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Nanotechnology and Biological Application

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ABSTRACT

Nanotechnology is a very modern technology, which is used by other technologies, which use nanomaterial in sizes ranging from 1-100 nm. Shown positive effects in broad areas of science such as medicine, engineering, agriculture and food. Nanoparticles have unique properties, which are incorporated into antimicrobial agents, electronic components, medical devices, pharmaceuticals and other fields. Also, the small size of nanoparticles improved their chemical properties. Nanotechnology technology plays an important role in increasing production and improving the quality of food produced by farmers. Many believe that this new technology will serve to secure the world's growing food needs. Nanotechnology has proven its place in agricultural sciences and related industries as a multidisciplinary and problem-solving technique. Nanotechnology is a promising method in the control of various plant diseases. The nanomaterial is have been used as biomarkers to detect pathogens, fungus, bacteria and parasites, as well as to benefit from nanotechnology in improving the properties and properties of many biocontrol agents such as fungal and bacterial preparations and their secondary insect pathogens As well as preparations used to combat various plant pathogens.

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INTRODUCTION

Nanotechnology is a science that is interested in studying materials on atomic and molecular scale 9ˉ 10 meters. Nanotechnology deals with dimensions of 1-100 nanometers. This science is not specialized in the science of biology, but is concerned with the properties of materials and is dependent on a pool of materials properties at the nanoscale. Nanoparticles show different materials when they have their conventional dimensions of more than 100 nanometers (Ghorbani *et al.,* 2011). Some materials may show a change in the surface area and the degree of extinction or melting. This opens up room for study, use and harness for human use when applied to other biological and industrial sciences (Musante, 2011).

It is worth mentioning that Nanoparticles are derived from Latin, since the Nano section, means Dwarf. Particulum means particles in the sense of dwarf particles (Raab *et al.,* 2011). Both Hosseini and Eghtedari, 2012, noted that the global source of nanoparticle production reached 103 tonnes in 2004, which is a continuous annual increase and can play an essential role in the economic development of developing countries in agriculture. It is also considered a large field in the 21st century, which has had a significant impact on the world economy and is a science with enormous potential works to improve the quality of life through its application in various fields such as agriculture and food. Agriculture occupies the second place in the list of the use of nanotechnology after the storage of energy and uses nanoparticles in Chemical and biochemical analyzes in medical diagnosis, for example, RNA, DNA, proteins and blood pressure tests (Bhushan, 2010).

Nanotechnology plays a vital role in increasing production and improving the quality of food produced by farmers. Many believe that this new technology will serve to secure the world's growing food needs. Nanotechnology has proven its position in agricultural sciences and related industries as a multi-disciplinary and problem-solving technology (Mousavi and Rezaei, 2011). It is also a tool to solve the challenges facing farmers in managing existing crop techniques by obtaining high-yield crops while minimizing the use of synthetic chemicals (Kumar 2013 Prasad *et al.,* 2014).

The use of agricultural chemicals on the plant through spraying, addition of soil and low concentrations on the plant does not achieve a simple purpose and does not achieve the desired goal and reach the target location of the crop because of the infiltration of chemicals and disintegration by photolysis and degradation by microorganisms in the soil and the repeated application of these chemicals is necessary to get the result Required to achieve negative impacts on water and soil pollution (Gutiérrez *et al.,* 2012).

Nair et al., (2010) show that nanomaterials possess all the necessary properties for use in agriculture such as effective concentration with high solubility, stability and good efficacy as well as control of release time in response to specific stimuli. It is also less toxic and safe and is used in small quantities and avoids repeat application of the plant. moreover, give the good result in the first application

In a study by Lee et al., (2010) when using aluminum nanoparticles (n Al2O3) with Arabidopsis thaliana L., these nanoparticles showed a positive effect on the growth and development of seed germination, root elongation and a number of leaves when using three concentrations (400), 2000, 4000 mg. L -1) by the Use of aluminum nanoparticles. Nanotechnology also has the potential to make a revolution in the agro-food industry as a technology that can enhance the ability of the plant to absorb nutrients quickly, and other intelligent sensors that are used against viruses and treat pathogens of other crops (Joseph and Morrison, 2006; Thul *et al.,* 2013).

