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Nano-Technology: Innovative Approaches for Crop Protection

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Introduction

Nanotechnology is a field of applied science and technology which involves in manipulating atoms and molecules to fabricate materials, devices and systems. The term nano derived from greek word "dwarf". Nanotechnology has led to the development of new concepts and agricultural products with immense potential to manage the aforementioned problems. The use of nanotechnology in agriculture is currently being explored in plant hormone delivery, seed germination, and water management, transfer of target genes, nano barcoding, nano sensors, and controlled release of agrichemicals. Researchers have created nano particles with desirable qualities such as form, pore size, and surface properties so that they can be utilized as protectants or for precise and targeted delivery of an active, such as a pesticide, via adsorption, encapsulation, and/or conjugation. The development of agricultural nanotechnology will lead to the creation of a new generation of pesticides and other active ingredients to control plant diseases.

The use of nano particles to protect plants can occur via two different mechanisms: (a) as crop protection, or (b) as carriers for existing pesticides or other actives. Nano particles can be applied by spray application or drenching/soaking onto seeds, foliar tissue, or roots. Nano particles, as carriers, can provide several benefits, like, enhanced shelf-life, improved solubility of less water-soluble pesticides, reduce toxic effect, and boosting site-specific uptake into the target pest . Another possible nano carrier benefit includes an increase the activity and stability of the nano pesticides under environmental stresses (UV and rain) and its reducing the number of applications, toxicity and reducing their costs.

Nanotechnology in Crop Protection

Pesticides are encapsulated into various forms to achieve the foregoing advantages. The encapsulating material that forms the shell around the active ingredient controls the

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physical, chemical, and release property of the nanopesticides thus formed. For encapsulation, the active ingredients are loaded inside or trapped in the polymeric material forming a nano sized structure. However, there is controversy as to whether 1–1000nm is the nano size of a colloidal system for pesticide delivery or if it should be 1–100nm, which is the actual range of nano. In this chapter, we have considered 1–1000nm as the nano range. Chemical pesticides were brought in to eradicate pests and pathogens. However, most of the pesticides used for crop protection are lost in air or as runoff or spray drift, which results in off-target deposition. Only less than 0.1% of the applied pesticides reach the target site the rest are photo degraded or pollute the environment. Utility of nano materials is an advanced and alternative method to overcome the foregoing limitations. Various nano-based systems involved in crop protection are systematically represented in Fig.

