Trends in Biosciences 10(6), Print : ISSN 0974-8431, 1327-1329, 2017

REVIEW PAPER

Innovation in Green-Chemical Technology for Insect Pest Management: Need for Application Oriented Research and Commercialization of Products

S. EZHIL VENDAN

Food Protectants and Infestation Control Department, CSIR-Central Food Technological Research Institute, Mysore, Karnataka
email: geneezil@yahoo.co.in

Agriculture is the main occupation of more than 60% population in India. With a projected increase in world population to 10 billion over the next four decades, an immediate priority for agriculture is to achieve maximum production and storage of food and other products in a manner that is environmentally sustainable and cost-effective. Often, the production in agriculture is reduced by losses as high as 40%, before or after harvesting, due to attack by variety of pests, including insects and nematodes, virus and bacteria induced diseases and competition by weeds (Oerke *et al.*, 1994). Insect pests are the major destroyers in agriculture industry. Since the beginnings of agriculture, farmers have developed a very wide range of farming and storage practices that contribute either directly or indirectly to pest management.

Management of stored product insects is a difficult task compared to field pests, because application of pesticides in warehouses will directly contaminate the grains and affect the human beings. Stored product insects are usually controlled by contact insecticides and with fumigants. Dusting and fumigation of grains are the most commonly used physical and chemical methods. Synthetic fumigant insecticides are currently the method of choice to protect stored grain from insect damage. Methyl bromide and phosphine fumigants have been used for decades to control stored pests. Continuous or heavy use of synthetic insecticides has created serious problems which have been the matter of concern for both scientists and public in recent years. Alternatively, environment friendly, comparatively less toxic and less expensive insecticides are urgently needed in insect pest management.

Natural products are an excellent alternative to synthetic insecticides as a means to reduce negative impacts to human health and the environment. In the current era, phytochemical and natural product studies have led to the discovery of an enormous number of compounds with a variety of chemical structures and bioactivities. Phytochemical insecticides are also known as 'botanical insecticides' and 'green-chemical insecticides'. In general, botanical insecticide investigators mostly concentrating on searching and screening of plant materials for insect pest management. In addition, newly emerging botanical insecticide scientists also following the same research trend. Recently, Isman (2014) reported that publications numbers are increasing in botanical insecticide research especially in India, China and Brazil; but the application value is less. Need of innovation in green-chemical technology is increasing with applied and product development oriented research for insect pest management. This short review aims to propose an outline of alternative way in green-chemical technology for promoting botanical insecticide research and product developments.

In botanical insecticide research, some of the reports are controversial in preliminary screening studies. In fact this information may affect progress toward botanical insecticide formulations and product development. Few examples are *Argemone mexicana* versus insect pests, screening concentration determination and positive controls in experiments. In natural environment, *Spodoptera litura* feeds on the leaves of *A. mexicana* (commonly known as a poisonous plant), it was observed by Vendan *et al.*, (2010). Whereas in the laboratory study, *A. mexicana* was reported as potential insecticidal plant and it was recommended for *S. litura* management (Malarvannan *et al.*, 2008) and also it was reported against some other insect pests. In addition, some toxic plants show remarkable results against insect pests in laboratory studies, whereas in the field trials studies their uses are not significant. As a result, it is evident that innovative research design is needed for enhancing the insecticidal action of plant substances (compounds or oils) than the preliminary researches on plant selection and screening. According to literature survey, standard lethal doses are not determined for screening of plants (crude extracts) against Lepidopteran insect pests, different doses are used as maximum 5% or 10% or 20% or 40%. Investigators should choose lowest concentrations with the expectation of highest insecticidal rate and it should be comparable to field applications. Universally known azadirachtin showing potential insecticidal activities at microgram levels and leaf crude extract showed promising activities at 1% concentration level. Recently, Isman[2] stated that one fourth of the research papers only included positive controls. According to the literature on neem insecticides research, investigators can use neem substances (crude extracts, oils and compounds) as positive control or model at lower doses for formulation of new insecticides or other products.

