NANOTECHNOLOGY IN AGRICULTURE

Abstract

Because of its multiple applications in industries like health, medicines, catalysis, energy, and materials, nanotechnology has attracted a lot of attention in recent years. Numerous uses for these nanoparticles with surface areas ranging from 1 to 100 nm are conceivable. Nowadays, sustainable agriculture is required. Nanochemicals have been used as potential agents for insecticides, fertilizers, and plant growth. Nanomaterials have now a days used as an alternate approach for controlling insects, fungus, and weeds. As antimicrobial agents in food packaging, a range of nanomaterials are used, with silver nanoparticles being among the most sought-after. Aside from their antibacterial properties, nanoparticles consisting of carbon nanotubes Ag, TiO2, CeO2, Zn, ZnO, Fe, Cu, Si and Al have been demonstrated to have certain deleterious effects on plant growth. Nanoparticles play an important role in food sector in producing high-quality, nutritional meals.

Keywords: Agriculture, Food Industries, Applications, nanoparticles, pesticides, fertilizers, Antimicrobials

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I. INTRODUCTION

Nanotechnology has sparked a lot of attention because to its numerous applications in fields such as health, medicines, catalysis, energy, and materials. The utilization of such nanoparticles, which range in size from 1 to 100 nm, in medicine, industry, and agriculture is a potential [1]. Scientists have made enormous progress in the development of nanoparticles by employing a variety of approaches such as biological, physical, and chemical ones. These approaches have various problems since scaling up the process is difficult, it is difficult to separate and nanoparticles are purified from the micro-emulsion, it consumes a lot of surfactants [2]. Green nanoparticle production methods based on plant extracts offer the advantages of being rapid, simple, and ecologically friendly. The use of eco-friendly and green nanomaterials has the potential to improve pesticides, fertilization, and plant growth regulators in agriculture [3]. Nanotechnology is currently increasing its popularity because of its many uses in industries like agriculture, the environment, and health. [4]. As a result, it aids in lowering environmental pollutants. The large surface area of tiny nanoparticles, in particular, makes them interesting for addressing problems that physical pesticides, chemical pesticides, and biological control techniques cannot [5].

Although there has been significant governmental investment in nanotechnology in agriculture during the past ten years and notwithstanding the fact that many technologies have fallen under the purview of agriculture, the industry is still in an appropriate developing stage. This might be related to the unique characteristics of agricultural production, which functions as an open system in which matter and energy are freely exchanged. There is no restriction over the input of nanomaterials into industrial nanoproducts, yet the amount of input material demand is constantly large. Nanotechnology enables the development of new agrochemicals and novel delivery systems to boost agricultural yield while lowering pesticide use. Some of the agricultural applications of nanotechnology that can increase crop productivity include postharvest management, plant genetic engineering, poultry production, plant disease diagnostics, animal breeding and animal health. Agrochemical nanoformulations for pesticide and fertilizer application for crop development. Precision farming techniques may be utilized to boost agricultural yields while reducing water and soil impact. Nanotechnology uses for plants include DNA or gene transfer, which may be used to generate insect-resistant cultivars, extend product shelf life and food processing and storage. the potential benefits of nanotechnology for aquaculture, fisheries, food and agriculture should be balanced against concerns about the environment, water and land as well as worker workplace safety and health. Nanomaterials are thought to have particular chemical, physical, and mechanical characteristics. Agricultural waste products have recently come to light as a source of renewable raw materials to be processed in place of a variety of different uses, as well as a raw material for the manufacture of nonmaterials. Insecticide resistance is a prime example of environmentally based evolution [1]. Because it aids our understanding of processes that operate in real time and because it is economically significant, the research of pesticide resistance is necessary. Insects are becoming a bigger issue for public health and agriculture. Numerous different selected regimes may be used in agricultural techniques. Agriculture and food technology are now testing applications for nanotechnology. The use of nanoparticles in agriculture aims to decrease the need for plant protection product spraying and boost plant yields. Examples of applications of the treatment and diagnosis of illnesses using nanoparticles and nanocapsules which are included in nanotechnology. In the area plant breeding and genetic modification, nanotechnology-derived technologies are also being investigated. Although nanotechnology has great promise for the agricultural sector, several concerns need to be resolved as part of the risk assessment. In this regard, carbohydrates and protein which are biopolymers, that have minimal effects on both environment and the human health are used as nanoparticle attractants. There are several applications of nanotechnology in agricultural product production, processing, storage, packaging, and transportation. By enhancing plant nutrient absorption, disease detection, and pest management, for instance, food industry and agriculture will be transformed by nanotechnology.

