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Nano-Particles as Management Tool against the Plant Pathogens

Sonia Yaseen*

Department of Botany, University of Lucknow, Lucknow, India

***Corresponding author:** Sonia Yaseen, Department of Botany, University of Lucknow, Lucknow, India, E mail: soniayaseen518@gmail.com

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Abstract

Nanotechnology is the one of most important and fascinating technology. This technology is progressing rapidly in sciences. The only purpose of this technology is that it has a potential to make many discipline which belong to sciences to make them modernized. It has also potential to make other technologies modernize which belong to medicine and agriculture. There are some reasons such as due to some plant pests and many pathogens causes loss of crops which is 20-40% this 20-40% loss of crops are lost every year due to these plant pest and pathogen attacks. Some toxic pesticides which are predominantly depends on the existing plant disease management these plant disease management depends on these toxic pesticides are very harmful for human life and to the environment where they live. Nanoparticles are basically existing as metalloids, metallic oxides, nonmetals, and carbon nano materials, and as functionalized, dendrimers, liposomes. The use of them as a bactericides/fungicides and its Nanoparticle have made them enable the only reason of their enabling them is their small size, large surface area and its high reactivity this make them enable to use. There are different number of Nano particles. In which NPs of single element and carbon nanomaterials which are effecting many plant pathogen and diseases. Ag, Cu and Zn are the only which have received much more attention. Some NPs that act directly as antimicrobial/fungicidal agents, while some of them function as more in altering the host as a nutritional status that thus plays a role for activating the plant defense mechanisms. It has been reported that in past few decades this “Nano technology” has excessively grown in phytopathology very exponentially. Some Nanomaterials which are integrated into strategies which are involve in plant diseases management strategies and some diagnostics and as a molecular tool. These are used in disease diagnosis, pathogen detection, and residual analysis that may have become much more precise, and quick with the use of nanotechnology. Nanotechnology could sustainably can mitigate that can face, many challenges that are included in disease management which can be done by reducing chemical inputs, and by use of promoting rapid detection of pathogens. Thus it was observed from the study, that all the nanoparticles are of different concentration that can bring about significant change which is by, inhibition in the germination of the spores.

Keywords: Food production; Nanotechnology; Targeted distribution; Disease managing

Introduction

From bacteria, fungiform and virus-related, plant pathologists are motivated to advance a successful key for protecting food and agricultural goods. In future plant pathogen detection and disease management could play a significant role by nanotechnology. Grower-friendly practices that can be willingly operating for crop protection by Nano-particles. There are significant opportunities of nanoparticles that work more beneficial and treat the harmful effects of fungicides and herbicides when they are exposed. Inside the embattled pathogens, the environment friendly fungicide having killing properties is under improvement by using nanotechnology. It is crucial to control diseases of food crops. Many attempts have made to emphasize on overcoming lack of synthetic fungicides and developing harmless management methods having less effects on humans and animals. According to the global estimation plant pathogens causing reduction about 20 to 40% in crop production. Pesticides have many advantages like consistency and fast action, as well as destructive effects on non-target organisms and development of resistance. About 90% of pesticides lost during the exposure. Now a day’s development of ecofriendly and grower’s friendly pesticide is motivated. In medicine and pharmaceutical industries nanotechnology is significantly used but less use in agriculture. Nanotechnology is used in controlled use of agrochemicals, seed germination, Nano sensors and Nano barcoding. Material scientists have designed Nano particles with such characteristics (shape, pore size and surface properties) so they can be used as protectants like pesticide. A new generation of pesticides and management of plant disease will enhance as Nano technology develops in agriculture. Nano particles can protect the plants via two methods (i) by providing crop protection (ii) carrier of existing pesticides, and application can be done by spray, foliar tissue or roots. Nano particles are beneficial in such a way like enhanced shelf life, improved solubility of poorly water-soluble pesticides, reduced toxicity and boosting site specific uptake into the target pest. As protectants nanomaterials play a significant role in crop protection while decrease soil leaching and toxicity. The efficacy of pesticide will increase through nanostructured catalyst and also reduced the dose level required for crop plants. Strom drought and flood effect on agriculture environment that cause daily food shortage in developing countries. pests cause 25% in rice, 5-10% in wheat, 30% in pulses, 35% in oil seeds,20% in sugarcane and 50% in cotton For developing countries like India the crop yield can be maximized by developing drought and pest resistance crop [1,2].

