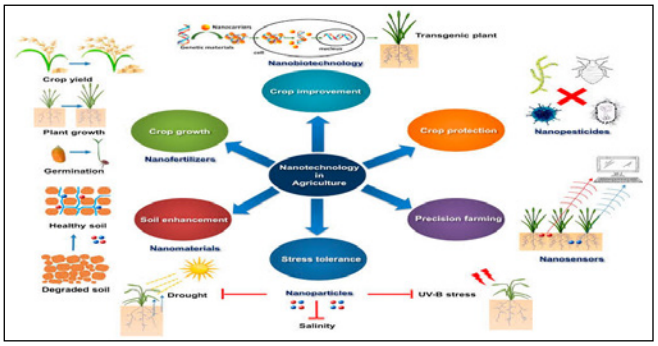

Figure 1: Role of nanotechnology in agriculture

or enters to water bodies, finally polluting our ecosystem. Important benefits of Nanofertilizers over conventional chemical fertilizer rely on their nutrient delivery system as they regulate the availability of nutrient act as control release mechanism. Nutrients can be released over 40-50 days in a slow-release fashion rather than 4-10 days by conventional fertilizers. Another advantage of Nano fertilizers is reduced cost of transport and reduced salt accumulation in soil. The miniature size, high specific surface area and high reactivity of nanofertilizers increase the bioavailability of nutrients. Nano priming is a new method for increase of seedling vigor and improvement of germination percentage and seedling growth. The results showed that an increase in the concentration of nano anatase caused a significant increase in the percentage of germination, germination rate index, root and shoot length, fresh weight and chlorophyll content. ZnO nanoparticles have attracted intense research efforts for this unique properties and versatile application. Zinc nanoparticles and zinc nano capsule provide an efficient means to distribute pesticide and fertilizer in a controlled fashion with high site specificity and thus collateral damage. Zinc oxide NPs have potential to boost the yield and growth of food crops. Peanut seeds were treated with different concentration of zinc oxide nanoparticles. Nano zinc oxide (1000 ppm) concentration was used which permitted seed germination, seedling vigor and plant growth.

Environmental and Health Concerns

- The properties of many nanoparticles are considered to be of potential risk to human health.
- The government reports and reviews published so far have not highlighted the uniqueness of the agricultural production system as compared with industry.
- Another interesting feature on farm production system is that it would be virtually impossible to control the fate and behavior of nano-material whereby are added to the system intentionally or unintentionally.
- Nutrient management with nanotechnology must rely on two important parameters. Ions must be present in plant available forms in the soil system and the second is nano

materials must facilitate process that would ensure availability of nutrients to plants in the rate and manner that plant demand. Further opportunities for applying nanotechnology in agriculture lie in the area of genetic improvement of plants.

Considering the pros and cons, "Nanotechnology in agriculture" needs an extensive research work to bringing out all possible outputs.

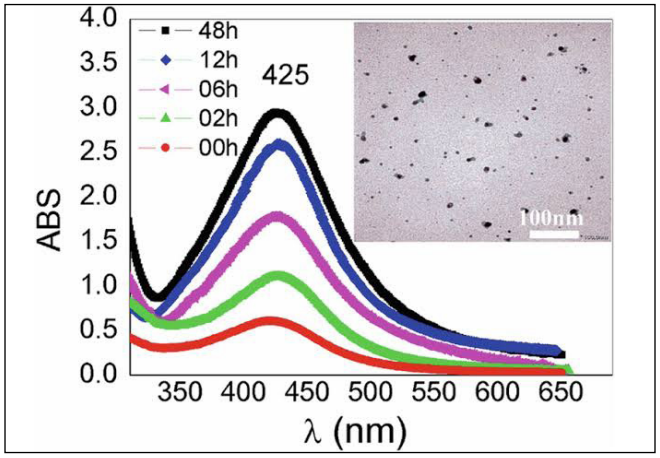

Figure 2: Yield response of maize seedlings on application of nano fertilizer

Conclusion

Nanomaterial has proven advantage on yield parameter, quality parameters and pest resistance under laboratory condition. But the field study is limited in this aspect. So there is a urge of conducting field studies in this aspect to find out the optimum level of nano particle application and to make clear the concern about the toxicity of nanoparticles on surrounding environment.

References

Kandasamy, S., Prema, R.S., 2015. Methods of synthesis of nano particles and its applications. *Journal of Chemical and Pharmaceutical Research* 7(3), 278-285.

Laware, S.L., Raskar, S., 2014. Influence of Zinc Oxide Nanoparticles on Growth, Flowering and Seed Productivity in Onion. *International Journal of Current Microbiology and Applied Sciences* 3(7), 874-881.

Mosanna, R., Khalilva, E., Behrozyar, 2015. Morpho-physiological response of maize (*Zea mays* L.) to zinc nano-chelate foliar and soil application at different growth stages. *Journal on new Biological Report* 4(1), 46-50.