Nanofertilizers for Eco-friendly environment.

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Abstract

Nanotechnology is the understanding and control of matter of sizes roughly in the range of 1 to 100 nanometres. Nanoscience has brought about a revolution in different fields by helping to develop process and products that are hardly possible to evolve through conventional methods. The literature pertaining to the role of nanotechnology in plant and soil systems demonstrates that nanomaterials may assist in the formulations of nanomaterial-based pesticides and insecticides, enhancement of agricultural productivity using bio-conjugated nanoparticles (encapsulation) for slow release of nutrients and water, use of nanomaterials for preparation of different kind of biosensors, use of nano clay composite superabsorbent for higher retention of soil moisture and essential plant nutrient is effective in mitigating the drought stress tolerance in the crop. However, limited knowledge concerning nanomaterial biosafety, adverse effects, fate, and acquired biological reactivity once dispersed into the environment, requires further scientific efforts to assess possible nano-agricultural risks. In this perspective, toxicological research should be aimed to define nanomaterial hazards and levels of exposure along the life-cycle of nano-enabled products, and to assess those physico-chemical features affecting nanomaterial toxicity, possible interactions with agro-system co-formulants and stressors.

Keywords: Nano fertilizer, Environment, Soil nutrients.

Introduction

The word "Nanotechnology" has originated from a Greek word "Nanos" which means "Dwarf". The term "Nanotechnology" was first used by Norio Taniguchi in 1947 [1]. The Nano particles produced with the help of nanotechnology can be exploited in the value chain of entire agriculture production system. The key focus areas for nanotechnology agricultural research are drug delivery, nano-biofarming, nano pesticides and nano herbicides and controlled release of nano fertilizers [2]. Nanotechnology as a powerful new technology has the ability to create a great revolution and transformation in food supply system in global scope. Nanotechnology has proved its place in agricultural sciences and related industries. Nano fertilizers are nutrient carriers of nano-dimensions ranging from 10 to 400 nm and capable of holding nutrient ions due to their high surface area and release it slowly and steadily that

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commensurate with crop demand. There are slow- release and super sorbent nitrogenous and phosphatic fertilizers [3].

Chitosan is a natural polymer derived from de-acetylation of chitin, which may be obtained from crustaceans, insects, fungi, etc. Some beneficial effects include increase in nutrient use efficiency, better yield and reduced soil pollution. Nano fertilizers can possibly enter the plant cells directly through the sieve-like cell wall structures. Nano fertilizers simply dissolve in solution and release the nutrients as soluble ions. Plants absorb the soluble nutrient ions as indiscriminately as they take in those from dissolved conventional fertilizers. Nano fertilizer had controlled release of agrochemicals, site targeted delivery, reduction in toxicity and enhanced nutrient utilization of delivered fertilizers [4]. These attributes of nanoparticles are due to their high surface area to volume ratio, high solubility and specific targeting due to small size, high mobility and low toxicity.

Nanofertilizer, Applications and Efficiency

Nano fertilizers are the important tools in agriculture to improve crop growth, yield and quality parameters with increase nutrient use efficiency, reducing wastage of fertilizers and cost of cultivation. Nano-fertilizers are very effective for precise nutrient management in precision agriculture with matching the crop growth stage for nutrient and may provide nutrient throughout the crop growth period. Nano-fertilizers increase crop growth up to optimum concentrations. Nano-fertilizers provide more surface area for different metabolic reactions in the plant which increase rate of photosynthesis and produce more dry matter and yield of the crop. It is also prevent plant from different biotic and abiotic stress [5].

Manjunatha studied the applications of nano fertilisers with the growing limitation in arable land and water resources the development of agriculture sector is only possible by increasing resources use efficiency with the minimum damage to agro ecology through effective use of modern technologies. Among these, nano technology has the potential to revolutionize agricultural systems, biomedicine, environmental engineering, safety and security, water resources, energy conversion, and numerous other areas [6,7]. In the management aspects, efforts are made to increase the efficiency of applied fertilizer with the help of nano clays and zeolites and restoration of soil fertility by releasing fixed nutrients. In the controlled environment agriculture and precision farming input requirement of crops are diagnosed based on needs and required quantities are delivered in right time at right place with the help of nano biosensor and satellite system. Nano herbicides are being developed to address the problems in perennial weed management and exhausting weed seed bank [8]. Nano structured formulation through mechanisms such as targeted delivery or slow/ controlled release mechanisms and conditional release, could release their active ingredients in response to environmental triggers and biological demands more precisely. The use of nano fertilizers causes an increase in nutrient use efficiency, reduces soil toxicity, minimizes the potential negative effects associated with over dosage and reduces the frequency of the application. Hence, nanotechnology has a high potential for achieving sustainable agriculture, especially in developing countries.

Excessive use of fertilizers, pesticides and insecticides also caused several health issues in population. Despite these problems there is also challenge to feed the growing population of country. Therefore in future, there is need to produce nutritive agricultural produce rich in protein and other essential nutrient required to the human and animal consumption that is why emphasis should be laid on production of high quality food with required quantity of nutrients and proteins. For solving these problems in crop production Nano-fertilizers, pesticides may be the effective tools in agriculture for better pest and nutrient management [9].

Risk Assessment

Risk assessment Risk assessment of agricultural chemical impact on human health is not an easy process because of the great variety of substances employed, mixtures used in the field, differences in exposure dose, and geographic as well as meteorological characteristics of the agricultural areas where agro chemicals are applied [10]. The hazard identification of nano-formulations needs to focus on the active ingredient concentration properties and the nano-component. A review of the body of literature on potential environmental and health hazards of NPs points out the challenge of interpretation for the purpose of hazard identification (Krug). If the nano-component simply protects the active ingredient from degradation, then the fate and behavior of the nano-component may be the same as in conventional pesticide formulation. In the case of pristine, inorganic, engineered NPs directly employed as biologically effective fertilizers, pesticides, or in the soil or water remediation, the hazardous behavior should be carefully viewed in a life-cycle perspective in the environment from the introduction into application fields up to the disposal of working residues [11]. Intentional and enhanced input of nanomaterials into agricultural ecosystems poses a number of questions regarding the environmental fate and transportation of these materials into the environment that still have to be answered. This seems an even more urgent issue to face considering the large number of nano formulations potentially employed in the agricultural practice as well as the uncertainties concerning possible interactions with variable environmental factors. These may include the still unknown influence of naturally occurring ultrafine particles on the fate of agrochemicals; the uncertainties concerning the alterations caused by aging, soil, and water features; as well as those induced by the diverse work procedures adopted together with the difficulties in quantifying all these variables into an adequate risk assessment process. However, these aspects should be taken into careful consideration because they may affect the physico-chemical characterization of nanomaterials, changing their toxicological profile and thus occupational risks.

Conclusion

Nano fertilizers mainly delay the release of the nutrients and extend the fertilizer effect period. Obviously, there is an opportunity for nanotechnology to have a significant influence

on energy, the economy and the environment, by improving fertilizers. Hence, nanotechnology has a high potential for achieving sustainable agriculture. Nano-fertilizers have opened up new opportunities to improve inputs use efficiency, minimize costs and environmental deterioration in some aspects. Therefore, the scope for application of nano fertilizers in agricultural system needs to be prioritized in 21st century to accelerate the productivity of crops and sustain soil health and environmental quality through promoting use of nanoparticles in fertilizers and nano-sensors in soil microbial activity.

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