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REVIEW ARTICLE

Review of Mode of action of some major botanical pesticides

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ABSTRACT

Botanical pesticides or botanicals are one of the alternatives to conventional pesticides. Botanicals are secondary metabolites which are present in the plants and are considered safe. They play an important part in agricultural pest management. The major botanicals used in India are Neem based, pyrethrum, and essential oil based like eucalyptus. The mode of action of these botanicals is discussed.

Keywords: Botanical pesticides, azadirachtin, pyrethrum, eucalyptus, pest management

INTRODUCTION

Pest management is one of the key factors in agriculture. Every year around 15-20% of major agricultural crop is lost to pest infestation which is a financial loss to the country. Although large amount of pesticides are applied to protect crops from target pests, only a fraction of it acts on these pests and majority of it reaches the environment and is harmful to the biota and the existing ecosystem [1, 2].

Botanical pesticides or botanicals are naturally occurring secondary metabolites (phytochemicals) present in plants and are extracted for different applications. Botanicals due to their lack of persistence, lack of bioaccumulation in the environment and low toxicity to humans [3, 4] are good alternatives to conventional pesticides and have been used for a long time in pest management. Inspite of this the current use of botanical pesticides has been marginalised due to less understanding of the mechanism of their action.

The major commercially used botanical pesticides in the agricultural pest management are

- Neem Based Pesticides
- Rotenone
- Pyrethrum
- Plant Essential Oils(eucalyptus)

These botanical pesticides are extracted in different ways and act on a wide range of pests [5].
The review looks at the mode of action of these botanical pesticides which are widely available and used.

AZADIRACHTIN (NEEM BASED BOTANICAL PESTICIDE)	
Source:	Neem tree (*Azadirachta indica*)
Active Ingredients	Azadirachtin, Salannin, Melandriol, and other limonoids.
Action Mechanism	Mitotic inhibitor, damages the hormonal system, food poison, feeding deterrent, oviposition deterrent, and impairs metamorphosis and reproduction, mortality.
Mode of Application	Neem Extract Cakes, Neem Oil, Kernel Extract.

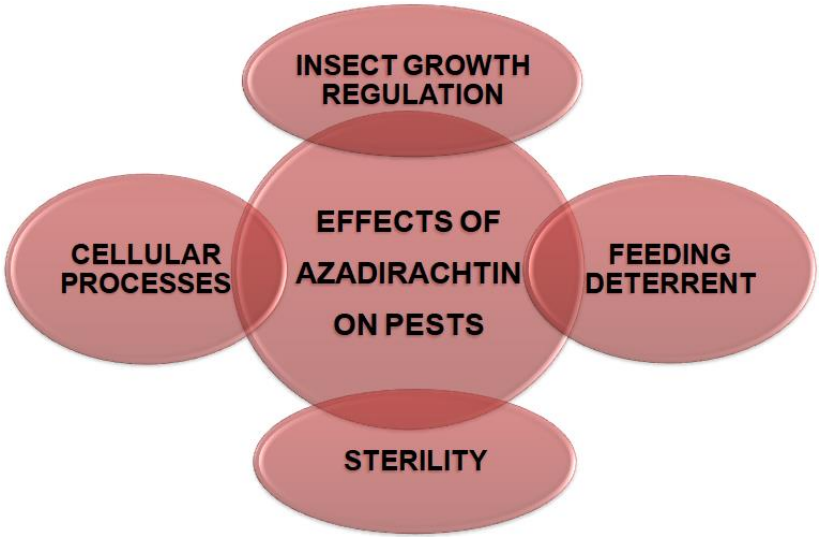

Figure 1: Effects of Azadirachtin (Neem Based) Pestidicide on Pests.

Mode of Action:
The various effects of Azadirachtin on Pests is shown in Figure 1**.** At the physiological level, azadirachtin blocks the synthesis and release of molting hormones (ecdysteroids) from the prothoracic gland, leading to ecdysis in immature insects. In adult female insects, a similar mechanism of action leads to sterility [6]. Azadirachtin, salannin, and melandriol, causes anti peristaltic wave in the alimentary canal of the insects which results in vomiting like sensation in the insects and thus neem acts as feeding deterrent. Neem controls pests by preventing the female insects from depositing eggs and this property is known as oviposition deterrent. Azadirachtin and other limonoids present in the neem based pesticides inhibits ecdysone 20 – monooxygenase, the enzyme responsible for catalyzing the final step in the conversion of ecdysone to the active hormone, 20 – hydroxyecdysone, which controls the insect metamorphosis process. These effects are probably due to the action of azadirachtin in blocking microtubule formation in actively dividing cells [7, 8]. Azadirachtin can also inhibit the release of a prothoracicotropic hormone (PTTH) and allalotropins from the brain – corpus cardiacum complex resulting in the problems of fertility and fecundity [8, 9]. Azadirachtin can also interfere with mitosis in the same way as colchicine, and has direct histopathological effects on insect gut, epithelial cells, muscles, and fatty tissue, resulting in the restricted movement and decreased flight activity [8, 10, 11, 12].

