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Nanopesticides in pest management

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Nanopesticides or nano plant protection products represent an emerging technological development that, in relation to pesticide use, could offer a range of benefits including increased efficacy, durability, and a reduction in the amounts of active ingredients that need to be used. A number of formulation types have been suggested including emulsions (e.g., nanoemulsions), nanocapsules (e.g., with polymers), and products containing pristine engineered nanoparticles, such as metals, metal oxides, and nanoclays. The Greek origin word 'nano' means dwarf. The major aim in the development of nano-pesticides is to lessen the environmental hazards of a pesticide active ingredient through improving the efficacy of a chemical. The absolute small size of the particles is the benefit here. The size of a nanopaticle generally ranges 1-100 nanometer and a nanometer is one billionth of a meter. The major benefits of these nanoparticles includes the improved solubility active ingredients, better stability of formulation, slow release of active ingredient and improvement in mobility caused by smaller particle size and higher surface area. The mode of action against target pests is expected to be enhanced with nanoparticles, as opposed to bulk materials. Moreover, nano-formulations provide systemic properties, uniform leaf coverage and improved soil properties to support their constructive use in agriculture. The application of synthetic pesticides has caused threat to non- target organisms and the environment due to their overuse (Savary *et.* al. 2006).

Need of Nano- Formulation:

- Meet the demands of efficacy
- Increase water solubility.
- Suitability to the mode of application
- Minimizing the damage to the environment

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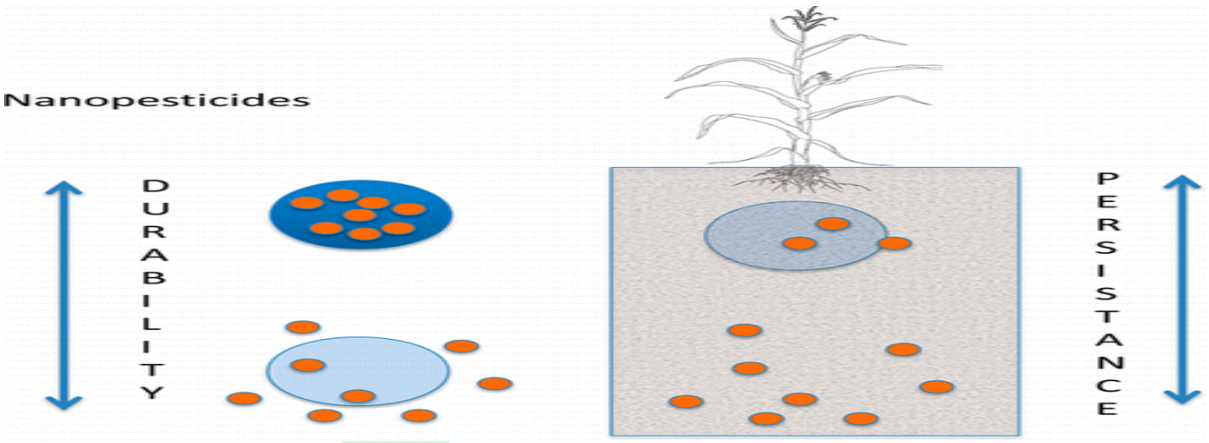

Formulations of Nano-Pesticides: Nano-pesticides are formulated according to their intended purpose as formulations improving solubility, slow release of active ingredients, prevent degradation etc.

1. **Nano-emulsions:** Consist of lipid or polymeric vesicles or particles (particle size20-200 nm) **Eg:** Oil in water nanoemulsion of neem oil has been developed for insect management using Tween 20 as the surfactant.

2. **Nano-suspension:** Submicron colloidal dispersions of pure active compounds (50-500nm) Eg: Aqueous dispersions of nano-permethin, novaluron and β-cypermethrin have been developed by researchers.

3. **Nano-encapsulation:** Packaging the nano-scale active ingradiant within a kind of tiny 'envelop' or shell. **Eg:** Controlled-release nano-formulation of the neonicotinoid insecticide

4. **Nano-fibres:** Nano-fibres are developed through electrospinning, thermal induced phase separation. Researchers have developed electospun nano-fibers loaded with the chemical, (Z)-9-dodecenyl acetate, an ingredient of pheromone which get embedded in the polymer matrix for the management of many lepidopteron insect pests.

SOLID NANOPARTICLES AS NANO-PESTICIDES: Among metals, silver, titanium oxide and copper are most preferred as nano particles. The bactericidal and viricidal activity of silver nanoparticles makes them favorable by nanotechnology researchers. The low toxicity, inherent charge, larger surface area and crystallographic structure increase its preference. The use of titanium dioxide to crops has proved effective antimicrobial and antifungal activity. Nano-copper formulations can cause cell wall damage of bacterial

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cells and found effective against pomegranate bacterial blight at very low concentrations. Cell wall damage was observed in nano-copper treated bacterial cell.

THE MAJOR ADVANTAGES OF USE OF NANO-PESTICIDES OVER CONVENTIONAL PESTICIDES ARE:

a) Nanotechnology offers a tool for developing novel formulations of eco-friendly pesticides as majority of nano-pesticide formulations are highly target specific.

b) Generally, targeted delivery and controlled release of nano-pesticides can improve pesticide utilization and reduce residue and pollution. For example, Nano-microcapsule formulations have slow release and protection performance because they have been prepared using light-sensitive, thermo-sensitive, humidity-sensitive enzyme-sensitive and soil pH-sensitive high polymer materials to deliver pesticides.

c) Nano-pesticide formulations improve adhesion of droplets on plant surface (reduces drift losses) which intern improves the dispersion and bio-activity of active ingredient (a.i.) of pesticide molecules. Therefore, Nano-pesticides will have high efficacy compared to the conventional pesticide formulations (i.e. D-Dust, G-Granule, P-Pellet, EC-Emulsifiable Concentrate, WP-Wettable Powder, WDG-Water Dispersible Granule,etc.) and due to their small size, improvable pesticide droplet ductility, wettability and target adsorption when sprayed in fields has made these nano-pesticides provide efficient and environmental friendly advantages.