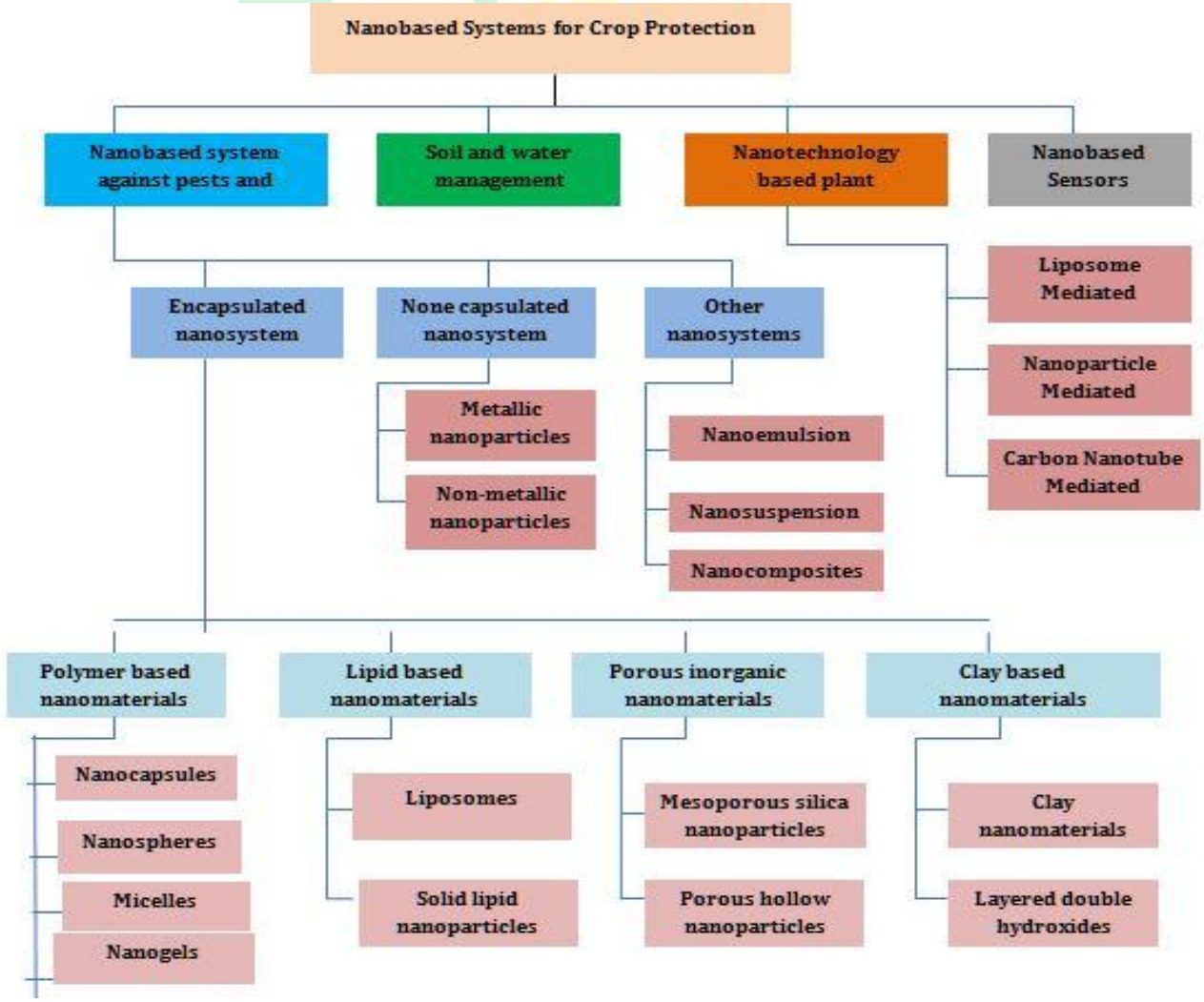

Figure: Different Nano Based Systems for Crop

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Environmental Fate of Nano Insecticides

- Designed for slow release and allowing them to persist in the environment.
- If the nano-component simply protects the active ingredient from degradation, then the fate and behaviour of the nano-component may be the same as in conventional pesticide formulation.
- Little is known about the amount of bio solid derived nano materials that may enter the food webs.
- The risk identification of nano-formulations requisites focus on the active ingredient concentration properties and the nano-component.
- Thus, it is important to investigate the environmental fate processes for both nanocomponent and the nano formulated insecticides.
- For a fair risk assessment of the fate of nano insecticides, a new framework has to be developed and practiced in near future.
- Existing regulatory protocols for environmental risk assessment are not sufficient for nano products with different properties than conventional insecticides.

Future Scenario of Nano Formulations

- Great capability of controlled release pattern of active ingredient- can solve eutrophication & residual pesticide problem.
- Improved solubility and stabilities of active ingredient- gives effective pest control.
- Natural polymer based nano insecticides can serve useful models.
- Lack of knowledge on the efficacy of nano pesticides -further research is required before any generalization could be made.
- Comparison of nano-formulation activity with pre-existing commercial product at field level to determine practical utility.
- Use of environmental sustainability principals for the development of nano formulations to maximize their efficiency.
- Development of smart nano pesticide and hybrid nano formulations.
- Nanogels may have good future in seed dressing / coating

Conclusion

- In the present scenario, prevention of losses due to pests is one of the best options to meet the challenge of world food security.

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- It may more efficiently be done by the adoption of new and safer technologies of crop protection.
- New chemistry insecticides and nano-pesticides may exert hazardous effects on human and environment and thus could become double edged weapons.
- Therefore, active research is required for their evaluation, so that these novel technologies may serve as efficient tools for future pest management

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