The Nano-technology was first defined by, Taniguchi (1974) to the science that largely deals, with synthesis and application; of Nano size particles, (1-100 nm or 1.0× 10-9) of any material. The Nano particles (NPs), have a high surface, to volume ratio that increases, their reactivity, and possible, bio chemical activity.

Nanoparticles are attracting, increasing attention, due to their unusual, and fascinating properties, which are strongly, influenced by their size, morphology and structure. Several methods have been, used for the green synthesis of NPs, using various biological materials as reducing agents, such as microorganism, marine, organisms, micro-fluids, and plant extracts,. Natural Nano particles also occur in many forms, such as volcanic dust, and oceanic salt sprays. Non-viral Nano particles, are quite irregular, and vary in size, whereas engineered Nano particles are generally more uniform, and can have unique shapes such, as spherical balls, sheets, rods and in more intricate, arrangements [4].

Properties,

Nanoparticles have a large number of qualities because they are small in size, and too much reactive in nature. Gold nanoparticles are vast in form and extremely reactive and inert. The gold nanoparticles are real in color, while TiO and ZnO are white inform. They are too much reactive, and also having a property to melt under extreme low temperature.

Synthesis,

Chemical reduction in the liquid phase is a conventional method for the synthesis of the nanoparticles. Nanoparticles can be synthesizing by many processes like *in Vivo* method in plants. Biological synthesis methods are quite unique in nature because they reducing the metals to small in size after exposing the metallic salt. According to the 2015 review 48 species of fungi can be used for the reduction of the metallic nanoparticles. Nanoparticles also biosynthesize by various in number of plant species Fusarium, Aspergillus, Verticillium and Penicillium [5].

Types of nano particles used in plant pathology,

The applications currently being explored, in Nano medicine against human pathogens, make their way in to the plant disease, management.

Metalloids, metallic oxides, and non-metal Nanoparticles

The use of these nanoparticles either, bactericides/fungicides or Nano fertilizers, to affect disease resistance. The value of Nano particles, in suppression of foliar, stem, fruit, and root rot pathogens. The metallic oxides, of Ag, Al, Au, Ce, Cu, Fe, Mg, Mn, Ni, Ti, and Zn, and the non- metals

Nano-silver,

Silver (Ag), Nano particles were the first investigated in plant disease management, given their historically known, antimicrobial activity. Park et al., Applied the Nano silver particles along with water soluble polymer on cucumber leaves against Podosphaera xanthii. No pathogen detected on leaves surface except on control plant found that Nono-particles nanoparticles have efficacy against rose powdery mildew. A considerable decrease in Sphaerotheca pannosa, colonies observed by application of silver nano particles. It urged the remedial effects of nano particles as they suppressed the also suppressed the nematodes and ecofriendly in nature [6].

The development of consistent processes, for the synthesis of silver nanomaterials, is an important aspect of current nanotechnology, research. One of such promising process, is green synthesis Calzada et al., (2007). Phytoextracts of fruits and vegetables used to synthesis green reactants for Ag Nanoparticles (Shankar et al., 2003). Silver nano particles exhibit antimicrobial, antifungal properties as they penetrate through their walls, modify the signaling pathway through dephosphorylation, damaging cell membrane permeability and respiration. Silver Nano particles are source of silver ions which have bactericidal effect against bacteria. They cause lysis and change the phosphotyrosine peptide bonding which in returns alters the signal transduction.

Nano-copper,

Copper nano particles were first used in agriculture field in 1761 to inhibit seed born fungal pathogen. Copper acts as metallic fungicides and increase resistance in plants against fungal pathogens. Copper nano particles used against bacteria and fungi under field conditions by Giannousi et al., he combined the Nano-particles to copper to generate nano-Cuo, Cu2o, and Cu/Cu20, for copper based foliar applications against fungi, including Kocide 2000 35 WG, Kocide opti 30 WG, Cuprofix Disperss, and Ridomil Gold plus, showed remarkable ability to suppress Phytophthora infestants, in tomato [7].