New chemicals are being isolated and characterized every day from plant and other biological sources. However commercialization of phytochemicals and phyto-essential oils for insect pest management is very less. Isman (2006) stated that challenges to the commercial application of plant based insecticides include availability of sufficient quantities of plant material, standardization and refinement of insecticide products, protection of technology (patents) and regulatory approval. In the United States, commercial development of insecticides based on plant oils has been greatly facilitated by exemption from registration for certain oils commonly used in processed foods and beverages (Quarels, 1996) . Some U.S. companies have introduced

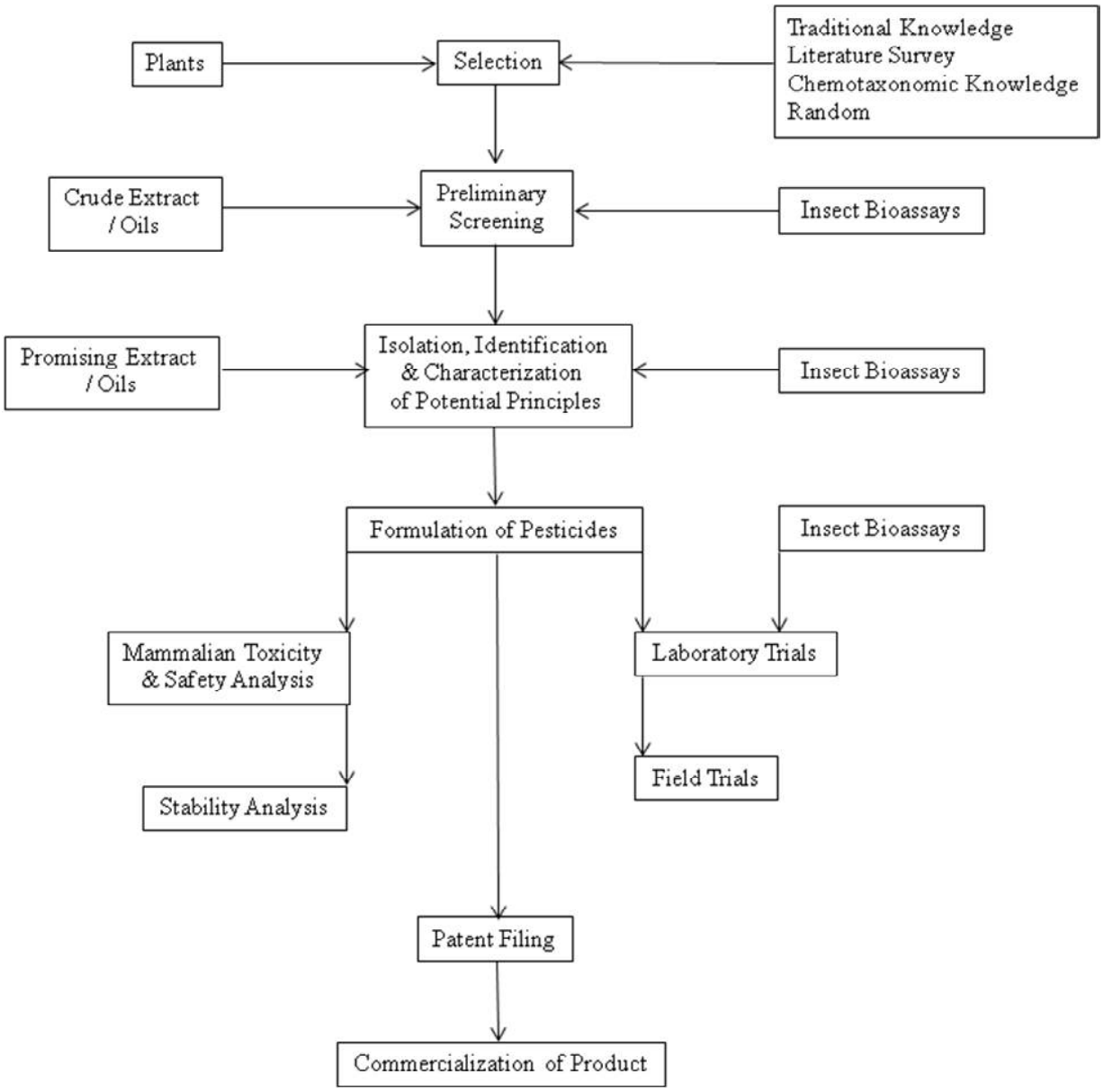

Fig. 1. Schematic general view of research on botanical pesticide formulations and product developments for insect pest management.

essential-oil-based insecticides in recent years (Koul *et al.*, 2008).

