Role of Nanoparticles in Pest Management

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SUMMARY

Nanotechnology is an emerging and relatively new technique in the field of science which deals with the use and application of materials and devices whose smallest functional organisation is atleast one dimension on the nanometer scale (one billionth of a meter), which is otherwise called as nanoparticles (1-100nm). It deals with science and engineering of manipulating particles at nano-scale. Nanoparticles may act upon pathogens in a way similar to chemical pesticides or the nanomaterials can be used as carrier of active ingredient of pesticides, host defence including chemicals etc, to the target pathogen. Nanoparticles killed pest and pathogen and when used along with chemical pesticides their efficiency increased significantly.

INTRODUCTION

In recent years, nanotechnology has extended its relevance in plant science and agriculture. Advancement in nanotechnology has improved ways for large-scale production of nanoparticles of physiologically important metals, which are now used for pest management. Nanotechnology applied to the field of agriculture could help tackle major global issues related to pest management and nanoparticles are nano materials with composite structure which constituted by two or more components of nano scale with special physical and chemical properties. Nanomaterial-based pesticides are also considered as alternatives to pesticide due to their ultra-sub microscopic size and gain high degree of reactivity and sensitivity and thus are very useful in controlling pest. Nanoparticles are advanced material having recently gained increasing attention due to their scientific and technological importance and they can be potentially used in the crop protection, for pest and nematode management. They could precisely release their active ingredients in responding to environmental triggers and biological demands. Nanoparticles have potential applications in agriculture system, viz., detection of pollutants, plant diseases, pests, and pathogens; controlled delivery of pesticide, fertilizers, nutrients, and genetic material and can act as nanoarchitects in formation and binding of soil structure (Ghormade *et al.* 2011).

Types of Nano-materials

Carbon based nanomaterials- Composed mostly of carbons, and they are of different shaped- Spherical, Ellipsoidal, Cylindrical.

Metal based nanomaterials- They include- Quantum dots, Nanogold, Nanosilver, Metal oxide. Ex: Titanium oxide, magnesium oxide, Zinc oxide.

Dendrimers- they are of nanosized polymers and the surface has numerous chain ends which can be used for drug delivery.

Nanocomposite- A nanocomposite is a matrix to which nanoparticles have been added to improve a particular property of the material.
Ex: Nanosized clay is added to products to enhance mechanical, thermal properties.

Role of Nanoparticles in Pest Management

- Nanoparticles are broad spectrum antimicrobial and have biocidal properties.
- Metal, nonmetal and metal oxide nanoparticles have strong inhibitory, antifungal, antibacterial, nematicidal and insecticidal activities.
- Nanopesticides helps in reducing the pest population below the economic threshold level.
- Nanopesticides is effective at very low concentration and can reduce the high rate of application.
- Nanoencapsulation of pesticide can be done by encapsulating the pesticide inside a artificially synthesized nanomaterial in a such a way that it facilitate the release of pesticide only in the targeted environment.
- Active ingredients present in the nanoparticles are highly versatile and are effective means of controlling pests.
- Nano-encapsulation is used to protect the active ingredients from the harsh environmental conditions and also to promote persistence and increase the insecticidal value.

- Nano-encapsulated pesticide formulation have slow releasing properties with enhanced solubility, permeability, and stability.
- Nanoparticles are known to induced abrasion on the insect cuticle and damage the cuticular water barrier.
- Nanoparticles also induces dehydration which results in insects death due to loss of water.
- Due to slow and controlled release of active ingredients greatly reduces the amount of pesticides input and have certain advantages such as cost effective, less environmental hazard by reducing pesticide overuse and soil leaching into waterways, reduce the risk of plants phototoxicity and toxicity to non target species. Formulation of insecticides, nematicides, herbicides, fungicides, aphicides, miticides, and etc. are done with this technique.

CONCLUSION

Nanotechnology is gaining immense interest in the field of pest management because nanoparticles have great potential for controlling plant pathogenic pest and has less negative effects towards environment and public health compare to chemical pesticides and also conventional controls were not sufficient to suppress these pest, so nanotechnology is one of the solution to overcome these pest problems by using modern pesticides formulation such as nano capsules, nanoparticles and nano suspension pesticides. Nanoparticles have extremely small size and greater surface area to volume ratio properties due to which their activity, efficacy and diffusion level is high on the targeted delivery site. The main aim of the nanoparticles based pesticides is protection and efficient management of pest and diseases with increased efficacy they also act as an excellent plant growth stimulator.

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