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Scope of Nanoscience and Nanotechnology in Agriculture

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Nanotechnology is the engineering of functional systems at the molecular scale, deals with particles sizes between 1 and 100 nanometer at least one dimension. Particle size reduced to nanometer length scale exhibit high surface area to volume size ratio thus showing unusual properties makes them enable for systematic applications in engineering, biomedical, agricultural and allied sectors. 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 the creation and utilization of materials, device, system, through the control of the properties and structure of the matter at the nanomatric scale. 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.

So far, the use of nanotechnology in agriculture has been mostly theoretical, but it has begun and will continue to have a significant effect in the main areas of the food industry: development of new functional materials, product development, and design of methods and instrumentation for food safety and bio-security. The effects on society as a whole will be dramatic. Nanotechnology can be used for combating the plant diseases either by controlled delivery of functional molecules or as diagnostic tool for disease detection.

Whenever a new technology has emerged, it has opened many vistas to be explored. The new nanotechnology with materials having unique properties than their macroscopic or bulk counter parts, has promised applications in various fields. 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, microwave assisted 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 may transform the entire food industry, changing the way food is produced, processed, packaged, transported, and consumed. 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.

However, creating a bio economy is a challenging and complex process involving the convergence of different branches of science. 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. These applications are largely intended to address some of the limitations and challenges facing large-scale, chemical and capital intensive farming systems.

Zinc, magnesium and Titanium are playing direct or indirect role in the photosynthesis process. The photosynthate leaches in the soil through plant root. In the rhizosphere, root exudation is a key process for carbon transfer into the soil, influencing the role of soil microbial communities in the decomposition of organic matter and in native nutrient cycling. Root exudates are the substances released by roots and may affect growth and activity of soil microorganisms in the rhizosphere.

Nanotechnology for Moisture Retention and Nutrient Mobilization

In the arid region where there is low water holding capacity of soil and low nutrient mobilization is a chronic problem. 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.

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.

Nano-Nutrient

Fertilizer play pivotal role in the agriculture production up to 35 to 40% of the productivity. To enhance nutrient use efficiency and overcome the chronic problem of eutrophication, nanofertilizer might be a best alternative. Attempts have been made to synthesize nanofertilizer particulary for zinc in order to regulate the release of nutrients depending on the requirements of the crops.

Precision Farming

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.

Conclusion

Nanotechnology will have large impact on rural development. Synthetic biology can revolutionize food production threatening traditional methods of agriculture. 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.

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