Nanotechnology in the management of polyphagous pest *Helicoverpa armigera*

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Abstract
Crop loss to the turn of 30% in plants caused due to the insect pests infesting several crop plants. The use of chemical insecticides and pesticides in crop protection deteriorates soil health, water bodies and affects human health. *Helicoverpa armigera* (Hubner) is one of the serious pests which feed on more than 150 crops throughout the world. Nanotechnology is promising field of science having great application in the field of agriculture, especially in pest management. The application of nanotechnology as supplement for the existing practices or strategies like trap cropping, biopesticides and pheromones are discussed in this review.

**Keywords:** Crop loss, insecticides, pesticides, *Helicoverpa armigera*, nanotechnology, biopesticides.

Introduction
*Helicoverpa armigera* (Hubner) (Lepidoptera: Noctuidae) is a highly polyphagous pest, feeding on tomato (Sharma *et al.*, 2011), cotton (Malik *et al.*, 2000), pigeonpea (Sreekanth and Seshamalakshmi, 2005), chickpea (Ahmad *et al.*, 1989), okra (Sarate *et al.*, 2012) and groundnut (Srivatsav *et al.*, 2009) (Fig. 1). Several practices including chemical, biological and biopesticides were used for its management. The agricultural application of nanotechnology can suggest development of efficient and potential implications for overcoming of the management of pests in crops. Nanoparticles can be used in the preparation of new formulations like pesticides, insecticides, insect repellents, pheromones and fertilizers (Barik *et al.*, 2008). This review deals with the biology of *H. armigera* along with the integrated practices for the management of *H. armigera* and the scope of application of nanotechnology.

Life cycle of *Helicoverpa armigera*
*Helicoverpa armigera* completes its life cycle within 35-40 d, depending upon the crops on which it feeds on. The life cycle of this pest is being studied by Singh (1972). In July-Aug, the female moths developed from caterpillars fed on corn, chickpea, and capsicum laid 1125.4, 1173.3 and 481.5 eggs respectively. In Aug-Sep, female moths, grown on okra, corn, tomatoes, tobacco, sunflower, leucerne and cabbage laid 996.0, 847.9, 955.2, 771.7, 744.3, 673.7 and 540.0 eggs, respectively. The female obtained from caterpillars fed on tomato fruits laid about 900 eggs in all the summer months. The incubation period of eggs lasted 2.7 d in July-Aug. The development of caterpillars and the number of instar depend on the type of food provided. In July-Aug, the female larvae on tomato fruits completed development in 18 d and weighed around 432 mg, where the male moths weighed 444.5 mg. When fed on gram pods, female larvae had the shortest developmental time (9 d) attaining average weight of 479.75 mg; the male larvae too developed in 8.7 d and weighed 471.6 mg.

The rate of development on other food plants is relatively slower, being slowest in the case of sunflower (26 d).

**Fig. 1. Helicoverpa armigera** adults: (a) Male and (b) Female.

Rearing of *H. armigera* on artificial diet
Rearing of *H. armigera* on artificial diet were done according to the protocol of NBAII (Singh *et al.*, 2002). *Helicoverpa armigera* is reared on a semi-synthetic diet. The composition of the diet is includes, Fraction A: Kabuli gram (105 g), Methyl Para-hydroxyl benzoate (2 g), sorbic acid (1 g), Yeast tablets (2 capsules), Fraction B: Agar agar (12.75 g), Fraction C: Ascorbic acid (3.25 g), Multivitamin (2 capsules), Vitamin E: 2 capsules, Streptomycin sulphate (0.25 g). The room temperature should be 26 ± 1°C and relative humidity is maintained at 60-70%. Ingredients of fraction “A” are mixed in 390 mL of water and blended for 2 min. Fraction “B” is boiled in 390 mL of water and added to fraction “A” in the blender and the blender was run for a minute. Contents under fraction “C” are added and blended again for a minute. The diet is then dispensed into sterilized glass vials or plastic container to a height of 2.5 cm and plugged with cotton wool or pin holed lid.

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IPM is thus, more complex for the producer to implement, as it requires skill in pest monitoring and understanding of the pest dynamics, besides the cooperation of all among the producers for effective implementation (Dhawan and Peshan, 2009).

Use of nanotechnology in controlling H. armigera

Nanotechnology is a recent discipline which has been used in pest control. The ingenuity of nanotechnology is the potential to precisely form matter to atomic level specificity. Thus, the major benefit of employing nano-based pesticides is the opportunity to enhance properties such as efficacy and specificity. The potential application and benefits of nanotechnology are enormous. These include insect pest management through the formulations of nanomaterials based pesticides and insecticides, bio-conjugated nanoparticles for slow release of nutrients and water. Nanotechnology has promising application in nanoparticle mediated gene transfer. It can be used to deliver DNA and other desired chemicals into plant tissues for protection of host plants against insect pests (Torney, 2009).

The pediculocidal and larvicidal activity of synthesized silver nanoparticles using an aqueous leaf extract of Tinospora cordifolia showed maximum mortality against the head louse Pediculus humanus and fourth instar larvae of Anopheles subpictus and Culex quinquefasciatus (Jayaseelan et al., 2011). Encapsulated citronella oil nano-emulsion is prepared by high-pressure homogenization of 2.5% surfactant and 100% glycerol, to create stable droplets that increase the retention of the oil and slow release. The release rate depends upon the protection time; consequently a decrease in release rate can prolong mosquito protection time (Sakulk et al., 2009). Nanoencapsulation is a process through which a chemical is slowly but efficiently released to the particular host for insect pests control. Release mechanisms include dissolution, biodegradation, diffusion and osmotic pressure with specific pH (Vidyalakshmi et al., 2009). Nanopesticides, nanofungicides and nanoherbicides are being used efficiently in agriculture (Owolade et al., 2008). Nanoparticles loaded with garlic essential oil are efficacious against Tribolium castaneum Herbst (Yang et al., 2009). Nanotube filled with aluminosilicate can stick to plant surfaces, while ingredients of nanotube have the ability to stick to the surface hair of insect pests and ultimately enter the body and influence certain physiological functions (Patil et al., 2009).

Conclusion

The potential application and benefits of nanotechnology are enormous. Nanotechnology in agriculture plays a very important role in the slow release effects which includes pest control with increased shelf-life to various applications in the agricultural fields. This review indicates the importance of nanoparticles, with respect to the life cycle of the pest controlling it biologically.
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References


