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Review Paper

Plant Based Biopepticide: An ecofriendly approach for Pest Control

DIPA KUMARI

Department of Zoology, R. N College, Pandaul, Madhubani, L. N. Mithla University, Darbhanga-846008

***Corresponding author's e-mail: deepa.kumari1970@gmail.com**

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ABSTRACT

Plants can be insecticidal, antimicrobial to bacteria, fungi, viruses and some are herbicidal too. The application of botanical pesticide for crop and stored product protection from insect pest has been a part of traditional agriculture for generation. Plant based biopesticide have environmentally friendly characteristic such as volatile nature, low environmental risk compared to current synthetic pesticide. The advance research and development in the field of biopesticide greatly reduce the environmental pollution caused by chemical pesticide. India has a vast potential for plant based biopesticides and leads in the use of botanicals where a number of products are registered under provisional registration. Through this review, I would like to highlight the role of plant based biopesticides in agriculture, its present status and future prospect in crop protection.

Keywords: *Insecticidal, Antimicrobial, Commercialization, Regulatory.*

INTRODUCTION

Chemical pesticides play an important role in the green revolution which can realized high yield varieties and the most effective pest management. Use of chemical pesticides and fertilizers have caused negative impact on environment by affecting soil fertility, water hardness, development of insect resistance, genetic variation in plant, increase in toxic residue through food chain and animal feeding thus increasing health problem and many more. An ecofriendly alternative to chemical pesticide is biopesticide. Biopesticide is a formulation made from naturally occurring substances that control pests by nontoxicity in ecofriendly manner hence gaining importance all over the world. Use of plant based biopesticides is now emerging as one of the important means to be used in protection of crop produce and the environment from pesticide pollution. Increasing health consciousness of people have created a demand of organic food. This indicates huge scope for growth of plant based biopesticides sector.

The application of botanical pesticide for crop and stored product protection from pest has been become a part of traditional agriculture. In general botanical pesticide are isolated from parts of plant such as leaves, barks, fruits, seed or seed kernels. The higher plants have the ability to synthesize and produce numerous secondary metabolites which alter the behaviour and life cycle of insect's pest which are called as semiochemical. Plants can be insecticidal, antimicrobial to bacteria, fungi, viruses but some are herbicidal. Many plant based pesticide exhibiting broad spectrum of activity against pest considered as attractive alternative to synthetic chemical pesticide as they are biodegradable, target specific, and pose more or less hazard to the environment. The future of botanical in modern concept of integrated pest management system appear to be very promising as they are biodegradable in

nature and much safer to higher animals including humans because of their low mammalian toxicity.

Plant diversity has provided on excellent source of biologically active material for use in traditional crop protection. Over the years more than 6000 species of plant have been screen and more than 2500 plant species belonging to 235 families (Saxena, 1998) were found to possess biological activity against various categories of pest. It has been observed that certain plants repel pests from stored food products, cultivated field and houses. Progress in plant biology and pest interrelationship studies as well as the mechanism of action of chemistry of natural substances showed that there repellent activity are connected to the existence of compound biosynthesized by plants and related mostly to secondary metabolism. Successful use of traditional botanicals aroused further interest on exploring plant diversity for new bioactive phytochemical as possible source of pest control agent.

The present review deals with plant based biopesticides used in protection of crop produce. The study is based on secondary data which has been collected from different sources.

Some of the plant products used for pest control are briefly described below

Neem (*Azadirachta indica*):

Contain several chemicals including azadirachtin which affects the reproductive and digestive process of a number of important pests. Neem is most promising plant used effectively and extensively for insect pest management program. Chemistry and use of Neem in pest control is well documented (Iman, 2006 and Koul, 1996) . It can contro1 431 insect species from several orders (Singh and Saxena, 1999) Research carried out in India and abroad had led to the development of effective formulation of Neem which are being commercially produced. As Neem is non toxic to bird and mammals and is non carcinogenic, its demand is likely to increase.