Many of the plant species have insecticidal activities; they are reported and recommended for insect pest management. Figure 1 shows a common view of formulation of botanical insecticides from plant sources. Recently, Kumar Das (2014) stated that more than 6,000 species of plants have been screened against various types of pests. Fumigant insecticidal actions of plant essential oils have been well demonstrated against stored product pests. Now, instead of searching and screening of more number of plant species, investigators can choose the following alternative ways for increasing the product productivity for insect pest management (Figure 2);

- Formulate new formulations using recorded or already reported potential plants for insect pest management
- With the collaboration of chemists, enhance the activity of insecticidal principles (phyto-compounds) by the way of structure modifications.
- Evaluate synergistic efficacies by the way of mixing of potential plants substances in scientific manner
- Studies on improvement of cultivation of pesticidal plants for more production of botanical insecticides
- Design new attractant or repellent or exterminate pest control devices using recorded or already reported substances with the support of physical and mechanical engineers
- Design and develop new bio-fumigant devices and eco-friendly bio-fumigants for stored product insect pest management

Arora *et al.,* (2009) pointed out that 40,000 metric tons of pesticides are used in India every year. However, biopesticides may represent about 4.2% of the overall

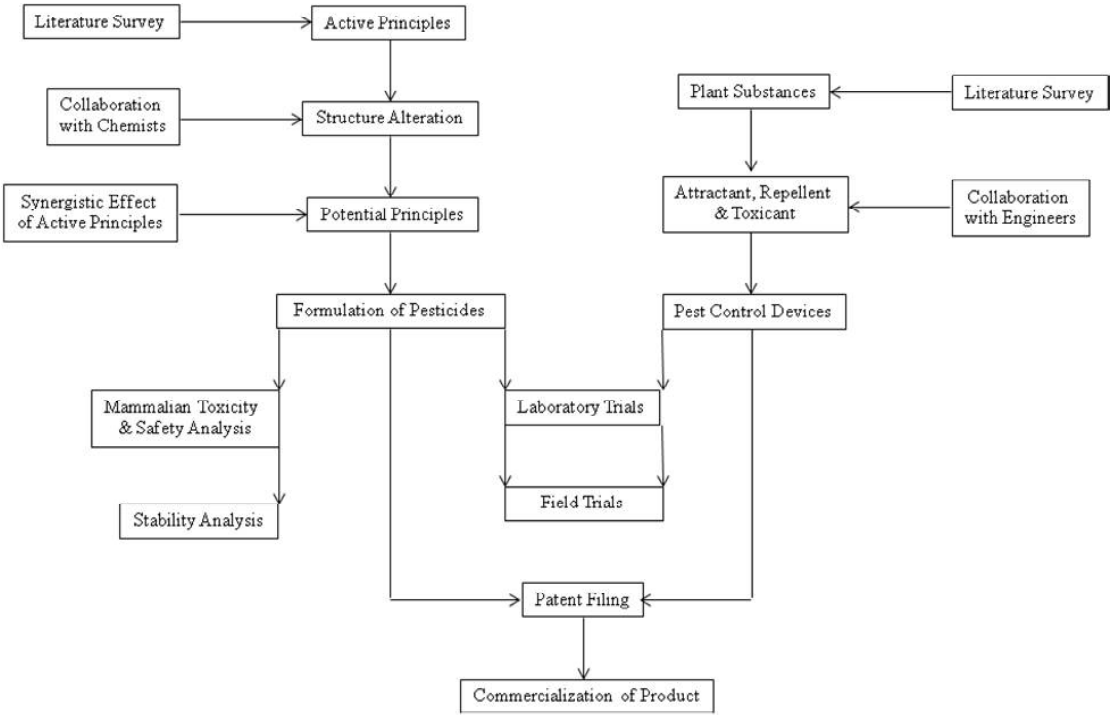

Fig. 2. Schematic alternative view of research to promote botanical pesticide formulations and product developments for insect pest management.