Classification of Nanomaterials

Nanomaterials can be divided into two main groups

Organic nanomaterials: which is the nanomaterials that have Carbon in their structure and is subdivided into two groups (Ghorbani *et al.,* 2011)

Biodegradable Organic nanomaterials, it includes

- Lipid nanoparticles like fats, waxes, phospholipids.
- polymers nanoparticles which divide to

Natural polymers like gelatin, chitosan

Synthetic polymers like polyglutamine

Non-biodegradable organic nanomaterials like

- polyethene glycol
- carbon nanotube

Inorganic nanomaterials: it divides into two groups

- Inorganic biodegradable materials like iron oxide, zinc oxide
- Inorganic non-biodegradable materials. It includes nanoparticles like gold, silver, silica, copper

Nanomaterials properties

The unique properties of nanomaterials lie in their nanomaterials, as materials at the nanoscale acquire new physical, chemical, and biological properties that did not even exist in the parent material from which they originated. There is an inverse relationship between the size of the material and its effective surface area. The increases in the effective surface area of the nanoparticles and the surface area increases stimulate strong reactions and thus increases the number of atoms on the surface (Bhushan, 2010). It is known that the surface atoms of any material are responsible for the chemical reaction with the other atoms because they possess electrons that are not constricted while the electrons within the material are constrained and thus not involved in the chemical reaction and the properties of nanomaterials

Mechanical properties: The hardness values of metal materials and their alloys are increased as well as their strength to cope with the stresses of different loads by reducing the size of the granules of the material and controlling the order of their atoms.

Melting point: The values of the melting temperatures of the material are affected by minimizing the dimensions of their granular measurements. The scientists justify the reason for the decline in the values of the melting point of the material and the decrease in the size of its granules to the increase in its external surfaces and the difference in the positions and arrangement of the atoms (Ghorbani *et al.,* 2011).

Optical properties: The optical properties of nanomaterials differ from those of large non-nanomaterials. The effect of particle size extends on the dispersion or refraction of the surface of the material. For example, the colour known as pure gold grains, which is more than 200 nanometers in diameter, is the golden yellow colour. Granules while when it became less than 20 nm (Bhushan, 2010). They are colourless and transparent. As granules size decrease, the granules appear in different colours, from the orange to the red, according to the dimensions of their diameter.

Electrical properties: Minimizing the volume of materials to the nanostructure increases their electrical properties, such as their high power conductivity. Non-conductive materials become conductors of electricity when they convert to nanomaterials (Gutiérrez *et al.,* 2012).

Biological properties: The biological properties of the material increase when they become nanoparticles. The gold and silver nanoparticles are characterized by unique biological properties in influencing many pathogens and insects as well as their importance on the medical side.

The mechanical action of nanoparticles

It is evident through biological studies and research that the mechanism of action of nanoparticles in the negative and positive effect varies according to the living organisms in which the nanoparticle is added and the particle size of the latter.

Varner (2010) reported that antimicrobial activity stimulates the action of nanoparticles as antimicrobials and parasites. For example, its anti-bacterial activity is caused by the rapid effect of silver ions that inhibit the enzymatic activity as it reacts with the basic SH (thiol) group

It also It inhibited the production of bacterial DNA (DNA), the the the breakdown of cytoplasmic, energy consumption and increased free-radical production (Naghsh *et al.,* 2012). Thus, bacteria lose their cell units and that lead to their death (Salam *et al.,* 2012).

As for their effect on fungi, nanoparticles have an antifungal effect, altering the structure and function of the cell membrane and inhibiting protein without ATP (Safavi *et al.,* 2012). It is effect on viruses, which is a pathogen, affecting and multiplying only when it is alive in animals and plants. The mechanism of action of nanoparticles is summarized in effect on viruses, explained by Mehrbod et al., (2009); Klippstein and others (2010) have shown that viruses possess two double strips of DNA and a protein-encoded RNA bar called the capsule. Viruses are characterized by their outer shell and are composed of proteins and fats. The protein capsule of viruses is associated with specific receptors of the host cell surface. This attachment can stimulate the protein capsule to cause changes Which results in fusion of the cellular and viral membrane and may lead to an infection of this, the role of silver nanoparticles is linked to protein capsule and prevent the occurrence of fusion and inhibition of the virus by linking with glycoprotein (gp120).

Applied fields of nanotechnology

Improving vegetative and plant growth characteristics

The nanoparticles are currently used to replace agricultural chemicals, not only to remove unwanted microorganisms in the soil when used with irrigation water, or to remove fungi, mould and other plant diseases, but also to stimulate plant growth, (Abdi, 2012). Some studies have shown that the use of silver nanoparticles has helped increase germination rates, seedling growth, stimulation of water absorption and fertilizer by roots, and increasing the activity of anti-oxidation enzymes like superoxide, catalase. This effect is not limited to silver nanoparticles only, but Nanocrystals, iron, zinc and aluminum also have positive effects on plant growth (Morteza *et al.,* 2013).

