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Use of Nanotechnology in Agriculture

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Nanotechnology is one of the fastest developing fields with potential to revolutionize industries such as pharmaceuticals, electronics, military manufacturing, and agriculture. Direct applications of nanotechnology in agriculture, the engineered nanomaterials that are used in commercial products and industries (non-agricultural) may also affect agriculture indirectly available on the interactions between nanomaterials. Many nano-based products are already in the market with or without proper labeling. Not much information is and biological systems. Therefore, understanding the impact of nanomaterials and related technologies on soil and plant health is very important. The present review focuses on the application of nanotechnology in agriculture and its possible impact on plant growth and soil micro flora. It emphasizes on more research to study the impact of nanotechnology on agriculture and develop regulatory protocols for safe production, use and release of nonomaterial's to minimize environmental nanotoxicity.

Key Words: Nanotechnology, Agriculture, Soil microorganisms, Nano toxicity.

Introduction

Nanotechnology, another upcoming discipline has revolutionary applications in pharmaceuticals, electronics, military, manufacturing, and other life sciences. Nanotechnology is the understanding and manipulating matter at scales measurable in nanometers (1-100 nm) at least in one direction (NNI 2007). At nanoscale, the surface area of the particles is very large relative to their small size, which can make them very reactive. Due to the very small size and high reactivity, the fundamental properties of the matter at nano-scale may differ from that of corresponding bulk material. These novel properties may help in the development of revolutionary technologies having application in different fields. For example, carbon in the form of graphite is relatively soft but nano form of carbon nanotubes (made of carbon atoms) is 117 times stronger than steel and 30 times stronger than kevlar (Chang et al. 2010). Thermal behavior of nanoscale materials may also differ from bulk materials (Pivkina *et al.*, 2004). Aluminum in its bulk form does not burn, however, aluminum nanoparticles combusts rapidly and are used as propellant in rocket fuel. Precise use of such novelmaterials can lead to enormous economic and societal benefits. Thousands of nanotechnology based products are already in the market in the form of medicines, cosmetics, food packaging, formulations, electronics etc. The nanomaterials entering water and soil ecological systems might affect soil and plant health and/or might be bio-accumulated through the food chain and finally accumulated in higher-level organisms. Although soil is a rich source of natural nanoparticles, little is known about the impact of engineered nanoparticles (ENPs) on food crops.

Application of Nanotechnology in Agriculture

Nanobiosensors for agricultural applications

The work on the development of nanotechnology-based biosensors to monitor soil health, plant growth, and disease onset is in progress. Biosensors have a biological component that reacts to changes in surrounding environment, and then produce a signal in a linked transducer, that can be further processed to generate data. Compared to the conventional methods, biosensors are more sensitive and specific and can give real-time analysis in complex mixtures in very less time. These biosensors can be linked with GPS system and connected to a computer for real-time monitoring. Use of these biosensors in agriculture, can be very useful in precision farming where productivity can be optimized by judging the soil and plant health and nutritional status before the appearance of visible symptoms of any deficiency or disease and providing the required inputs and conditions, in a timely manner with precision (Day 2005, Joseph and Morission M. 2006). The large surface area and electro-catalytic activity of carbon nanotubes increase the sensitivity and stability of electrode. However, such biosensors using inhibition of acetylcholine esterase (AChE) for the detection of OP compounds are not specific, and are more indirect and slow. A preferred direct biosensing route for detecting OP compounds involves the biocatalytic activity of organophosphorus hydrolase (OPH) as described by Deo et al (2005).

Nanosensors for detection of food pathogens

Nanobiosensors are being used in the packaging material to detect microbiological and biochemical changes in food items, indicating food spoilage. Chip-based micro-arrays, Quantum dots and magnetic nanoparticles have been developed for rapid detection of biological pathogens like *E. coli, Salmonella; Staphylococcus* etc. in food. Nanobiosensors can also be designed to detect presence of pesticides and possibly genetically modified crops within the food system.