Dozens of studies have demonstrated the toxicity of Neem oil, oil cake, extract leaves, roots or root exudates against many species of nematodes. Azardirachtin is highly photolabile, either breaking down or isomerising under sunlight which led to significant reduction in bioactivity.

Turmeric (*Curcuma longa*):

Essential oil extracted from the leaves of turmeric.

Curcuma longa was investigated for contact and fumigant toxicity and its effect on progeny production in stored product beetles *Rhizopertha dominica* (lessergrain borer) *Sitophilus oryzae* (rice weevil).

Chinese Bitter Sweet (*Celastrus angulatus*):

The powdered root bark of chinese sweet (*Celastrus angulatus*) is traditionally used in china to protect plant from insect damage.

Euronymus bungeanus are antifeedant against pieris rapae.

Schoenocaulon officinale: Sabadilla are the among the most potent natural product insecticide.

Annonaceous actogenin are the slow stomach poison particularly effective against chewing insects such as Lepidoptera and the Colorado potato beetle (Leptinotarsa decemli neata). Annonaceous acetogenius are their crude extract can be employed as safe effective

economical and environmentally friendly pesticide within an emphasis on the home garden, ornamental green house and market.

Melia Azedarach: Fruit extract of media Azedarach and its recently described limonoid were investigated. The antifeedent activity of herbivore and granivore insect through choice test.

Epilachana paenulata germ (Coleoptera) coccinellidae larvae reared on the food treated with fruit extracts of melia azedarach ate less, gained less weight and suffered greater mortality rates than control larvae.

Mammey (*Mammea americana*):

Seed and leaf extract of Mammea americana (mamey apple) have a historical use as a biopesticide with Mammea leaves are wrapped around young tomato plant to keep mole cricket and cut worms away. The same effect is also obtained from infusion of half ripe fruits. Mendes, John (1986),

Basil (*Ocimum basilicum*):

Basil oil and its three major active constituents (trans-anethole, estragole and linalool) obtained from basil effective against tephritid fruit fly, *Bactrocera dorsalis*.

Quassia (*Quassia amera*):

Quassia amare wood chips or bark is used as a natural insecticide for getting rid of head lice, flies, ants, aphids, mosquitoes in fish pond without killing fish.

Sweet Flag (*Aconus calamus*):

Repellant activity of *Aconus calamus* against beetle of *Tribolium castaneum* (red flour beetle) and *Tribolium confusum* (confused flour beetles).

Artemisia monosperma: This has been reported to contain under light induced condition has been found to be as active as DDT against housefly *Musca domestica* and cotton leaf worn *S. littoralis* larva.

Aglaia:

Genus Aglaia have revealed the presence of rocaglamides aglains triterpenes and ligrans with interesting biological activities. Rocaglamides derivative have strong insecticidal activity against neonate larva of *Spodoptera littoralis* .

Tabebuia serratifolia showed antifugal activity

Tagetes minuta exhibits root extract of nematocidal activity against several herbivurous insect such as *M.sexta* and mosquito like *Aedes aegypti.*

Solanum tuberosum: Tomatine and solanine the steroidal alkaloid glycosides from *Solanum tuberosum* and *Lycopersian esculentum* and their aglycone tomatidine and solanidine exhibit antifeedent properties. These have insecticidal and nematicidal action.

Pyrethrum:

This is the most widely used botanical extracted from the flower of *Chrysanthemum cinerariasefolium*. It is highly effective against house flies mosquitoes ,flea , lice and many other indoor arthropods pest. Pyrethrin have low toxicity to vertebrate and have wide acceptance world wide. Like most other natural pesticides pyrethrum are labile have limited stability under field condition and rapidely degraded by sunlight.

Rotenone:

This is the first generation of botanical pesticide have extensively used in past to control house hold and agriculture pest. Its use however had to be dispensed with due to high fish/mammalian toxicity. It is obtained from root of Derris.

Oleander (*Nerium* oleander):

Larvicidal activity of *Nerium oleander* (Apocynaceae) flower extract against culex quinque fasciatus mortality. Leaf extract of *Nerium oleader* insecticidal against *Trogoderma granarium* and *Drosophila rufa* larvae in feed.