A study of Lilium Asiatic L. by Vinodh et al., (2013) showed that plant treatment with nanoparticles and concentrations (25,50, 75 mg, L-1) gave an ex-tension of flower life of 17.8 days compared to thecomparison treatment (8.3) Days) and worked to reduce the transpiration and increase in the abilityof the plant to retain water and reduce the water deficit of the plant. In another study to observe the effect of different concentrations of silvery nano- particles (0,20,40,60,80 mg / l-1) on the pelargo- nium zonale L., it was found that the peroxidase and catalase enzymes in the plant showed each of them a different effect from the other by different concentrations of Used nano, as peroxidase achieved the highest and most effective concentra-tion of 60 mg. L-1, but catalase has achieved a clear effect when using 20 and 40 mg. L -1 of silver na- noparticle and, in general, different concentrations of nanoparticles have improved the plant's defence enzymes (Hatami and Ghorbanpour, 2013).

In a study conducted by Aghajani et al., (2013) on Thymus kotschyanus L., it was found that the use of nanoparticles with concentrations (40,2060, 100.80 mg, L-1) in addition to the comparison treatment for its effect on the growth, productivity and plant content of oil, silver nanoparticles showed positive effects in the plant growth stages and the amount of secondary compounds and also increased the plant content of the main oil and the content of seeds of α-terpinyl acetate. A study on Valeriana officinalis L. showed that the use of silver nanoparticles and different concentrations significantly affects the removal of bacterial contaminants well when tissue culture is carried out without detrimental effect on plant growth. It is more suitable and less toxic than antibiotics when applied to tissue culture (Abdi, 2012).

Beni et al., (2013) used silver nanoparticles on L. Polianthes tuberosa, an important commercial plant with a short floral period, which found that nanoparticles increased water uptake and plant protein content and reduced lipid oxidation compared to comparison treatments. In a study conducted by Hatami et al., (2014), the use of silver nanoparticles at 33-nanometer lengths prolonged the life of plant flowers and increased the amount of water absorbed by the plant compared to the comparison treatment. Silver Nanoparticles also had a significant effect in clearing the plant from bacterial growths. In a study of the effect of silver nanoparticles on tobacco plant tobacco Nicotinia tabacum, the use of very low particles size of nano-silver 35 nm was used to remove bacterial contaminants from the plant medium (Safavi *et al.,* 2011).

The adverse effects of silver nanoparticles on the plant both Mazumdar and Ahmed (2011) indicated that treatment of L. Oryza sativa in silver nanoparticles with nano-nano-size 25 had an adverse effect on plant growth and included the effect on root growth and damage by entering nanoparticles into roots cells through the small openings in the cell wall thus caused damage to cells and cellular gaps.

Combating agricultural insects and parasites

Nano-pesticides are defined as any compound made up of nanometer-size components. The properties of this compound are related to this range of volumes. Nanocides are made up of active organic substances such as polymers and inorganic materials such as metal oxides in different forms of particles or molecules.

Types of Nanopesticides

Nanoemulsions: They are very fine emulsions of transparent colour with droplets ranging from 20 to 200 consisting of a fatty phase, aqueous phase and emulsifiers. The benefit of nano-chemical emulsions is to increase the solubility of low-soluble active substances and reduce the percentage of emulsifying agents as well as the reduction of potions used and the reduction of adverse effects on non-target organisms. Nanoparticles are also well stable in storage conditions with a temperature range (-10 To 55) (Musante, 2011). For example, the nano-emulsion of the Pelargonium graveolens extract was highly effective against the Phthorimaea operculella potato tuber moth, achieving the highest mortality rate of more than 80% with stability under field conditions compared with non-nano-extract (Abdi, 2012).

Nanosuspensions: Nanoparticles can be defines as nanoparticles ranging in size from 1 to 100 nanometers, which are used as aqueous solutions in the control of pests such as silver particles, silica and nanoparticles. In a study to assess the effect of nanoparticles for sulfate Cds, silver AgNPS and TiO2 against cotton leafworm, the concentration was 2400 ppm, achieved killing rates of 93, 56 and 73%, respectively, after 9 days, when The value of the lethal midpoint was reached 5050, 1403 and ppm respectively (Gutiérrez *et al.,* 2012).

