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NANOTECHNOLOGY IN AGRICULTURE

Popular Article

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ABSTRACT

Nanotechnology is the engineering of functional systems at the molecular scale, deals with particles sizes between 1 and 100 nanometer at least one dimension. Nanomaterial can create from bottom up or top down approaches using physical, chemical and biological mode of synthesis. Intentionally created nanoparticles are much useful to mitigate the chronic problem of moisture retention in arid soils and enhance crop production by increasing the availability of nutrients in rhizosphere.

Introduction

Nanotechnology is a novel and innovative science that attracts researchers and scientists from different disciplines, including physicists, chemists, engineers, and biologists across the globe. Owing to its high surface area to volume size ratio, exhibit significantly novel and improved physical, chemical, and biological properties, phenomena, and functions, which are used in various fields such as optical devices, catalytic, bactericidal, electronic, sensor technology, biological labeling, cosmetics, clothing and numerous consumer products, and treatment of some cancers. Nanobiotechnology may increase agriculture's potential to harvest feedstocks for industrial processes. Agro-Nano connects the dots in the industrial food chain and goes one step further down. With new nano-scale techniques of mixing and harnessing genes, genetically modified plants become atomically modified plants. Pesticides may be more precisely packaged to knock-out unwanted pests, and artificial flavorings and natural nutrients engineered to please the palate (Raliya *et al.*, 2013).

The essence of nanotechnology is the ability to work at the molecular level, atom by atom, to create large structures with fundamentally new molecular organization. The aim is to exploit these properties by gaining control of structures and devices at atomic, molecular, and supra-molecular levels and to learn to efficiently manufacture and use these devices.

Nano-structured material creation

Synthesis of nanoparticles involves a number of chemical, physical, aerosol and biological methods including chemical reduction in aqueous or non-aqueous solution, micro emulsion, template, sonochemical, microwaveassisted and fungal mediated biosynthesis of nanoparticles. In recent biological methods for nanoparticle synthesis is preferred over the physical and chemical owing to ecofriendly environment concern and reduced agglomeration.

Application in agriculture

Nanotechnology has the prospective to modernize the agricultural research and development with new tools for the molecular treatment of diseases, rapid disease detection, enhancing the ability of plants to absorb nutrients etc. Smart sensors and smart delivery systems will help the agricultural industry combat viruses and other crop pathogens. In the near future nano structured catalysts will be available which will increase the efficiency of pesticides and herbicides, allowing lower doses to be used. Nanotechnology will also protect the environment indirectly through the use of alternative (renewable) energy supplies, and filters or catalysts to reduce pollution and clean-up existing pollutants. Technology may address the challenges of growing demands for healthy and nutritionally balanced food. In the agricultural sector, nanotech research and development is likely to facilitate and frame the next stage of development of genetically modified crops, animal production inputs, chemical pesticides and precision farming techniques. While nano-chemical pesticides are already in use, other applications are still in their early stages, and it may be many years before they are commercialized. These applications are largely intended to address some of the limitations and challenges facing large-scale, chemical and capital intensive farming systems.

Nanotechnology is one of the most important tools in modern science yet only a few attempts have been made to apply these advances for increasing crop productivity. It is possible to develop microorganisms as bionanofactories for synthesis of agriculturally important particles.

Nanotechnology for moisture retention and nutrient mobilization

Organic polymers can play important role in ecosystems by accumulating biologically important elements and also by retaining soil moisture after aggregating soil particles. Extracellular polymeric substances (EPS) play an important role in cell aggregation, cell adhesion, and biofilm formation that subsequently protect cells from a hostile environment. Furthermore, certain polysaccharides from microbial sources are surface active, and thus attempts have been made to use them as metal chelaters, emulsifiers and flocculants in industrial and environmental fields/domain. Such use of microbial polysaccharides has infused renewed interest in its production and characteristics. Worldwide efforts are being done in this direction. As Zn is the structural component of phosphatases and phytase enzymes as well as polysaccharides, it can be hypothesized that application of nano–Zn may help more secretion of polysaccharides for better soil aggregation, higher moisture retention as well as phosphatases and phytase enzymes secretion, which may be involved in phosphorous mobilizing for plant nutrition from mainly unavailable organic sources.

Precision farming

Nanotechnology supports the application of information technologies applied to the management of commercial agriculture. Precision farming’s enabling technologies include satellite-positioning systems, geographic information systems, and remote sensing devices. By connecting global positioning systems with satellite imaging of fields, farm managers could remotely detect crop pests or evidence of drought. Information about these conditions would trigger an automatic adjustment of pesticide applications or irrigation levels. Dispersed throughout fields, a network of sensors would relay detailed data about crops and the soil.

Food processing

Nanotechnology may be used in agriculture and food production in the form of nanosensors for monitoring crop growth and pest control by early identification of animal or plant diseases. These nanosensors can help enhance production and improve food safety. The sensors function as external monitoring devices and do not end up in the food itself. Nanomaterials can also be introduced in or on the food itself. The effectiveness of pesticides may be improved if very small amounts are enclosed in hollow capsules with a diameter in the nanometer range which can be designed to open only when triggered by the presence of the pest to be controlled. Nanopesticide residues on the food and from animal feed and veterinary medicine may end up inside the stomach but what happens then is not clear.

Conclusion

It is necessary to create international standards for nanotechnology and in addition special international organizations in the area of nanotechnologies to reduce national differences in assessing of nanotechnologies and risk governance practices. Nanotechnology can pose significant risks to food production, food distribution and healthcare systems that are poorly understood that are particularly important to a small country that can ill afford to mount the research effort required to manage the risks that are likely to emerge with the accelerating global development of nanotechnology. For these purposes it is necessary to create the research infrastructure for toxicology and risk assessment.

References

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