Rotenone:
Rotenone a broad spectrum botanical pesticide is extracted from the roots and stems of tropical legumes *Derris* (*Derris elliptica*, *Derris involuta*), *Lonchocarpus* (*Lonchocarpus utilis*, *Lonchocarpus urucu*) and *Tephrosia virginiana* [13,14].

ROTENONE	
Source:	*Derris* spp., *Lonchocarpus* spp., and *Tephrosia* spp.
Active Ingredients	Rotenone
Action Mechanism	Contact and food poison, cellular respiratory enzyme inhibitor, stomach poison.
Mode of Application	Dried root powder, spray.

Mode of Action:

Rotenone is both a contact and a systemic insecticide in insects. Rotenone is a cell respiratory enzyme inhibitor and acts as a stomach poison in insects [15. It disrupts cellular metabolism, acting between NAD^+ and coenzyme Q resulting in failure of respiratory function, thus inhibits the ATP production [16, 17]. In insects, rotenone exerts its toxic effects primarily on nerve and muscle cells, causing rapid cessation of feeding. Death occurs several hours to a few days after exposure [6].

Pyrethrum:

Pyrethrum is one of the most important botanical pesticides used in India, which is extracted from the flowers of *Chrysanthemum cinerariaefolium* [6]. The higher concentration of pyrethrum is found mainly in the flowers of the plant compared to other parts of the plant [14, 18, 19].

PYRETHRUM	
Source	*Chrysanthemum cinerariaefolium*
Active Ingredients	Pyrethrin I and II, Cinerin I and II, Jasmolin I and II.
Action Mechanism	Disrupts the sodium and potassium ion exchange processes in the nerve fibres, contact poison.
Mode of Application	Flower extracts as a spray or dust.

Mode of Action:

Pyrethrums are the contact poisons that rapidly penetrate into the nervous system. They exert their toxic effects by disrupting the sodium and potassium ion exchange process in insect nerve fibres and interrupting the normal transmission of nerve impulses. These insecticides are extremely fast acting and cause an immediate knockdown paralysis in insects [6]. Many insects can survive from the toxic effects of pyrethrum since the metabolic enzymes present in the insects are able to breakdown the pyrethrum into nontoxic compounds. Thus, to prevent this, pyrethrins are coupled with the synergist, piperonyl butoxide or n – octyl bicycloheptone dicarboximide which protects the pyrethrums from enzymatic degradation by the insect's enzyme system [20].

Eucalyptus Essential Oil:

Eucalyptus oil is a complex mixture of various phytochemicals such as monoterpenes, sesquiterpenes, aromatic phenols, oxides, ethers, alcohols, aldehydes, and ketones. The composition and proportion of the chemical constituents vary with the species.

Eucalyptus	
Source	*Eucalyptus spp.*
Active Ingredients	8 – cineole (eucalyptol), citronellal, citronellol, citronellyl acetate, p – cymene, eucamalol, limonene, linalool, and α – pinene
Action Mechanism	Antifeedent, Repellant, ovicidal, larvicidal, pupicidal and adulticidal,
Mode of Application	extracts as a spray or dust.

Mode of action

The bioactivity of the essential oil depends upon the type and nature of the constituents and their individual concentration. It also depends on the species, season, location, climate, soil type, the methods used to process the plant material to extract oil [21]. 1,8-cineole present in Eucalytus has the maximum pesticidal property [22]. Eucalyptus oil acts as a natural insect repellent and antifeedant against number of insect pests.

CONCLUSION

Botanical pesticides are the major alternatives to the conventional synthetic chemical pesticides due to various advantages over conventional pesticides. Improvement in the understanding of the mechanisms of action can offer new prospects for using these substances in agricultural management.

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