Nanoencapsulation: Nanocapsules can be known as active substances within nanocapsules. These capsules are made from natural polymers such as ketosan and gelatin or manufactured polymers such as Polyethene Glycol (PAG) (Bhushan, 2010).

Nanoparticle forms: Nanospheres: Active substances collected by homogenously distributing polymeric fillings, such as the use of the glyceryl ester of fatty acids in the packaging of the active substance of carbaryl in the form of a nanoparticle known as nanosphere (Morteza *et al.,* 2013).

Nanocapsules: The accumulation of active substances is concentrated near the center and is coated with polymeric fillings, such as the use of polymer polyethylene glycol to encapsulate the active substance (garlic oil) and the active ingredient of the deltamethrin pesticide in the form of nanoparticles.

Nanogels: Water-loving polymers that absorb a large volume of water used in the preparation of a polymer from Lignin to encapsulate the active substance of the Aldicarb in the form of a nanoscale known as nano gel (Safavi *et al.,* 2011).

Micelles are compounds formed in water solutions by molecules consisting of two halves, one water-loving and the other water-averse. was used in the preparation of the polymer polyethylene glycol and Dimethylester in the packaging of the active substance of carbofuran. In the form of a compound known as micelles

Detection of pesticide residues

Studies and research have led to the development of new nanotechnology-based methods for detecting pesticide residues using nanobiosence, which are characterized by high speed and accuracy in detecting pesticide residues. Examples include:

Development of a nanoscale sensor that detects organophosphorus pesticides at a concentration of 5 ng. The method is based on the association of cholinesterase enzyme with a converted film of carbon nanotubes

The possibility of using cadmium nanoparticles in detecting residues of pesticide residue D 2,4 with the uptake of more than 250 ng.

Gold Nanoparticles of 30 nanometers had been found among the nanoscale sensors developed to detect organic chlorine residues with a sensitivity of up to 27 ng. This nanosensor is also an appropriate technique for detecting many toxins in food and environmental samples for its efficiency and speed. Detection of pesticide residues.

Pesticides Destruction

The use of nanoparticles in the destruction of chemical pesticides and their residues is one of the most promising applications. Studies have shown that pesticides such as Atrazine, Molenate and Chlorpyrifos are the most sensitive pesticides for iron nanoparticles (100 nm) (Abdi, 2012). The particles also showed efficiency in the destruction of the cyclodin group pesticides, which are resistant to various decomposition agents. It was also observed that the use of nanoparticles for 200 nm iron sulphate polymers helps break down the lindane pesticide, an organic chlorine pollutant for drinking water and food (Bhushan, 2010).

Control pathogenic of plants

Nanotechnology is one of the most promising methods in controlling various plant diseases. Nanomaterials have been used as biomarkers to detect pathogens, fungus, bacteria and parasites as well as their role in controlling various plant pathogens.

Some examples that can be mention are

- Use of silica nanoparticles in the detection of *Xanthomonas axonopodis* bacteria causing bacterial spot disease
- Use of Gold nanoparticles AuNPs in the detection of wheat diseases caused by *Tilletia indica*
- The use of silver nanoparticle at a concentration of 10 ppm was actually in the fight against the mildew disease caused by the fungus Sphaerotheca panrosa, which affects the flowering plants, including Rose in greenhouses (Safavi *et al.,* 2011). 95% of the infection was eliminated after two days of treatment as well as inhibiting the growth of fungi and germination for fungus *Rhizoctonia solani* and *Sclerotinia sclerotiorum*
- The use of zinc nanoparticles to prevent the growth and production of the of carrier *Candida* and conidia of fungi treated with Botrytis cinerea and *Penicillium expansum* when used at the concentration of 3mmol / L (Marhoon *et al.,* 2018).

Improving the properties of biological control agents

Several studies have indicated that nanotechnology can be used to improve the properties and characteristics of many biocontrol agents such as fungal and bacterial preparations and their secondary insecticide products as well as the preparations used to combat various plant pathogens. As can

- Protection of biological control agents such as bacterial and fungal preparations from the effects of ultraviolet radiation as well as protection from drought and lack of moisture
- Increase the capacity of preparations to withstand inappropriate storage conditions
- Maintain the stability of bacterial products of enzymes, inhibitors and antibiotics, which are promising biological control factors in pest control (Wathah, and Marhoon, 2018).
- The delivery of genetic material to the plant, such as DNA or the double strand of RNA, through RNA interference, one of the most promising technologies in pest control and plant improvement.

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