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Utilizing Plant-Based Insecticides as Fundamental Ingredients for Insect Pest Management

Kaushik Kumar Das[1,*] and Surender Singh Yadav[1]
[1]Department of Entomology, CCS Haryana Agricultural University, Hisar, Haryana, India-125004

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Abstract

The persistent use of synthetic chemicals for insect control raises concerns about their detrimental effects on human health, animals, and consumers. This has spurred a renewed interest in botanical insecticides, which offer minimal costs and ecological side effects. These botanicals serve as effective alternatives to synthetic compounds, operating through repellent, feeding deterrent, toxicant, growth retardant etc. mechanisms. The exploration of plant-derived solutions underscores the importance of transitioning towards safer and environmentally conscious insect control methods in sustainable agriculture.

Keywords: Insecticide, Botanicals, Azadirachtin, Insect pests.

Introduction

Botanicals being plant secondary metabolites offer an attractive and favourable alternative for pest management. Many secondary metabolites, such as phenolics, terpenes, alkaloids, lignans, and their glycosides, are produced by higher plants. These are important components of the plant defense system and can be effectively used for the production of novel pesticides (Lydon and Duke, 1989). Compared to their synthetic counterparts, the development process for plant-based insecticides is more laborious; however, the reduced environmental impact of these insecticides makes them a desirable substitute.

Botanical insecticides used in pest management

Pyrethrum

Pyrethrum is extracted from the flower *Chrysanthemum cinerariaefolium*. It targets insect's nervous system after ingestion and causes rapid paralysis, exhibit fast knockdown action. Due to low mammalian toxicity, it can be effectively applied on field and horticultural crops.

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Rotenone

Rotenone is broad spectrum stomach poison, derived from roots of two tropical leguminous plant *Lonchocarpus* spp. and *Derris* spp. It disrupts the cellular metabolism and influences the respiratory system of insects. It shows toxicity to mammals when inhaled; skin contact can result in irritation and inflammation (Guleria & Tiku, 2009).

Azadirachtin

Azadirachtin is a limonoid, a type of secondary metabolite derived from the neem tree. It is considered a tetranortriterpenoid, is derived from neem seeds and has gained popularity in organic and sustainable agriculture due to its relatively low toxicity to non-target organisms and its environmentally friendly characteristics. It acts by disrupting various physiological processes in insects, such as interfering with feeding, growth, development, and reproduction.

Ryania

Ryania is in a botanical extract derived from the roots of the plant *Ryania speciosa*. Ryanodine, the active alkaloid primarily acts as a muscular poison by interfering with the release of calcium ions from the sarcoplasmic reticulum in striated muscles of insects. It causes paralysis and death in insects that come into contact with or ingest it.

Sabadilla

The alkaloid is derived from the seeds of tropical lily plant *Schoenocaulon officinale.* It is a nerve poison, causes paralysis and death of insects. Veratridine and cevadine are the essential ingredients which shows the insecticidal property mostly against chewing pests. It is sensitive to sunlight, breaks down quickly leaving no toxic residue (Guleria & Tiku, 2009).

Nicotine

Nicotine is obtained from the leaves and stems of tobacco plant, commercially available as nicotine sulphate. It causes severe disruption and failure of central nervous system. Warm blooded mammals and insects are sensitive to nicotine toxicity. It is mostly used as fumigants under greenhouse conditions against sucking and chewing pests.

Limonene

Citrus peel extracts is used as contact poison against mites, aphids, whitefly etc. it is mostly nerve poison and absorbed via skin contact.

