Journal of Survey in Fisheries Sciences
ISSN: 2368-7487 08(3) 494-496 2022

Utilizing Nanotechnology in Agriculture is a Subject of Research and has Garnered Significant Attention.

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ABSTRACT
As global population continues to grow, the adoption of modern technologies like bio and nanotechnologies in agricultural sciences becomes imperative. Nanotechnology, characterized by operations at a scale of 100 nm or less, holds numerous applications across food production, processing, storage, packaging, and transportation stages. Its integration is poised to transform pharmaceuticals, agriculture, and food industries through groundbreaking innovations, enhancing plant nutrient uptake efficiency with targeted approaches. Nanotechnology serves as a potent tool against environmental stressors, bolstering systems for processing, storage, packaging, as well as disease detection and control.

INTRODUCTION
Agriculture is the backbone of most of the developing countriesin which a major part of their income comes from the agriculture sector and more than half of the population 'Asia population is equivalent to 59.76% of the total world population'. In developing countries, a large part of thesechoices are faced by daily food shortages as a result of environmental impact or political instability, while in the developed world. Pest-resistant technology is strong in developing countries, it helps in maximum yield. The foodindustry is driven by the demand of consumers in developed countries which is fresh and healthy food.
Nanotechnology assists in science and reduces environmental pollution by producing nanoparticles and nanocapsules to enhance the efficiency of pesticides for pesticide application or by reducing the environmental pollution by producing more efficient and environmentally friendly and nano-crystals with the ability to control delayed absorption.
They can also be used to change the dynamic release profiles ofdrugs and to achieve a more sustainable release of drugs with the reduction required for frequent doses. Among the various diseases, the viral disease is the most difficult to control, because one has to stop the spread of this disease by vectors. These nano-based diagnostic kits not only speed up detection but also enhance detection power.
Nanotechnology will indirectly protect the environment by reducing pollution and cleaning up existing pollutants through the use of alternative power supplies and filters or catalysts..
There are new challenges in the sector, including healthy, safe food, growing disease risk, and growing demand for agricultural and fishery products from the changing climate. Creating a bio-economy is a complex and challenging process. It is connected with the transformation of different branches of science.
Application of Nanotechnology in different branches of Science
Nanotechnology is an interdisciplinary field that has penetrated a wide range of applied sciences such as chemists, physicists, biologists, physicians, doctors, and engineers. The overall range of nanomaterials is between 1 to 100 nm. For comparison, the wavelength of visible light is between 400 and 700 nm. The size of a bacterium 1000-10000 nm, protein 5-50 nm, deoxyribonucleic acid (DNA) ~ 2 nm (width), leukocytesis 10000 nm, and virus 75-100 nm. Nanotechnology considers viruses and other pathogen scale problems.
Nanotechnology and agriculture In the agricultural sector, nanotech research and development could potentially provide support and framework for the development of genetically modified crops, animal products, chemical pesticides, and precision agriculture. Although the useof nanotechnology in agriculture is largely theoretical, it has already begun and will continue to have a significant impact onkey food sectors. The development of new functional substances, the development of products, and the design ofmethods, food safety and bio-security are all related to theapplication of nanotechnology. The impact on society as a whole will be dramatic. Recent advances in chemistry and materials science have led to proficiency in nanoparticle technology, with a wide range of agricultural applications. One field, in particular, is the cotton industry where current techniques of spinning cotton have failed quite well. More than 25% of the cotton fiber is scraped or damaged from the time the cotton is picked up until the fabric is finished. Nanoscience research on agriculture and food science.

The Contributions of nanoscience research in agriculture in the following fields
1. Food security and bio-security

Food processing and product development
Material Science
Food Packaging

Nanoparticles control plant diseases
Some of the nanoparticles that have entered the field of plant disease control are nanoforms of carbon, silver, silica, and alumina-silicates.

Nanosilver
Nanosilver is the most studied and nanoparticle for bio- systems. It has long been known for its strong barrier and bactericidal effects, as well as a broad spectrum of antimicrobial activities.
Silver nanoparticles, which have a higher surface area and a higher fraction of surface atoms, have higher antimicrobial effects than bulk silver. The antifungal efficacy of the solution of colloidal nanosilver (1.5 nm average diameter) is due to the weight of the spermatheca pannosa in the powdery mildew. It isa very widespread and common disease in both greenhouse andoutdoor-derived roses. It reduces leaf distortion, leaf curling, early defoliation, and flowering. The double capsule nanosilver was created by the chemical reaction of the silver ion using a physical method, reducing agents and stabilizers.It is extremely stable in aqueous solution and spread very well. This creates a barrier for unwanted microorganisms in the soil and planting hydroponics systems. It is being used as a spray tostop fungus, mold, rot and several other plant diseases.