Nano-zinc,

Zinc nano particles studied against wide variety of nematodes e.g M.incognita, bacterial and fungal pathogens including Rhizoctonia solani A. alternata alternata, B. cinerea, ,Mucor plumbeus, Panicillium expansum, F.oxysporum *in vivo* and invitro studied caused significant fungal growth inhibition.

Metalloids, metallic oxides and non-metal nanoparticles,

Al, Au, B, Ce, Fe, Mg, Mn, Ni, and S nano particles effective against plant diseases. Nanoparticles of MgO, SiO, AND TiO have highest intention now a day to control disorders of plants. Ag-Si nanoparticles highly suppressed fungal growth of Powdery mildew. Concluded SiO nanoparticles reduced disease severity of Fusarium wilt of watermelon. However individual application of silicon particles did not prove effective. Imada et al., stated that Systemic acquired resistance against Ralstonia solanacearum induced through nanoparticles of MgO in tomato seedlings and significant reduction exhibited against disease incidence. Nano-Ti and photosynthesis, has captured the attention, of researchers. In fact, the photocatalytic activities, of nano- liO particles showed effective anti-fungal activity said thatt-activated nano-Tio2/Zn nanoparticles, composed to quench bacterial growth of Xanthomonas sp. that cause flower spot of rose. Because they consist the disease suppressing, nano-ZnO, so nano-TiO2. Elmer et al., noted that nano-Ag-nano-Cu, and nano-Zn cause huge suppression. Non-particles have high impact as compared to conventional application metallic fungicides. Copper, manganese, and/or zinc containing bactericides effectively reduced the infection. Development of pathogen resistance to chemicals, is also a concern. Maximum reduction in disease severity attained by TiO2 caused by Curvularia lunata and bacterial leaf blight, Xanthomonas oryzae. Same results were noted in field applications, of TiO2 on cowpea against Cercospora leaf spot, and brown blotch diseases studied that combinations of TiO2, Aluminum and silica controlled the both powdery mildew and downy mildew. Oxidation caused by TiO2 destroys the cell membranes, of pathogens, cause leakage and death, of pathogen. Inspite of strong oxidizing power TiO2 provide environment safety [8].

Carbon nanoparticles,

Diversity of shape and function exhibited by carbon containing nanomaterial due to allotropic forms of carbon. Carbon tubes, graphene oxides and fullerenes are commonly known categories of Nano material. Carbon nanomaterial used in paints, engineering, textiles, medicine, and electronic industry. Recent studies revealed the antimicrobial effectivity of carbon nanomaterials against bacteria, and fungi along with positive growth effects. Significant decrease noted in Radial growth of A.niger, Aspergillus oryzae and F.oxysporum with graphene oxide at variable concentrations explained that single –wall carbon nanotubes,most efficaciously inhibited conidial germination F.graminearum and Fusarium poae, followed by carbon nanotubes and graphene oxide [9].

Carbon Nano material have sharp edges of graphene oxide directly damaged the cell membranes and walls of microbial pathogens due to reactive oxygen which inactivate the bacterial growth and effects polysaccharides and chitinous compounds of fungi. Fusarium sp. growth inhibited by carbon nanoparticles studied that evidence that functionalized carboxylates,single-walled carbon nano-tubes ,disrupted the oxidative enzymes, of white-rot fungi Trametes versicola and Phlebia tremellosa. Sarlak et al., 2014 In vitro experiments cleared that the new nano-carbon structure superiorly inhibited the Alternaria alternata as compared to fungicide alone.

Liposomes,

Spherical vesicles composed of phospholipids bilayers, vary in size of nano range can be filled with antimicrobial material and herbal extracts encapsulated in liposomes, to inhibit gram-negative bacteria and they have long-term stability in water. Long term stability character made its use effective with irrigation water. In fact noted that amphotericin, that was bound to liposomes formed Nano disks delayed the onset of disease caused by F. oxysporu f.sp. ciceris in chickpea.