Chilli (*Capsicum annuum*):

Chilli have numerous species and varieties and have been used for many centuries. A repellent effect of chilli powder or extracts was observed against *Callosobrunchus maculatus*, *Rhyzopertha dominica*, *Sitophilus zeamais* Motsch and *Tribolum oryzae*.

Nicotine (*Nicotiana tobacum*):

Nicotine an alkaloid obtained from *Nicotiana tobacum* is well established botanical insecticide however due to high mammalian toxicity and detrimental effect on human health , its use as an insectide has decreased considerably (Table 1).

Table 1
List of Plants used as Biopesticide

Common Name	Botanical Name	Family	Effective range	Plant part used
Annona	*Annona reticulatc*	Annonaceae	Contact and stomach poison antifeedant	Seeds
Andean lupin	*Lupinus mutabilis*		Antifeedant nematicidal fungicidal	seed
Basil	*Ocimum basilicum*	Lamiacae	Insecticidal, repellent growth inhibiting aginst ticks	Leaves ripe seeds and essential oil
Bystropogon *sp.*		Labiatae	Protectant for stored products	Powder bark seeds oil leaves
Chilli	*Capsicum annuum*	Solanaceae	Stomach poison antifeedant repellent	Fruit
Derris	*Derris elliptca*	Leguminosae	Contact and stomach poison	Roots
Garlic	*Allium sativum*	Lilianceae	Insecticidal and repellent. Insectidical ,repellent ,antifeedant, bactericidal, fungicidal, nematicidal and effective against ticks	Cloves
Karanja	*Pongamia pinnara*	Leguminosae	Insecticidal	Seeds oil
Madre da cacao	*Gliricidia sepium*	Leguminosae	Rat poison	Seeds or powder bark
Malabar Nut	*Adhatoda vasica*	Acanthaceae	Insecticidal, fungicidal	Leaves
Mammey	*Mammea americana*	Guttiferacae	Contact and stomach poison, insecticidal, repellent, nematicidal and effective against ticks	Seeds
Melon tree	*Carica papaya*		Fungicidal	Leaves
Mugwort	*Artemisia vulgaris*	Compositae	Bactericidal, fungicidal and insecticidal properties	Leaves
Neem	*Azadirachta indica*	Meliaceae	Insecticidal, repellent,	All plant parts

			antifeedant, nematicidal	
Oleander	*Nerium oleander*	Apocyanaceae	Rat poison,grain protectant	Leaves
Persian Lilac	*Melia azedarach*	Meliaceae	Contact and stomach poison. Insecticidal, repellent, antifeedant, growth inhibiting, effective against ticks	Dried leaves
Physic Nut	*Jatropha curcas*	Euphorbiacae	Molluscicide, rodenticide and as an insect repellent	Laves and seeds
Pyrethrum	*Chrysanthemum cinerariaefolium*	Compositae	Pure contact poison. Insecticidal, repellent, antifeedant	Flowers
Quassia	*Quassia amera*	Simarubaccae	Contact and stomach poison insecticidal, larvicidal, nematicidal, Quassia also acts systematically	
Ryania	*Ryania speciosa*	Flacourtiaceae	Contact and stomach poison	Dried roots, leaves or stalks
Sabadilla	*Schoennocaulon officinale*	Liliaceae	Contact and stomach poison insecticidal, repellent, rodenticidal	Seeds
Sweet Flag	*Acorus calamus*	Araceae	Insecticidal, repellent, antifeedant, antifertile	Dried rhizomes
Sweet Pigweed	*Chenopodium ambrosioides*	Chenopodiaces	Grain protectant	Oil
Tomato	*Lycopersicon esculentum*	Solanaceae	Repellent, prevents egg laying	Leaves
Turmeric	*Curcuma domestica*	Zingiberaceae	Insecticidal and repellent	Root

In Asia, India leads in the use of botanicals where a number of products are registered under provisional registration. Among the lastest commercial botanical, neem based product seem to have good future. However apart from neem some botanicals have demonstrated their antifeedent efficacy in the field. Several essential oil based insecticides fungicides and herbicides using rosemary oil, clove oil and thymine oil as active ingredients have been developed particularly for control of green house pests and disease and for control of domestic and veterinary pest (Koul *et al*., 2008). Several smaller companies in united states and the united kingdom have developed garlic oil and mint oil pest control product for home and garden use.