II. NANOTECHNOLOGY IN FRTILIZERS AND PESTICIDES

Sustainable agriculture is necessary now a day. It might be regarded as providing an ecosystem with a beneficial long-term plan. Excessive soil tilling, which encourages erosion, and irrigation without enough drainage are also methods that can affect soil over time. Salinization will occur as a result. This is done to meet the growing need for fiber, food, and animal feed.

Long-term research are required to illustrate how diverse strategies alter soil properties that are critical to sustainability and to obtain critical information for this objective. A federal organization in the United States has discovered nano-chemicals as potentially helpful instruments for pest control and plant development. Fertilizers are required for the development of the plant. Improved crop quality and reduced environmental toxicity may include if the features of nanomaterials used as fertilizers. Phytotoxicity and the impact of different NPs on plant growth includes those of zinc oxide, zinc and alumina on the germination, magnetite (Fe_3O_4) nanoparticles on plant growth and root growth of five plant species, they are cucumber, rape, lettuce, radish and corn. Wheat may grow to produce more when silver nanoparticles are present. The growth and production of wheat were significantly enhanced by 25 ppm single nucleotide polymorphism(SNPs) added to the soil.

Despite the fact that plants only require trace amounts of zinc, it is considered a vital mineral for plant metabolic activities. Zinc is essential for the conversion of tryptophan to IAA, for the creation of the chlorophyll and carbohydrates required during metabolic pathways. Zn deficiency may have an impact on agricultural output and produce quality. Insects are showing pesticides resistance are raising concern for agriculture and public health.

III. CONTROL OF PESTS IN PLANTS

The damaging diseases of tomato and lettuce like *fusarium* wilt, development of resistance races and protracted fungal survival in soil in many regions due to high production loses. The use of pesticides and disease-resistant cultivars can help to some extent to decrease the disease. However, there is a persistent issue with the evolution of new pathogenic races and the emergence, and chemical treatment both costly and occasionally ineffective. Nanomaterials of magnesium oxide (MgO), copper oxide (CuO), magnesium hydroxide (MgOH) and zinc oxide (ZnO) are effectively synthesized by utilizing extracts of *Chamaemelum nobile* flowers, *Punica granatum* peels and *Olea europaea* leaves [1]. The screening of artificially created bio-nanoparticles showed that these nanoparticles might significantly raise the death rate of green peach aphids. The accumulations of metal oxide nanoparticles in the green sweet pepper fruits and leaves were studied after the glasshouse experiments. None of the plant fruits exhibited any metal accumulation, results showed.

According to foliar spray experiments using green pepper leaves and MgOH nanoparticles, spraying leaves with metal nanoparticles at concentrations between 100 and 800 ppm is extremely advantageous results in healthier plants with greener leaves and fruit by promoting plant development that is of higher quality than the control. Numerous approaches, including physical, chemical, and biological ones, were used by researchers to synthesize nanoparticles. The ability of agriculture to improve plant growth, pesticides, and fertilizer may be increased by the use of nanomaterials produced using the environmentally safe and sustainable ways. Furthermore, this approach reduces the quantity of dangerous substances that contaminate the environment [4]. In peaches the green peach aphid is recorded as a significant pest and a worldwide problem on other horticultural and arable crops, including Jordan. It is thought that this bug is one of the most significant agricultural pests in the globe. By overproducing carboxyl esterase’s, an insecticide-degrading enzyme, this ravaged pest fights against organophosphorus and carbamate pesticides. As a result of the overproduction of aphid resistance to chemical pesticides like carbamates, organophosphates, and pyrethroids, controlling this pest is also getting harder.

Magnesium hydroxide (MgOHNPs), copper oxide (CuONPs), zinc oxide (ZnONPs), and magnesium oxide (MgONPs) were among the nanomaterials that were created using various physical and chemical processes. One recently developed aspect of the intersection of nanotechnology and biotechnology is the biosynthesis of nanoparticles, has drawn more interest as the demand to reduce the usage of environmentally hazardous compounds, such as pesticides, has grown. Plants have been shown to reduce metal ions at a pace that is significantly quicker than microbes, and stable nanoparticle production has also been noted.

