Role of Botanicals and Bio Control Agents in Plantation Crops and Major Spices

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ABSTRACT

Crop pest protection is one of the world's most pressing issues. Synthetic insecticides are constantly employed to control insects; nevertheless, their toxicity puts the health of farm workers, livestock, and food consumers at risk. Because of their ecological side effects and low cost, botanical pesticides have garnered renewed study in response to the detrimental effects on human health. The use of plant compounds (flavonoids, essential oils, glycosides, alkaloids, fatty acids, and esters) with anti-insect properties is reviewed here, along with their value as a substitute for chemicals that are employed in various insect removal scenarios, such as growth retardants, repellents, feeding deterrents/antifeedants, attractants, toxicants, and chemosterilants. Botanical pesticides are safe, residue-free food sources that only harm targeted insects—they do not eliminate helpful natural adversaries. As a result, we advise employing botanical insecticides in conjunction with an integrated pest control approach to significantly decrease the usage of synthetic insecticides.

INTRODUCTION

Natural substances called "insect toxins" that are obtained from fresh or dried plant parts, minerals, or plants and dissolved in ethanol, water, or other organic solvents, along with other extractives like essential oils and oleoresins, are known as botanical insecticides. They are also called natural insecticides. Furthermore, insecticide resistance to synthetic pesticides resulted in large food losses due to chemical failure in

pests and yearly economic losses of several billions of dollars globally. This review will concentrate on the use of botanical products for the biological control of insects in crop production. We categorize the effects of botanical pesticides on insects and give a summary of them from a chemical perspective.

Types of botanical insecticides

1) **Essential oils:** Synthetic or chemical pesticides can be effectively substituted by plant secondary natural products, which are natural compounds derived from aromatic plants. Additionally, the Food and Drug Administration (FDA) of the United States has acknowledged that essential oils, or botanical pesticides, are safer than synthetic pesticides that raise the risk of ozone depletion, neurotoxicity, carcinogenesis, teratogenic effects, and mutagenic effects in non-targets, as well as cross- and multi-resistance in insects (Regnault-Roger, Vincent, & Arnason, 2012).

2) **Alkaloid:** The most significant class of naturally occurring compounds that have been linked to the biological processes of the majority of plants and are crucial to their insecticidal qualities is alkaloids.

3) **Flavonoids:** Flavonoids could be useful in a pest-management strategy. Plants use flavonoids to defend themselves from herbivores and insects that feed on plants.

4) **Glycosides:** Plant defense compounds, or cyanogenic glucosides, are found in some plant species and are thought to play a significant part in a plant's ability to fend off herbivores. As fumigants, they work well against insects found in stored products. Cyanohydrins are an alternative fumigant that can also be utilized as a soil fumigant because of their insecticidal activity.

5) **Esters and fatty acids:** They produce fast toxic effects at low concentrations, leading researchers to conclude that fatty acid mixtures are poisonous and repellent against strains of the main pests that are resistant to and vulnerable to insecticides. They also aid in reducing the body weight of larvae.

Classification of botanical Insecticides

The physiological traits of the insect species and the type of insecticidal plant determine how different insects are affected by botanical insecticides are divided into 6 categories given below:

1. **Repellants:** A botanical pesticide have a repellent property, where keeps away the insect pest, and protect the crops (Isman, 2006) with minimal impact on the ecosystem, as they drive away the insect pest from the treated materials by stimulating olfactory or other receptors

2. **Feeding deterrents/antifeedants:** Botanical pesticides that make the treated materials unappealing or disagreeable to insects inorder to prevent or interfere with their feeding. The insects stay on the treated material for an extended period of time before starving to death.

3. **Toxicity:** Certain toxic plant insecticides kill stored product insects (Wachira *et al*., 2014).

4. **Growth retardants and development inhibitors:** Insect growth and development were negatively impacted by botanical pesticides, which caused the weight of the larva, pupa, and adult stages to decrease and the development phases to extend.

5. **Sterility/reproduction inhibitors:** A chemosterilant, a chemical substance used to control economically damaging or disease-causing pests, can be used to

induce sterility (Chaudhary *et al*., 2017). It prevents the maturation of the young into a sexually functional adult stage or by causing temporary or permanent sterility of one or both sexes.