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Various effects of botanicals on insect pests

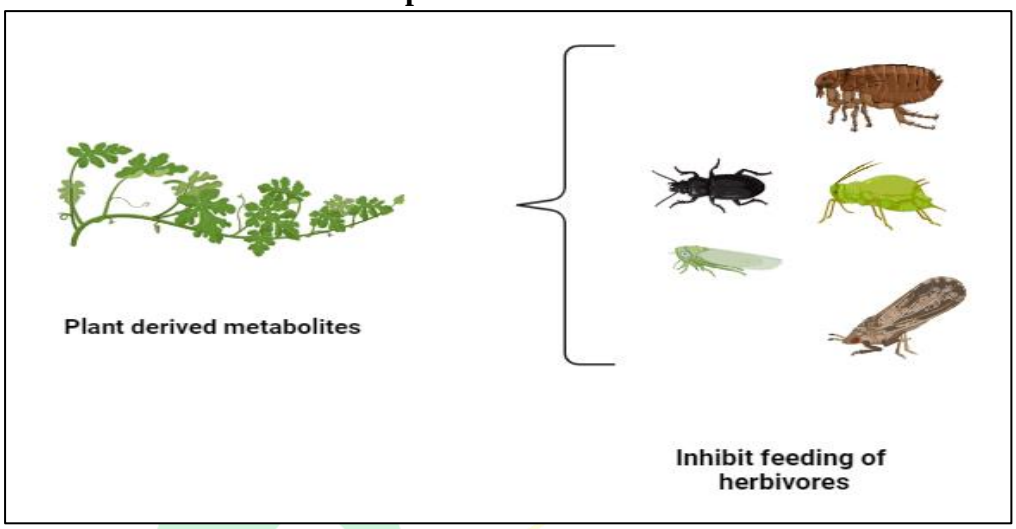

Fig. 1. Botanicals and their target pests

Antifeedants

These substances derived from plants that have the ability to inhibit feeding of herbivores. They work by affecting the feeding behaviour of the target organisms, making the treated plants less palatable or attractive to herbivores. The oil extracted from paperbark plant (*Melaleuca alternifolia*) shows antifeedant effects against the gram pod borer (*Helicoverpa armigera*) (Liao *et al.*, 2017)

Repellents

Repellents deter pests from approaching or feeding on treated plants by affecting their olfactory or other sensory receptors. For example, coriander (*Coriandrum sativum*) oils for applying in organic food protection due to repellent activity of essential oils on *Tribolium confusum.*

Toxicity

Botanicals have toxic effects on insects and other organisms that attempt to feed on or damage the plants, disrupting their physiological processes. *Lavandula angustifolia* essential oil exhibited significant contact and fumigant properties against granary weevils. Thymus vulgaris, commonly known as thyme essential oil, has shown significant larvicidal activity against *Culex pipiens* (Hikal *et al.*, 2017).

Growth retardants

Growth regulators often interfere with the insect's endocrine system, affecting the synthesis or action of hormones that regulate growth, metamorphosis. Neem seed oil

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considerably lengthened the development period of aphids that survived to adulthood while also raising nymphal mortality rates of 80 and 77%, respectively.

Reproduction inhibitors

Plant extracts combined with grains have been shown to reduce insect egg layings, postembryonic growth, and offspring development. Hexane extracts derived from Andrographis *lineat* exhibited 100% ovicidal efficiency against *Anopheles subpictus* (Elango *et al.*, 2009).

Factors associated with the use of botanicals

- **Availability of Raw Materials: -** A steady supply of raw materials and, more crucially, a cultivable source plant are required for the industrial manufacturing of botanical pesticides.
- **Chemical standardization: -** Chemical standardization important for maintaining a consistent chemical profile of the botanical product to ensure its biological activity (Guleria & Tiku, 2009).

Advantages of botanicals

- Derived from natural sources, often considered environmentally friendly.
- Biodegradable and generally have lower environmental impact.
- Can be part of integrated pest management (IPM) strategies

Disadvantages of botanicals

- The onset of action of botanicals can be slower than some synthetic pesticides
- Botanicals pest control is mostly a prophylactic control, once the pest reaches the ETL, curative measures should be adopted.

Conclusion and Prospects

Insect pest management with botanicals is a potential approach to sustainable farming. Using chemical substances produced from plants provides a greener alternative to synthetic pesticides and is consistent with integrated pest management principles. Despite obstacles like inconsistent effectiveness and legal restrictions, botanicals have shown benefits including less of an adverse effect on the environment and a decreased chance of resistance emerging. To fully utilize botanicals pest management, more investigation and technological developments in chemical standardization, and application techniques are required.

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