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Nanoformulation of Insecticides - Novel Products

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The ever increasing human population and subsequent worldwide demand for food has urged for a better protection of agricultural crops from the infestation by different groups of insects. This initiated the intervention of modern techniques for the development of novel strategies of plant protection. Over the past decade, there has been a considerable amount of active research on the possible application of nanotechnology in the current agricultural practices including development of novel plant-protection products. In particular, designing of nanoformulation of different insecticides has emerged at high speed and which can be basically attributed to the fact that the composition of many conventional insecticides are feebly water soluble and require a delivery system for their application in the field. Compared to bulk substances, nano-insecticides have many added advantages such as: (a) less environmental contamination through reduction in pesticide application rates and reduced losses; (b) enhanced efficiency of chemical and natural insecticides by controlled release; (c) renders insecticides more susceptible to photodegradation; (d) easy/safe handling with reduced toxicity risks to animals and; (e) less toxicity towards non-target organisms compared with bulk. Among other benefits, nanoformulation of many natural insecticides (e.g. neem oil) has protected them from premature degradation in the environment and thus helped in delivering maximum impacts on the target organisms.

Polymer-based nanoformulations have been exploited for the encapsulation of most of the insecticides. Different polysaccharides (e.g., chitosan, alginates, starch), and polyesters (e.g., poly-ε-caprolactone, polyethylene glycol) have been considered for the synthesis of nanoinsecticides. The first formulation containing polymer for controlled release of biocides dates from the early 1970's. With the growing awareness for environmental pollution, application of biodegradable and biocompatible polymers of natural origin is preferred over the synthetic ones. The metabolites produced from the degradation of such polymers are of little concern. On the other hand, the growing general trend of preferring polymeric nanoformulations by researchers can be correlated to the manifestation of higher efficacy in insecticidal property of the encapsulated ingredient compared to commercial formulations. The efficacy tests have been confirmed from many field studies for different target organisms. Slow release, protection against degradation, and low solubility of the encapsulated insecticide are the most important features of polymeric nanoformulation making them first choice for nanoencapsulation. This valuable information has paved way to further development and practical application of polymeric nanoinsecticides with huge potential. Different form of polymer-based or non-polymer-based nanoformulations, such as nanosphere, nanocapsule, nanogels, micelles, nanofibers, nanometals and nanoemulsions has been proposed for encapsulation of insecticides. Among these, nanocapsules are by far the most widely used for controlled release of insecticides. Very recently, a novel concept of hybrid nanoformulation (encapsulation of nanoemulsion or liposome coating) has been suggested for the controlled release of some insecticides. However, the efficacy of the proposed novel approach needs to be tested for a broad spectrum line of insecticides.

This is highly anticipated that application of nanoinsecticides for plant protection inevitably results in new benefits to human and environmental health. However, environmental safety issue on application of nanoinsecticides has been recently addressed. In order to ensure efficacy, most of the nanoinsecticides have been designed for slow release and allowing them persistence in the environment. Thus, it is important to investigate the environmental fate processes for both nanocarriers and the nanoformulated insecticides. Existing regulatory protocols for environmental risk assessment are mostly applicable to the bulk insecticides and cannot access the nanoformulated products because of different properties. For a fair risk assessment of the fate of nanoinsecticides, a new framework has to be developed and practiced in near future.

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