PRESENT STATUS

Advantages and Obstacles for Commercial Development of Plant based Biopesticides

To the environmental hazards generated by synthetic pesticide one can easily oppose all the advantages for using them in IPM. As product of metabolism resulting from species co-evolution plant product have in fact many environmental advantage (Regnault - Roger, 2005c).

* They possess a selectivity and specificity in their effects on the target species.

* Biosynthesized, they are enzymatically biodegradable with, in general, short half lives.

* The association of several compounds can be synergistic decreasing the effective amount of active ingredients.

* They belong to several different chemical families.

It is necessary to raise the question of impending factors that limit commercial development. According to Isman (2005 a) the industrial development of formulation containing plant compound is subjected to several factors or challenges to commercialize plant based pesticide include non availability of sufficient quantities of plant material. In addition as the chemical profile of plant *sp*. can vary naturally depending on geographic genetic climate, annual or seasonal factors. Pesticide manufactures must take additional steps to ensure that their products will perform consistently. Procedure of regulatory approval in the countries that represent the most economically interesting markets. The difference of procedure between north America and Europe has significant consequences at the commercial level. Regnault (Roger, *et al*.). Necessity of an appropriate regulatory approval for plant based biopesticide.

Even though farmers realise the importance of using plant products as alternative to chemical pesticide, the wide spread use of the product will take a while to become very popular. One of the way by which they become very popularise it to process it and make it available to the farmers in a readily usable form.

As the synthetic pesticide the improper and excessive use of botanical pesticides may also develop pest resistance. The phytotoxicity is also a matter of botanical pesticides such as neem oil based biopesticide is often phytotoxic to tomato, brinjal and ornamental plant at high oil levels. Although plant extracts are considered to be relatively safe to humans still this is not yet confirmed for all plant species such as Aconitum *sp.* and *Ricinus communis* have notoriously high toxicity to man and *Tephrosia vogeli* having well known adverse effects against fish.

FUTURE PROSPECTS

The bioactive compounds isolated so far is countless and some of compounds may also contribute in future to develop novel plant based biopesticide of organic food production. The appropriate selection of biomolecule to prepare biopesticide with multiple mode of action against target pest is unquestionable safer alternative for organic food production. Recent development in this field of research is disseminated to the scientific world through journal of biopesticide are greatly appreciated.

The prospects of new source of active substance within tropical and temperate flora for being incorporated in pest control formulation will contribute to widen the range of available biopesticide of plant origin.

Improvement in the knowledge of interspecific relationship between plant versus phytophagous insect and pathogen and mechanism of plant defence have shown that plant based biopesticide play an important role in plant self protection against pest and parasites. These biopestcide have an unquestionable potential as alternative and innovating approaches to plant protection.

The potential of synthetic modification to improve upon a natural product or a lead molecule has been demonstrated successfully in the past with discovery of synthetic analogues with improved activity and enhanced stability. Such fascinating development shall continue to emphasize the importance of nocturnal products as important source for developing new agriculture chemicals for use in pest control.

CONCLUSION

The science of plant biopesticide is still considered to be young and evolving. The interest in organic farming and pesticide residue free agriculture produce would certainly warrant increased adoption of plant based biopesticide by farmers. Research is needed in many area such as production, formulation, delivery and commercialization of the production. We need to create awareness among farmers, manufacturers government agencies, policy makers and the common men to switch over to plant based biopesticide for pest management requirement. Locally available plant like neem, garlic, triphala *etc*. can be easily processed and made available to farmers. Journal of biofertilizers and biopesticide play important role towards advancement of our understanding about the plant based biopesticide for the food and environmental safety.

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