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NANOTECHNOLOGY- A NEW SENSATION IN PRESENT DAY AGRICULTURE

Suprava Biswal and Taru Dumi

Department of Vegetable and Spice Crops, Uttar Banga Krishi Viswavidyalaya, Pundibari, Coochbehar, West Bengal-736165

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Corresponding author: Suprava Biswal supravabiswalchc2 @gmail.com

ABSTRACT

The world population has increased at a tremendous rate during the last 50 years. So far, the modern agricultural system has permitted the emerging higher yield of major crops to feed the increasing human population. The use of hazardous chemicals as pesticides and insecticides, results in severe environmental deterioration as well as creating health issues in the case of humans. Even after using such chemicals, around 20 to 40% of crops are lost to insect and pest attacks. Emerging new technology, such as nanotechnology, can act as an effective remedy like decreasing the toxicity level, higher impact with lower amounts of pesticides, and better soluble pesticides. Nanotechnology could reduce the impact of pesticides on the environment as well as on ecology. This mini review will explore two directional uses of nanoparticles- They can be used solely as a protectant and also applied as nanocarriers for fungicides, insecticides, herbicides, and RNA-interference molecules. Despite the various advantages associated with the uses of nanoparticles, their use in agriculture is not ample. In other sectors, nanotechnology proves an impactful position in the world market.

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INTRODUCTION

Infestation of plant pathogens and pests causes significant reduction (20 to 40%) of productivity globally (Flood, 2010). Nowadays, pest management is easy due to the massive application of harmful chemicals in the form of insecticides, pesticides and herbicides, to control insect pest infestation. In spite of various advantages found in pesticides application, they also have some of the worst side effects such as development of resistance, the resurgence of pest populations etc (Stephenson, 2003). Hence, there is an increased motivation to raise new technology which has high efficiency with lower doses of application, less adverse effect to the environment as well as being cost-effective.

Nanotechnology gives rise to emerging new ideas in the agricultural sector with enormous potential to cope with the aforementioned issues. The recent use of nanotechnology in agriculture platforms mostly emphasized on delivery of plant hormones, water management, seed germination, transfer of targeted genes, nanosensors, nanofertilizers, and nano barcoding (Hayles *et al*. 2017). Material scientists derived nanoparticles of various characteristics such as shape, pore size and surface properties precisely to be used as protectants, such as pesticides, following the mechanisms of encapsulation, conjugation and adsorption (Khandelwal *et al*. 2016).

Nanoparticles can be used in two different mechanism to protect the plant from harmful pathogens (a) directly used in crop protection as a protectant (b) can be used as carriers for other actives as well as for existing pesticides and can be applied as directly drenching in the soil or soaking with the seeds (Figure 1), foliar spray, etc. Another new advantage of nanocarriers involves an increase in the efficiency of the activity and stability of the nanopesticides under environmental conditions (rain and UV), so that they will help to reduce the doses of applications thereby lowering the toxicity level and minimizing the cost.

CLASSIFICATION OF NANOTECHNOLOGY

Classification of nanotechnology for plant disease management

1. Nanoparticles used as protectants:- As the name indicates, nano means small, ranging between 10-100 nanometer (nm), and can be created having distinctive physical, chemical and biological properties in which they can differ from each other having different molecular and bulk counterparts (Yang *et al*. 2008). Different metal nanoparticles such as Cu, Ag, titanium dioxide and ZnO have been researched for identifying their antibacterial, antifungal and antiviral properties. (Gogas *et al*. 2012). Recently, silver nanoparticles came into consideration as they are helpful for preventing many pathogens like *Macrophomina phaseolina*, *Rhizoctonia solani*, *Curvularia lunata*, and *Sclerotinia sclerotiorum* by well diffusion assay (Krishnaraj *et al*. 2012). Chitosan is another type of nanoparticle with various characteristics like environmental friendly, biodegradable with lower toxicity level for animal and human beings. It also induces viral resistance against harmful plant pathogens, especially mosaic disease of groundnut, potato, snuff, cucumber and alfalfa (Kochkina *et al*. 1994).

2. Nanoparticles that act as carriers:- Silica nanoparticles are mostly used as carriers as they are created with a limited size, shape, structure and are effective for transportation (Mody *et al*. 2014).

3. Nanoparticles that act as carriers for insecticides, fungicides, and herbicides:- For insecticides nanoparticles can be differentiated in two types- as systemic (absorbed by plant)

or contact type (where direct contact occurs) and can be categorized around 55 different classes having various groups according to metabolic functions affected: muscle/nerve, respiration, midgut, growth (Sparks *et al*. 2015).

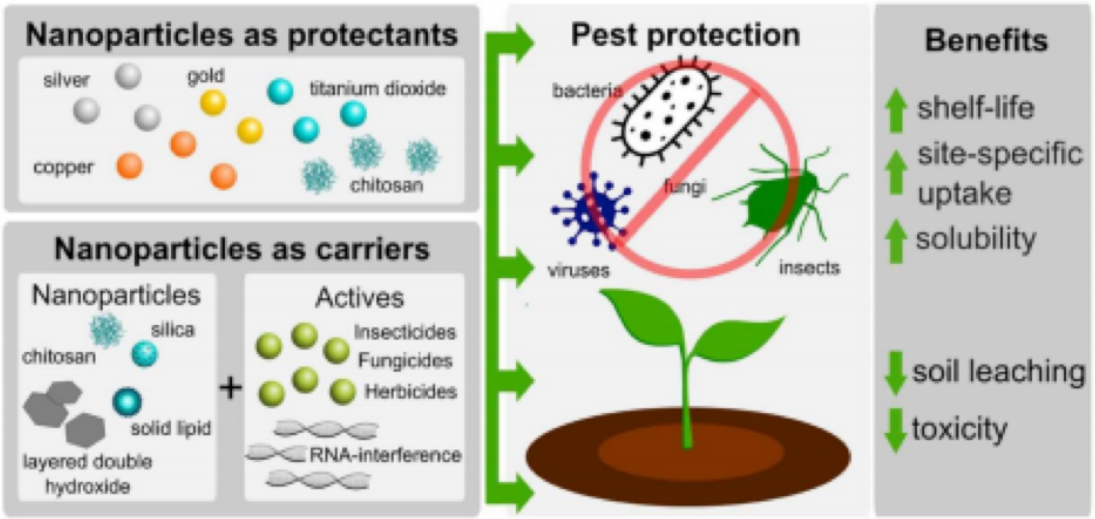

Figure 1 Different roles of nanoparticles

CONCLUSION

Nanotechnology can bring a revolution in the existing technologies used in pest management and in many agricultural applications. Development of nanopesticides can offer unprecedented advantages like

(i) improved solubility of poorly water-soluble pesticides,

(ii) increased bioavailability and efficacy of pesticides when loaded onto nanoparticles and reduced toxicity due to pesticides,

(iii) controlled delivery and enhanced shelf-life of actives. The potential advantages that nanopesticides represent for the environment and human health, could be used for safe agricultural practices.

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