Nanoparticles can act as a protectant,

Nanoparticles are materials with size range between 10 to 100 nanometers, (nm) and could be designed with unique chemical, physical, and biological properties. Nanoparticles can be directly applied on plant seeds, foliage, or roots for protection against pest and pathogens, such as insects, bacteria, fungi and viruses. Metal nanoparticles such as zinc oxide, silver, copper and titanium dioxide extensively researched because of their antibacterial, antifungal and antiviral properties. Silver nanoparticles have become popular due to their antifungal antibacterial properties as silver nanoparticles cause inhibition, of Alternaria alternate, Sclerotinia sclerotiorum, Macrophomina phaseolina, Rhizoctonia solani,Botrytis cinerea and Curvularia lunata. Sun-hemp, rosette viruses were inhibited by silver particles sprayed on bean leaf. Copper, titanium dioxide, and gold are other commonly used nanoparticles for disease management through fertilizers. The titanium dioxide nanoparticles used in fertilizers to protect crop from bacterial and viral attack Gold nanoparticles introduce through abrasive damage induce resistance against Barley yellow mosaic virus. Chitosan nanoparticles have low toxicity to humans and animals while they are highly compatible, non-allergic and biodegradable in nature. Chitosan nanoparticles induce viral resistance in alfalfa, snuff, peanut, potato, and cucumber Figure 1. Chitosan nanoparticles due to their antifungal properties used against root rot in tomato, Botrytis bunch rot, in grapes, Fusarium crown, and Phyricularia in rice but showed little effectivity against bacterial pathogens. Malerba and Cerana stated that chitosan cause inhibition to H+-ATPase activity, agglutination, disruption of the cell membrane, inhibition of toxin production, and microbial growth, inhibition of the synthesis of messenger RNA and proteins, and blockage of the nutrient flow. Antiviral effects of chitosan have been studied in beans against Bean mild mosaic virus, and in tobacco against tobacco necrosis virus and mosaic virus. Chitosan also has effectiveness against, oleander aphid, cotton leaf worm root-knot nematode and nymphs, of the spear psylla (Cacopsylla pyricola). Chitosan has shown,an enormous potential as a nanocarrier against pathogens [10].

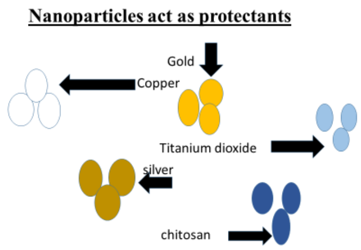

Figure1: Nanoparticles.

Nano Particles as Carriers for Fungicides,

Nano fungicide study can be started in 1997 integrating the fungicide to solid form of wood. Chitosan, silica and polymer mixes are the Nano particle carrier improve the low water solubility tubuconozole and also increasing the leaf area adherence by using the by using the Nano size bacterial flash. Almost six plants are tested (rice, soya, cabbage, cotton, barley and corn) due to its adherence ability to the plants. By comparing the efficacy of the nanoparticles to commercial preparations, have a role in decreasing the toxicity of the disease tested the efficacy of the nanoparticles in zebra fish. He places the zebra fish for 96 hours with the combinations of butylene succinate and also poly shells and at least he found that nanoparticles have a great role in reducing the toxicity Figure 2. Calcium carbonate can be released in a slow form when validamycin summarized nanoparticles were used for the control of the Rhizoctonia solani. Kumar et al., used carbendazim loaded with polymeric nanoparticles that also play a huge role in the inhibition of the fungal Fusarium oxysporum and Aspergillus. The use of Nano verbalized with carbendazim is good for the long germination of the root growth Cucumis sativa, Zea mays, and Lycopersicum esculentum.

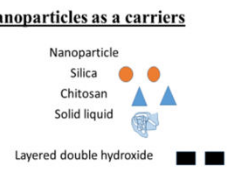

Figure2: Nanoparticles.