6. **Attractants:** Botanicals that cause insects to make oriented movements toward their source are called insect attractants. They affect the sensilla, or gustatory (taste) and olfactory (smell) receptors. They can be used to direct insects to the incorrect oviposition sites, causing hunger or the production of unfertilized eggs, which will reduce their population.

TABLE 1: VARIOUS BOTANICALS DERIVED FROM PLANTS

Crop	Plant part used	Active principle	Mode of action
Neem (*Azadirachta indica*)	Leaves, fruits, seeds	Azadirachtin	Insecticidal, ovicidal, anti feedant, repellant, oviposition deterrent, insect growth regulator
Pongamia (*Pongamia pinnata*)	Leaves, fruits, seeds and roots	Pongamol and pongapin	Insecticidal, ovicidal, anti feedant, repellant, oviposition deterrent, insect growth regulator
Derris (*Derris elliptica*, *Derris chinensis*)	Roots	Rotenone	Insecticidal and anti feedant
Custard apple (*Annona squamosa*)	Leaves and bark	Annonin and squamocin	anti feedant, oviposition deterrent, insect growth regulator
Ryania (*Ryania speciosa*)	Roots, leaves and stalks	Ryanodine	Contact and stomach poison
Nirgudi (*Vitex negunda* and *Vitex trifolia*)	Leaves, flowers and roots	Vitexin and Negundoside	Insecticidal, anti feedant, repellant
Chrysanthemum (*Chrysanthemum cinerarifolium*)	Leaves, flowers and roots	Pyrethrin I, Pyrethrin II, Jasmolin I, Jasmolin II, Cinerin I, Cinerin II	Insecticidal, ovicidal, anti feedant
Chilli (*Capsicum annum*)	Leaves, fruits	Capsicin	Insecticidal, repellant, oviposition deterrent
Sweet flag (*Acorus calamus*)	Rhizomes	Calamol	Insecticidal, ovicidal, anti feedant, repellant, oviposition deterrent, chemosterilant effect
Ocimum (*Ocimum sanctum*, *Ocimum basilicum*)	Leaves, stems and plant oil	Ocimim, Juvocimene I, Juvocimene II	Insecticidal, ovicidal, anti feedant, repellant, oviposition deterrent, insect growth regulator
Datura (*Datura stramonium*)	Leaves, fruits, roots and seeds	Atropine	Insecticidal, ovicidal, anti feedant, repellant
Tobacco (*Nicotiana tabacum*)	Whole plant	Nicotine and Nornicotine	Insecticidal, ovicidal, oviposition deterrent
Garlic (*Allium sativum*)	Leaves, flowers, whole plant, bulbs	Allicin, Diallyl disulphide	Insecticidal, ovicidal, anti feedant, repellant
Marigold (*Tagetus erecta*)	Leaves, flower,	Tagetone, Mycene	Insecticidal, Nematicidal, Repellant, fungicidal
Lemon grass (*Cymbopogan marginatus*)	Leaves and roots	Cymbopogone, cymbopogonol	Insecticidal, anti feedant, repellant

TABLE 2: VARIOUS BOTANICALS USED AGAINST DIFFERENT PEST AND DISEASES IN MAJOR PLANTATION AND SPICE CROPS

Crop	Name of the pest	Botanicals	Bio control agents
Coconut	Rhinoceros beetle (*Oryctes rhinoceros*)	NSKE powder 100gm/palm	**Microbials:** Baculovirus, *Metarrhizium anisopliae* **Predators:** *Santalus parallelusm*, *Pheropsophus occipitalis*, *Harpalus sps*, *Scarites sps*, *Agrypnus sps*, *Platymeris laevicollis* **Nematodes:** *Rhabditid* nematodes
Coconut	Red palm weevil (*Rhynchophorus ferrugineus*)	NSKE powder 100gm/palm	**Predator:** *Chelisoches moris* **Microbials:** Cytoplasmic polyhedrosis

