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Nanotechnology: An alternative for chemical fertilizers

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Across the world, a heavenly use of chemical fertilizer is major environmental issue in agricultural fields for sustainable growth of plants. Hence, the chemical fertilizers show adverse environmental effects in human life along with degrade the quality of soil fertility and polluting the water. So there is a need to develop an alternative approach to minimize the high consumption of chemical fertilizers. Now nanotechnology is an alternate approach, touching nearly all aspect of modern life of human welfare as well as plants growth. In the various fields of sciences, nanotechnology based devices are frequently used for the sustainable development of agriculture, clinical medicine, environmental cleaning, food processing, targeted drug delivery and enhancer of plant growth with safe and successful by different ways. However, use of nanotechnology in agriculture field especially for plant protection and production, is an under-explored area in the research community. The appropriate elucidation of physio-chemical, biological and molecular mechanistic approach of nanoparticles in plant leads to better growth in plant with safe and eco-friendly agriculture. Conventional fertilizers are generally applied on the crops by either spraying or broadcasting. However, one of the major factors that decide the mode of application is the final concentration of the fertilizers reaching to the plant. In practical scenario, very less concentration (much below to minimum desired concentration) reaches to the targeted site due to leaching of chemicals, drift, runoff, evaporation, hydrolysis by soil moisture and photolytic and microbial degradation. It has been estimated that around 40–70 per cent of nitrogen, 80–90 per cent of phosphorus, and 50–90 per cent of potassium content of applied fertilizers are lost in the environment and could notreach the plant which causes sustainable and economic losses. These problems have initiated repeated use of fertilizer and pesticide which adversely affects the inherent nutrient balance of the soil. According to an estimate by International Fertilizer Industry Association, world fertilizer consumption sharply rebounded in 2009–2010 and 2010–2011 with growth rates of 5–6 per cent in both campaigns. World demand is projected to reach 192.8 Mt by 2016–2017. But the large-scale use of chemicals as fertilizers and pesticides has resulted in environmental pollution affecting normal flora and fauna. Reported that excess use of fertilizers and pesticide increases pathogen and pest resistance, reduces soil micro-flora, diminishes nitrogen fixation, contributes to bioaccumulation of pesticides and destroys habit at for birds. Hence, it is very important to optimize the use of chemical fertilization to fulfill the crop nutrient requirements and to minimize the risk of environmental pollution. Accordingly, it can be favourable that other methods of fertilization be also tested and used to provide necessary nutrients for plant growth and yield production, while keeping the soil structure in good shape and the environment clean.

Nanotechnology has provided the feasibility of exploring nano-scale or nano-structured materials as fertilizer carrier or controlled-release vectors for building of the so-called smart fertilizers as new facilities to enhance the nutrient use efficiency and reduce the cost of environmental pollution. Anano-fertilizer refers to a product in nanometer regime that delivers nutrients tocrops. Nanoparticles (NPs) are commonly accepted as materials with at least two dimensions between 1-100 nm. For example, encapsulation inside nanomaterials coated

with a thin protective polymer film or in the form of particles or emulsions of nanoscale dimensions. Surface coatings of nanomaterials on fertilizer particles holdthe material more strongly due to higher surface tension than the convention alsurfaces and thus, help in controlled release. Delivery of agrochemical substance such as fertilizer supplying macro and micronutrients tothe plants is an important aspect of application of nanotechnology in agriculture. Nano-fertilizers show controlled release of agrochemicals, site targeted delivery, reduction in toxicity, and enhanced nutrient utilization of delivered fertilizers. 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. Nanotechnology has immense potentials in agricultural uprising, high reactivity, better bioavailability, bioactivity and the surface effects of NPs. NPs can be used as growth promoters, nanopesticides and nanoherbicides, nanofertilizers.

Without any doubt, nanotechnology is an evolutionary science and has introduced many novel applications in the field of science. Nanotechnology has the potential to increase food quality, global food production, plant protection, detection of plant and animal diseases, monitoring of plant growth and reduce waste for "sustainable amplification". The aim of the use of nanomaterials (NMs) in the field of agriculture is to improve the efficiency and sustainability of agricultural practices by putting less input and generating less waste than conventional products and approaches. Therefore, it is essential to understand plant nanoparticles interaction and optimization of size and concentration of NPs before practical applications in the fields so that their possible negative impact can be reduced on natural environment and crops as well. Thus, an extensive research on nanomaterials could help in the reduction of the adverse effects in both of agricultural development and of environmental systems.

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