Effects of Nanoparticles on plant pathogenic fungi,

Plant pathogens are important controlling factors in the production of food materials, various methods used but no when is a best for the crop protection and lessening the crop productivity and they have role in the destruction of the fungi growth stated the effects of the different micronutrients like CuSo4 and Na2B407 that have a role in monitoring the peas plant rust disease. They also have a some other benefical aspects of micronutrients like a manganese control the charcoal rot disease and dumping off in sunflower plants. For checking the fungicidal efficacy by using the silver nanoparticles by comparing with the PVP in the diverse yeasts and molds such a Candida albicans, C.krusei, C.tropicalis, C.glabrata and Aspergillus brasiliensis. At last they showed a strong antifungal activity against the different microorganisms. To study the antifungal activities of zinc oxide nanoparticles used some traditional techniques for the study of fungicides effects. The used Raman spectroscopy, traditional microbiological plating and electron microscopy techniques and they have a role in altering the morphological and cellular configurations of the fungal hyphae. The growth of B.cinerea and P.expansum, is inhibited by using the zinc oxide concentration greater than 3 times and it is found too much susceptible. They also reduced the shape of the hyphae of B.cinerea and blocked the formation of the conidiophores in P. expansum that causing the death of hyphae of the fungal worked on different plant pathogens in fungi like a Alternaria alternate, Sclerotinia sclerotiorum, Macrophomina phaseolina, Rhizoctonia solani, B.cinerea and Curvularia lunata for checking the efficacy of silver nanoparticles. The nanoparticle has a role in inhibition of the pathogens growth studies on the zinc nanoparticles for suppression of the A.flavus.

Effects of Nanoparticles on Bacteria

Zinc, nanoparticles have an antibacterial activity, against P. aeruginosa, that is stated by,. Bacterial colonization zone shows maximum inhibition of bacteria. So, ZnO nanoparticles have an act, as an antimicrobial agent. Silver nanoparticles synthesized against the bacteria Staphylococcus, aureus (gram positive bacteria), E. coli (gram negative bacteria), and also in the Bacillus spores that studied by. CuO nanoparticles also have an anti-bacterial activity, against the S. aureus, Bacillus, subtilis, P. aeruginosa, and, E. coli started that silver, nanoparticles presented, high antimicrobial, and bactericidal, activity against gram positive, bacteria such as E. coli, P. aureginosa, and S. aureus that have a resistant strain against these bacterial diseases.

Nano Pesticides

Plant pathogen invasion and reducing the pest population by using the full active formulations at the root part of the plants. That protected the plants from different pathogens attacks . The preparations causing the spore not enter in the host pathogens and also increase its effectiveness. The chemical formulations reduce the amount of the pesticides that is important to controlling the plant diseases. There harmfull effects on environment and also on human reduces time to time. Nano applications against the pesticide should be beneficial if their quantity is 10 to 15 times smaller as compared to other chemical preparations. The smaller amount should best and attain a satisfactory in management of the crop diseases. Nano suspensions can help as a better, pesticide distribution system. Chemical ingredients can become best due to the Nano suspension that act as a transporter for pesticide distribution system. Nanoparticles are small plotted structure. Nanoparticles show beneficial properties, such as arduousness, absorbency, crystallinity, updraft constancy, solubility and biodegradability. The nanopesticides preparations, haveea large surface area, and increased the sympathy to the target. Nano suspensions, Nano summarizes, Nano ampules and Nano enclosures, are some of the nanopesticides distribution, methods,that are helpful in plant protection. discovered the possibility of applying chitosan nanoparticles, on the release of various fertilizers. Nano layers labelled with the kaolin clay that used for coating of the material that is used as control studied. Nanoparticles labelled also used in various way to protect the plant from diseases. Nano-clay particles have a high surface ratio against the diseases stated the growth of sodium Dodecyl Sulphate (SDS), modified photocatalytic TiO2/Ag nanomaterial conjugated, with dimethomorph (DMM) that have a great effect in controlling the plant pathogen diseases.