			virus, *Bacillus sps*, *Serratia sps*
Coconut	Black headed caterpillar (*Opisina arenosella*)	NSKE powder 100gm/palm	**Parasitoids:** *Bracon hebetor*, *Goniozus nephantidis*, *Elasmus nephantidis*, *Brachymeria nosatoi*, *Apanteles taragamae*, *Xanthopimpla punctata*, *Trichospilus pupivora*, *Tetrastichus Israeli* **Predators:** *Parena nigrolineata*, *Calleida splendidula*, *Cardiastethus sps*, *Ankylopteryx octopunctata candida*, *Cheiracanthium sps*, *Heteropoda laprosa*, *Morpisa calcutaenisis*, *Melanostoma sps*, *Olios lamarcki*, *Rhene sps*, *Sparassus sps* **Microbials:** *Serratia marcescens*
Coconut	Eriophyid mite (*Aceria guerreronis*)	20 ml Neem oil +20gm garlic extract+ 5gm soap in 1 litre of water (or)10kg neem cake /palm /yr	**Predatory mite:** *Leptotarsonemus sps*, *Bdella indica*, *Amblysieus sps*, **Microbials:** *Hirsutella thompsonii* fungi
Coconut	Slug caterpillar (*Macroplecta nararia*)	NSKE 100gm/palm /tree	**Microbials:** *Paecilomyces lilacinus* fungi
Tea	Tea mosquito bug (*Helopeltis theivora*)	NSKE 5% spray	**Parasitoids:** *Erythmelus helopeltidis*
Tea	Looper caterpillar (*Biston supressaria*)	NSKE 5% spray	

Arecanut	Rugose spiraling whitefly (*Aleurpdicus rugioperculatus*)		**Predators:** *Nephaspis oculatus*, *Encarsia guadeluopa*, *Encarsia noyesii*
Cashew	Cashew tree borer (*Placaederus ferrugineus*)	5% Neem oil	
Cashew	Cashew shoot and blossom borer (*Lamida moncusalis*)		**Predators:** *Apanteles sps*
Cocoa	Bag worm (*Pteroma plagiophelps*)	Neem oil Azadirachtin EC1500ppm	**Microbials:** *Fusarium solani*
Cocoa	Tussock moth caterpillars (*Euproctis fraterna*), Web worms (*Acria sps*)	Neem oil Azadirachtin EC1500ppm	
Turmeric	Rhizome rot/storage rot (*Rhizoctonia solani*, *Sclerotium rolfsii*)		*Trichoderma sps*
Black pepper	Foot rot (*Phytophthora capsici*)		*Trichoderma viridae*, *Trichoderma harzianum*, *Gliocladium virens*, *Arbuscular Mycorrhizal fungi*, *Paecilomyces lilacinus*
Black pepper	Slow decline (*Rhodophilus similis*, *Meloidogyne incognita*)		*Gliocladium virens*, *Arbuscular Mycorrhizal fungi*, *Trichoderma viridae*, *Trichoderma harzianum*, *Verticillium sps*, *Chlamydosporium sps*, *Pasteuria penetrans*
Ginger	Soft rot (*Pythium aphanidermatum*, *Pythium myriotylum)*		*Trichoderma viridae*, *Trichoderma harzianum*
Vanilla	Root rot (*Fusarium oxysporum* , *Sclerotium rolfsii*)		*Trichoderma viridae*, *Trichoderma harzianum*
Vanilla	Stem rot, stem blight, beans rot, beans yellowing and rotting shoot tip rot		*Trichoderma viridae*, *Trichoderma harzianum*, *Bacillus subtilis*, *Pseudomonas*

	(*Fusarium oxysporum* , *Sclerotium rolfsii*, *Colletotrichum gleosporoides*, *Phytophthora meadii*)		*fluorescens*

CONCLUSION

Natural compounds with insecticidal qualities that are isolated from plants are known as botanical insecticides. They are a great substitute for chemical or synthetic pesticides in crop protection, as they don't have the same drawbacks or adverse effects. Essential oils, flavonoids, alkaloids, glycosides, fatty acids, and other botanical pesticides have a variety of chemical characteristics and modes of action. They influence insects in a number of ways, including growth retardants, repellents, feeding deterrents/antifeedants, toxicants, chemosterilants, and attractants. Therefore, using botanical pesticides rather than synthetic ones is preferred, and organic crop growers in developed nations are aware of the benefits of using these botanical insecticides. Therefore, we advocated for the use of botanical insecticides in our country, and they are being researched to uncover new sources.

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