Titanium dioxide (TiO2) nanoparticles
Titanium dioxide (TiO_2) exhibits good photocatalytic properties, for which it is used in a combination of antiseptic and antibacterial. It is reducing organic contaminants and germs. It is used in the printing ink, self-cleaning ceramics, and glass, coatings, etc. It is used in making cosmetic products like sunscreen cream, whitening cream, morning and night cream, etc. Titanium dioxide is a very strong disinfectant compared to chlorine and ozone. TIO2 is not harmful, for this reason, it is approved for use in food products up to 1% of the final weight. The TIO2 photocatalyst technique has great potential, includingplant protection in various agricultural applications because it does not produce toxic and hazardous compounds and it achieves great pathogen disinfection skills. Scientists are trying to improve the phytopathogenic disinfection skills of TI2 thin films by dye doping and other appropriate methods.

Nano-alumino-silicate
Leading chemical companies are now developing efficient nanoscale pesticides. One such example is the use of alumino-silicate nanotubes with active ingredients. Alumino-silicate nanotubes are sprayed on the surface of the plant and insects are destroyed. Silica nanoparticles have shown that Mesopotamian silica nanoparticles can supply DNA andchemicals to plants, creating a powerful new tool for deliveringtargets to plant cells.

Carbon nanomaterials
'Among the various engineered nanomaterials, carbon-based nanomaterials (such as single-walled carbon nanotubes (SWCNTs), multi-walled carbon nanotubes (MWCNTs), buckyballs, graphene, etc.), occupy a prominent position in various nano-biotechnology applications'. Increased use andexposure to carbon nanomaterials can cause environmental concerns. Thus, it is extremely important to regularly study the effects of plant carbon nanomaterials occupying a major component of the food chain.

Magnetic Nanoparticles
The range of magnetic nanoparticles has been widely used in biomedicine to provide drug site-targets for the treatment of various diseases. However, in plant biology, this kind of application is still in its emerging stage. Magnetic-based nanomaterials can be used in the site-target delivery of systemic plant protection chemicals to treat diseases that only affect specific areas of the plant. Diseases can be easily diagnosed if the trachea of internal magnetic nanomaterials can be tracked by external magnets. The advantage of using carbon-based nanomaterials (such as SWCNT and MWCNT) with magnetic nanoparticles is that the interior space allows them to replenish suitable plant protection chemicals, and functional magnetic nanoparticles allow nanoparticles insideplant systems.
Nanotechnology provides new ways to improve and refineexisting crop management strategies
The plant is protected by chemical sprays. Plant nutrition is protected by the application of nanotechnology. Only nominal concentrations of chemicals are required for spraying due to problems such as chemical opening, photolysis, hydrolysis, andmicrobial corrosion damage. The effective concentration reaches the target of the crop. The need to detect plant diseases at an early stage to protect tons of food from potential outbreaks has led nanotechnologists to look for nano solutions for food and agriculture from bacteria, fungi, and viral agents. An identification technique that takes less time and can yield results in a matter of hours, is simple, portable, and accurate and does not require any complicated

techniques. If an autonomous nano-sensor connected to a GPS for real-time monitoring could be distributed across the field for soil conditions and crop monitoring, it would be very helpful.

Plant Pathogens in Biosynthesis of Nanoparticles

Research on nano science and nanotechnology mainly involves the preparation and use of nanoparticles of various components and compounds. Nanoparticles are also being used as antimicrobial agents to control plant diseases. The formation of nanoparticles can be achieved via several processes which may be either physical or chemical

Fungi

Fungi are relatively recent in their use in the synthesis of nanoparticles. However, fungi being eukaryotes are lessamenable to genetic manipulation compared to prokaryotes.Due to the smooth flow processing, fungi have changed from bacteria to be used as natural 'nano factories'.

Therefore, any alteration of fungi at the genetic level for the synthesis of more nanoparticles would not be so easy. It is important to know the process of synthesis of nanoparticles in microbial systems to get better control over the size, shape, andother desirable properties of the synthesized nanomaterials. Bacteria: Among microbes, prokaryotes have received the mostattention for the biosynthesis of nanoparticles (Mandal *et al*., 2006).

Bacteria

Bacteria are mostly used to biosynthesize silver, gold, Fes, and magnetite nanoparticles and quantum dots of cadmium sulfide (CdS), zinc sulfide (ZnS) and lead sulfide (PbS).

Plant virus

Plant viruses especially spherical/icosahedra viruses represent the examples of naturally occurring nanomaterials or nanoparticles. The smallest plant viruses known to date is satellite tobacco necrosis virus measuring only 18 nm in diameter Plant viruses are made up of single or double-strandedRNA / DNA as a genome that is covered by a protein coat. The protein coat/shell is structurally and functionally present as a container carrying the nucleic acid molecule from one host to another as cargo. Their ability to infect the nucleic acid genomeat a specific site on the host cell, replicate, package the nucleic acid, and exit the host cell properly. They need to be used in nanotechnology in an orderly manner. A complete review of the use of plant viruses as nanometers and bio-templates for their application was recently completed by Young *et al*.

CONCLUSIONS

Nanoscale science is simply known as nanotechnology. Nanotechnology has invented new materials and structures as the basis of solutions. The goal of nanotechnology is to improve human health, optimize readily available energy and water resources, support a vibrant economy, improve living standards, and enhance security

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