Control of pests and weeds using nano-based

The use of nanocapsulated herbicides for the control of parasitic weeds also reduces the ecotoxicity of herbicides. Surface modified hydrophobic nanosilica has been successfully used to controlrange of agricultural insect pests (Barik *et al*. 2008, Rahman *et al.* 2009). Photosensitiveagrochemicals can be encapsulated in porous hollow silica nanoparticles (PHSN), with a shell thickness of nearly 15 nm and a pore diameter of 4–5 nm, which provide shielding protection from degradation by UV light. Use of nanoparticles in bioremediation Nanotechnology can also play important role in pollution sensing and remediation of contaminated agricultural lands, groundwater and drinking water by exploiting novel properties of nanomaterials. Nanosensors are capable of detecting microbes, moisture content and chemical pollutants at very minute levels. Photocatalysis using metal oxide semiconductor nanostructures can degrade organic pesticides and industrial pollutants into harmless and often useful components (Baruah and Dutta, 2009). This technology can help in the remediation of contaminated agricultural lands and water bodies. Efficiency of the nanoscale iron particles have been demonstrated for transformation and detoxification of a wide variety of common environmental contaminants, such as chlorinated organic solvents, organochlorine pesticides, and polychlorinated biphenyls (PCBs) Lanthanum nanoparticles can absorb phosphates in aqueous environments. Application of these nanoparticles in water bodies can absorb available phosphates thus preventing the algal growth (Joseph and Morrison, 2006). Nanofiltration (NF) has been shown to be an effective way of removing organic micropollutants from drinking water due to its size exclusion properties.

Use of nanoparticles in bioremediation

Nanotechnology can also play important role in pollution sensing andremediation of contaminated agricultural lands, groundwater and drinking waterby exploiting novel properties of nanomaterials. Nanosensors are capable ofdetecting microbes, moisture content and chemical pollutants at very minutelevels. Photocatalysis using metal oxide semiconductor nanostructures cadegrade organic pesticides and industrial pollutants into harmless and often useful components. This technology can help in theremediation of contaminated agricultural lands and water bodies. Efficiency ofthe nanoscale iron particles have been demonstrated for transformation anddetoxification of a wide variety of common environmental contaminants, such aschlorinated organic solvents, organochlorine pesticides, and polychlorinatedbiphenyls (PCBs). Lanthanum nanoparticles can absorbphosphates in aqueous environments. Application of these nanoparticles in waterbodies can absorb available phosphates thus preventing the algal growth. Nanofiltration (NF) has been shown to be an effective wayof removing organic micropollutants from drinking water due to its sizeexclusion properties.

Future Prospective

Agriculture must be taken as an ecosystem method, where abiotic–biotic-living beings live in accord with a co-ordinated stability of food chains and their related energy balances. New technologies, modernization, increased Sustainable in use of nano-chemicals, specialization and government policies are adapted to maximize the production in agriculture. To overcome the situation, it is mandatory to establish the recent technology in the food industry. Therefore, the new and future technology is nanotechnology thatpossesses very unique property in food supply chain (from the field to table: crop production, use of agro-chemicals such as nanofertilizers, nanopesticides, nanoherbicides, etc., precision farming techniques, intelligent feed, enhancement of food texture and quality, and bioavailability/nutrient values, packaging and labeling, etc.) round the world agricultural sector. Some focused areas may need more attention in near future researches in the field of agricultural nanotechnology or nanofoods.

Conclusion

Agriculture which is the only provider of human’s food that should produce from transitional and final inputs with well-known technologies. Thus, it is necessary to take a modern knowledge in agriculture. In spite of being relative advantages in agriculture process, still developing countries are suffering from lack of high importance of food products. Despite a lot of information about individual nanomaterials are available, but toxicity level of many NPs is still indefinable, thus the application of these materials is limited due to the lack of knowledge of risk assessments and effects on human health. Development of comprehensive database and alarm system, as well as international cooperation for regulation and legislation are necessary for exploitation of this technology.

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