IV. NANOINSECTICIDE POTENTIAL

There are several ways to make copper oxide nanoparticles (CuONPs), including chemical reduction and precipitation. There have been reports of several plant aqueous extracts, including citrus lemon juice and carob leaves. For the green synthesis of ZnONPs, many plant extracts, including those from *Azadirachta indica*, *Solanum nigrum* leaves, and *Olea europaea*, have been described in the open literature. There are several documented ways to make MgOHNPs and MgONPs, including the hydrothermal pathway, microwave reaction and water-in-oil microemulsion. Utilizing non-toxic and environmentally friendly materials including *Punica granatum* peels, acacia gum and *Brassica oleracea*, MgOH was produced utilizing green techniques. There are several applications for nanotechnology in the agricultural industry, for instance, nano-vector-based molecular farming attempts to replace viral vectors, while nanotechnology-based herbicides and fertilizers have a big influence on plant growth.

V. ACTIVITY OF ANTIMICROBIAL

Among the many nanomaterials silver nanoparticles are employed as antibacterial agents in food packaging. Other nanoparticles now in use include magnesium oxide (MgO), titanium dioxide (TiO_2), silicon oxide (SiO_2), zinc oxide (ZnO), gold and silver. As an illustration, zinc nanocrystal exhibits antifungal and antibacterial activity. Silver, silver zeolite, and silver were used by NASA and the Russian space station to purify and sterilize water. Gold has excellent antibacterial and antifungal activities against 150 distinct microorganisms, low volatility, high temperature stability, and low flammability. Since silver has an excellent result against germs, the FDA approved its direct use as a disinfectant in commercial water in 2009. These had an antibacterial impact on *Staphylococcus aureu, Ecoli* and *L. monocytogenes*; Similar outcomes were obtained with nanosilver particles coated with cellulose acetate phthalate. There is evidence that certain nanoparticles have antifungal properties. *Candida albicans*, Yeast and *Aspergillus niger* are some of these fungi. *Staphylococcus aureus* with methicillin resistance has also been shown to be susceptible to AgNPs [9]. Additionally, it has been shown that nanoparticles with antibacterial characteristics other than silver, such as titanium oxide (TiO2), exist. UV light clearly showed it to have antibacterial properties. In packaging materials, zinc oxide is said to offer antibacterial properties [9].

VI. NANOTECHNOLOGY AS FUNGICIDE APPLICATION

Recent research has examined the effectiveness of nanosilver against the phytopathogen *Colletotrichum gloeosporioides* [7]. In addition to their antibacterial qualities, some nanoparticles have been observed to have some negative impacts on plant development. The development of beneficial soil bacteria, including *Pseudomonas putida* KT2440, can occasionally be impacted by nanoparticles. The use of eco-friendly insecticides caught the attention of several research organizations. Research into nanoparticle-based systems in depth might end the heavy reliance on pesticides in agriculture. Nanoparticles' antifungal qualities can be used to create insecticides that contain nanoparticles [7].

1. **Using Nanotechnology To Combat Plant Viruses:** Plant viruses, particularly those that are spherical, are thought to be naturally occurring nanomaterials. The tiniest plant virus known to date is the satellite tobacco necrosis virus, which has an 18 nm diameter [10]. A protein coat surrounds the genome of plant viruses, which is made up of single or double stranded RNA or DNA. Their capacity to reproduce, transport the genome of nucleic acids to a specified location inside the host cell, infect, package nucleic acids, and exit the host cell accurately and orderly has made their usage in nanotechnology necessary.

2. **Packaging for Food Using Nanotechnology:** The development of foods with excellent nutritional value is being led by the food industry. Pathogens, chemicals, and gases may all be found in food using nanosensors. The phrase "smart packaging" is used in contemporary jargon to describe this kind of packaging. According to certain research, the risks associated with nanoparticles' direct inclusion in food are preventing consumers from embracing it. As a result, various safety precautions must be offered in order to lower the danger and ensure human security.

VII. CONCLUSIONS

New pathogenic races continue to emerge, which is an issue, and using pesticides to manage pests may be expensive and ineffective. The use of nanomaterials as a substitute for traditional methods of plant disease management has recently come under consideration. Typical agricultural methods involve the systematic administration of a broad spectrum of active substances at varying doses and frequency, which comprise a broad spectrum of selective regimes.

The green peach aphid has been managed by metal oxide nanoparticles. The green peach aphid has been managed by metal oxide nanoparticles. In comparison to other artificial nanoparticles, magnesium hydroxide, a bionanoparticle, was the most effective inhibitor of Myzus persicae.

The use of plant extracts in green techniques for nanoparticle synthesis is favorable since it is quick, easy, and environmentally benign. This method contributes to a decrease in environmental contaminants. Because of its many uses in areas including agriculture, health, and the environment, nanotechnology has lately attracted attention. The small nanoparticles' vast surface area makes it appealing to use them to address problems that other control systems are unable to handle.

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