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Role and mechanism of botanicals in pest management

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Abstract

Pest management is one of the essential components in the agriculture. Conventional pesticides caused various environmental issues such as imbalances in the ecosystem, loss of soil fertility, and deterioration of marine life. Conventional pesticides also caused various harmful and serious issues on the humans and animal health leading to severe cancers, neurological disorders, hormonal disturbances, and reproductive issues. Botanical pesticides obtained naturally from plant-based chemicals were found to be an effective alternative to conventional pesticides. Neem based pesticides are one of the most important botanical pesticides used widely in India for agricultural pest management followed by pyrethrum, and Eucalyptus oil based pesticides. Various botanical pesticides are used in the conventional, sustainable and integrated pest management.

Introduction

Botanicals are derived from fresh or dried plants, plant parts, or plants' isolated or extracted in water, ethanol, or other organic solvents used for flavouring, fragrance, functional health benefits, medicine, or other biological and technical activities. These are naturally either occuring plant products or materials derived rather simply from plant materials. These may be crude preparations of plant parts ground to produce a dust or powder that may be used full-strength or diluted in carriers such as clay, talc or diatomaceous earth. Some worth mentioning are discovery of pesticidal properties of perthenin (from *Parthenium hysterophorus*) and related compounds, insect growth inhibition, antifeedent and antifungal activity of compounds isolated/derived from *Zingiber officinale* Rosae (Ginger) rhizomes, Antifungal activity of limonoids from Khaya ivorensis, Antifeedant/IGR activity of Aza-A and Tetrahydro Aza-A against *Helicoverpa armigera*.

All of the researches showed a general trend of getting specific, bioactive, and safe molecule with least environmental hazard and main emphasis is given on producing analogues of

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existing bioactive molecule and exploitation of the unexplored wealth of flora and fauna for plant protection, which will certainly be a distinct order of tomorrow. As they contain a virtually untapped reservoir of pesticides, they can be used directly or as templates for synthetic pesticides. Numerous factors have increased the interest of the pesticide industry and the pesticide market in this source of natural products as pesticides.

Why Botanicals?

Botanical pesticides are environmentally safer, unique with novel mode of action, rich source of biologically active compounds. There is still an unexplored area of study in the field of agrochemicals, chemically complex in nature and different stereoisomers are possible imparting less resistance, showed excellent activity in pharmaceuticals.

Botanical are now emerging as a viable component of integrated pest management (IPM) strategies for all crops due to their:

- Efficacy to managing pest,
- Environmental and public health safety,
- Eco-friendly nature, and cost effectiveness
- Rich source of biologically active compounds
- Very useful tools in organic agricultural system.

Recent Development in Botanical pesticides

Now a day's scientists are working to develop some new botanical pesticides, which are very safer for human beings. Some of these are discussed below:

1. Pyrethrins

Pyrethrins, which are esters with insecticidal properties, are obtained from pyrethrum (*T. cinerariaefolium*) flowers. The compounds obtained from this plant which have known insecticidal activity are six esters formed by the combination of the acids chrysanthemic and pyrethric and the alcohols piretrolone, cinerolone and jasmolone. These compounds act both on the central nervous system and in the peripheral nervous system causing repetitive discharges, followed by convulsions. Research has shown that these compounds block sodium ion influx resulting in the channels being affected by intermolecular forces which causes alterations in moving ion conductivity as a result of the changes in the channels. There is no doubt that the most important characteristic of these compounds is their irritating effect or "knock down" which causes the insect to stop feeding as soon as it encounters a treated

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surface. Pyrethrins are the best example of products copied in the laboratory since their modifications gave rise to the pyrethroid family of insecticides.