Future Aspects of Nanotechnology in Plant Pathology

In agriculture sector a huge of disruption in the food production due to over long period of drought and an increasing in the temperature every day by day. Many challenges facing many growers and also plant pathologists. In the disease management and plant growth is becoming better by using the nanoparticles as a new weapon. In plant pathology literature the used of nanotechnology best in the plant disease management. There are various ways in which nanoparticles can be used like they can be used a direct exploring and also as a fertilizer. It acts as a fast diagnostic weapon for bacterial disease detection. Some nanoparticles have a role in increasing the diagnostic effects on the plant pathogens. To analysis the pathogens activity with the help of bio sensors that are an analytic device that have a biological role in pathogens disease detection. It produces a signal of electronic when used a physiochemical transducer with him. Pathogens density can be increased by using an electrical sign method. Bio sensor formation can be done by using different types of nanoparticles such as metal oxide, carbon nanoparticles and metalloid. Currently nanotechnology used for promoting the crop production and also reduced the waste production in plants.

Non-essential nanoparticles have a systemic resistance such as TiO2 and Al2O3. Nanoparticles applications have a great role in crop production and in decreasing the disease. In future the research targeted on the important elements and also optimize treatment assessment effects success in the crop production.

Conclusion

Examination of the literature and critical analysis of the significant information's have revealed that nanotechnology has potential prospects of use and application in the detection, diagnosis and management of plant diseases. The limited studies so far showed on this aspect are sufficient enough to warrant potential future use of the nanotechnology in plant disease management. The researches have shown that the direct application of nanoparticles significantly suppressed the plant pathogenic fungi and bacteria tested. Nanomaterials and microcapsules can efficiently carry higher concentration of active ingredients of pesticides, host resistance inducing chemicals, polyamines synthesis inhibitors etc. The nanoparticles of Au, Ag, Co, Ti, etc., may greatly help in the precise and quick diagnosis of plant infection and also residue detection of pesticides. Nanotechnology can provide solutions for agricultural applications and has the potential to revolutionize the existing technologies used in pest management. Development of Nano pasticides, can offer unprecedented advantages like

Improved solubility of poorly water-soluble pesticides

Increased bioavailability and efficacy of pesticides when loaded onto nanoparticles and reduced pesticides toxicity

Enhanced shelf-life and controlled delivery of actives

Target-specific delivery of the active molecules

Smart delivery of RNAi molecules for disease management

Nanoparticles as carriers to slow down degradation of active molecules and improve the formulations' UV stability and rain-fastness

Nano pesticides to improve the selective toxicity and overcome pesticide resistance. However, nanotechnology in the agricultural sector is not reaching the market. Most of the developed nanoparticle-based pesticides, are at the very early stage of development. The pesticides loaded onto silica nanoparticles only two of them have conducted field trials, chlorfenapyr loaded onto silica nanoparticles with additional emulsions was applied to Brassica Chinese, and imidacloprid loaded onto sodium alginate nanoparticles. An-other issue with early stages of research on nanoparticles in plant protection is the current lack of long term trials. Tested for insecticidal activity for 5 months after application of their formulation on stored grain, and studied Azadirachta in either zinc oxide or chitosan nanoparticles in a jar of ground nuts infested with the ground nut brunched insect over 180 days. Nanopesticides are an emerging technological advancement where, in relation to pesticide use, there is a lack of a clear definition of what is, and what is not a Nano pesticide, by regulatory bodies also discussed in depth that, unlike conventional pesticides, the effects of Nano pesticides may be dependent on the uptake, bioavailability, concentration, and toxicity of the nanoparticles, as well as the ratio of the active bound to them. There is also a limited data concerning the issue of pesticide resistance and how the addition of nanoparticles could conceivably reduce its incidence. Without using the comprehensive analytical tools, regulatory requirements for risk assessment cannot be generated. Only eight out of 30 insecticides MoA groups, 10 out of 49 fungicides FRAC groups, and eight out of 23 herbicide HRAC groups have been loaded onto nanoparticles and tested, to date. Current pesticide application requires rotation between groups to prevent pesticide resistance and a broad range of nanopesticides would need to be available for future commercial applications.

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