pesticides market in India (Das, 2014). It is a needful demand to increase more productivity of biopesticides for pest management in agriculture. Weaver and Subramanyam (Weaver and Subramanyam, 2000) suggested that fumigant activity in botanicals could have a greater potential use than grain protectants in future on the basis of their efficacy, economic value and use in large-scale storages. Accordingly, plant essential oils based bio-fumigant techniques and equipments can be developed for large scale stored product protection. Recently, Packiam *et al.*, (2012) formulated and patented a phytopesticide 'Ponneem' for field crop insect pest management, and few pest control devices were developed and patented by Mohan from Tamil Nadu Agricultural University (TNAU), Coimbatore for stored product insect pest management (http://agritech.tnau.ac.in/patents/patent%20updated%20%202013.pdf). Similarly, new more eco-friendly pesticides and pest control devices are essential for promoting Integrated Pest Management (IPM) and environment safe organic farming in India.

LITERATURE CITED

Oerke, E. C., Dehne, H. W., Schonbeck, F. and Weber, A. 1994. Crop production and crop protection: Estimated losses in major food and cash crops. *Elsevier Science; Amsterdam,* 808.

Isman, M. B. 2014. Botanical insecticide research: many publications, limited useful data. *Trends Plant Science*, 2014, **19**, 140-145.

Vendan, S. E., Lingadurai, S., Paulraj, M. G. and Ignacimuthu, S. 2010. Incidence of *Spodoptera litura* Fab. (Lepidoptera: Noctuidae) on *Argemone mexicana* Linn. (Papaveraceae). *Insect Environment*, **16**, 20-21.

Malarvannan, S., Giridharan, R., Sekar. S., Prabavathy, V. R. and Nair, S. 2008. Bioefficacy of crude and fractions of *Argemone mexicana* against tobacco caterpillar, *Spodoptera litura* Fab. (Noctuidae: Lepidoptera). *Journal of Biopesticide,* **1**, 55-62.

Isman, M. B. 2006. Botanical insecticides, deterrents, and repellents in modern agriculture and an increasingly regulated world. *Annual Review of Entomology*, **51**, 45-66.

Quarels, W. 1996. EPA exempts least-toxic pesticides. *IPM Practice*, **18**, 16-17.

Koul, O., Walia, S. and Dhaliwal, G. S. 2008. Essential oils as green pesticides: potential and contraints. *Biopesticides International,* **4**, 63-84.

Das, S. K. 2014. Recent development and future of botanical pesticides in India. *Popular Kheti*, **2**, 93-99.

Arora, S., Dureja, P., Kanojia, A. K. and Bambawale, O. M. 2009. Pesticides, their classification based on WHO and global status of hazardous pesticides. P. viii, 110. National Centre for Integrated Pest Management, Lal Bahadur Shashtri Bulding, Pusa Campus, New Delhi.

Weaver, D. K. and Subramanyam, B. 2000. Botanicals. In: *Alternative to pesticides in stored product IPM* (ed. Subramanyam, B. H. and Hagstrum, D. W.,) Kluwer Academic Publishers, MA, pp. 303-320.

Packiam, S. M., Anbalagan, V., Ignacimuthu, S. and Vendan, S. E. 2012. Formulation of a novel phytopesticide *PONNEEM* and its potentiality to control generalist herbivorous Lepidopteran insect pests, *Spodoptera litura* (Fabricius) and *Helicoverpa armigera* (Hubner) (Lipidoptera: Noctuidae). *Asian Pacific Journal of Tropical Disease*, **S2**, 720-723.

Received on 01-02-2017 *Accepted on 07-02-2017*