2. Azadiractin

This compound is a tetraterpenoid characteristic of the Meliaceae family but particularly from the Neem tree (*A. indica*), indigenous to India. The compound is found in bark, leaves and fruits of the tree but seeds have the highest concentration. This compound has not yet been synthesized in the laboratory, but when isolated and tested pure the results have been less than when extracts are used. In the extract 18 compounds have been identified among which salanine, meliantrol and azadiractin are most prominent, the latter being in the highest concentration. Azadirachtin shows antifeedant activity, is a growth regulator, inhibits oviposition and is also a sterilizing compound. Today, commercial formulations of neem may be found with names like Neem Gold, Neemazal, Econeem, Neemark, Neemcure and Azatin among others, in many countries including the United States, India, Germany and several Latin American countries. Nicotine is an alkaloid obtained from some plants in the Solanaceae family, particularly tobacco (*Nicotiana tabacum*).

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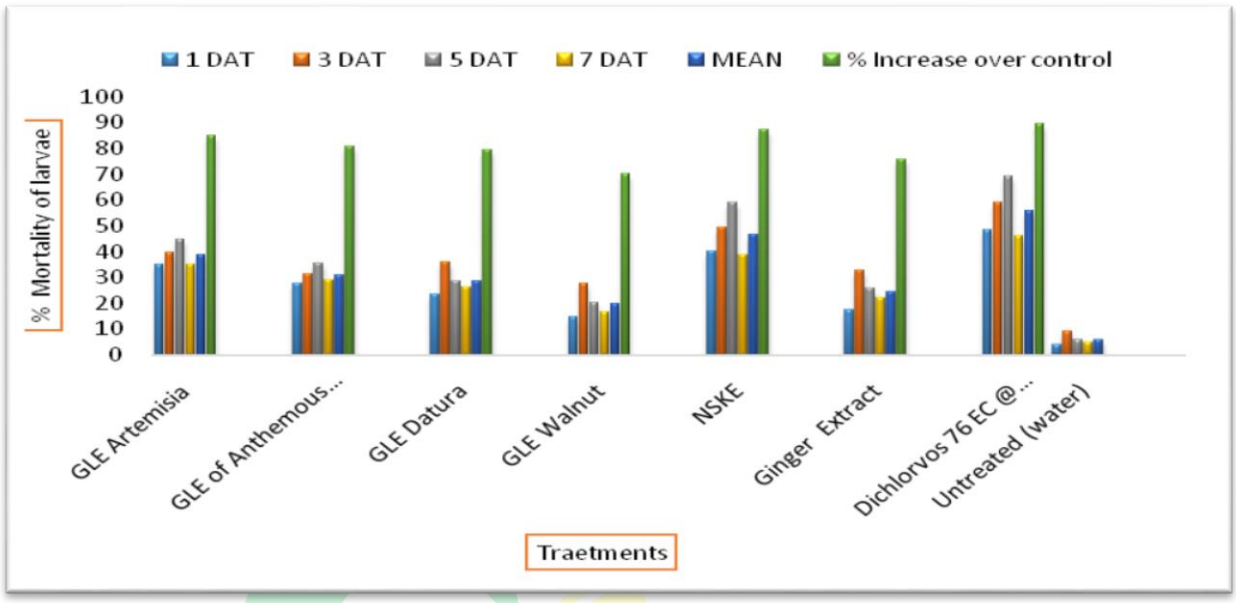

Fig: 2 Efficacy of various botanicals and DDVP against *Mythimna separata in Oats*

Among all plant extracts, 5% NSKE found effective against M. *Separata* with highest mean percent mortality of 46.65% and reaming extracts with decreasing order of efficacy treated with Neem seed extract as compared to the control where the lowest average yield of 6.52 was recorded.

3. Nicotine

The insecticidal properties of nicotine were recognized in the first half of the XVI century. This compound is not found free in the plant but in the form of maleates and citrates. Nicotine is essentially a non-persistent contact insecticide. Its mode of action consists in mimicking acetylcholine when it binds with its receptor in the post-synaptic membrane of the muscular union. The acetylcholinic receptor, is a site of action of the postsynaptic membrane which reacts with acetylcholine and alters the membrane permeability. Nicotine activity causes the production of new nerve impulses which cause convulsions, and death. An important new class of insecticides, commonly known as neo-nicotinoids, are synthetic copies or derivatives of the nicotine structure. These include imidacloprid, thiacloprid, nitempiram, acetamiprid and thiamethoxam, among others.

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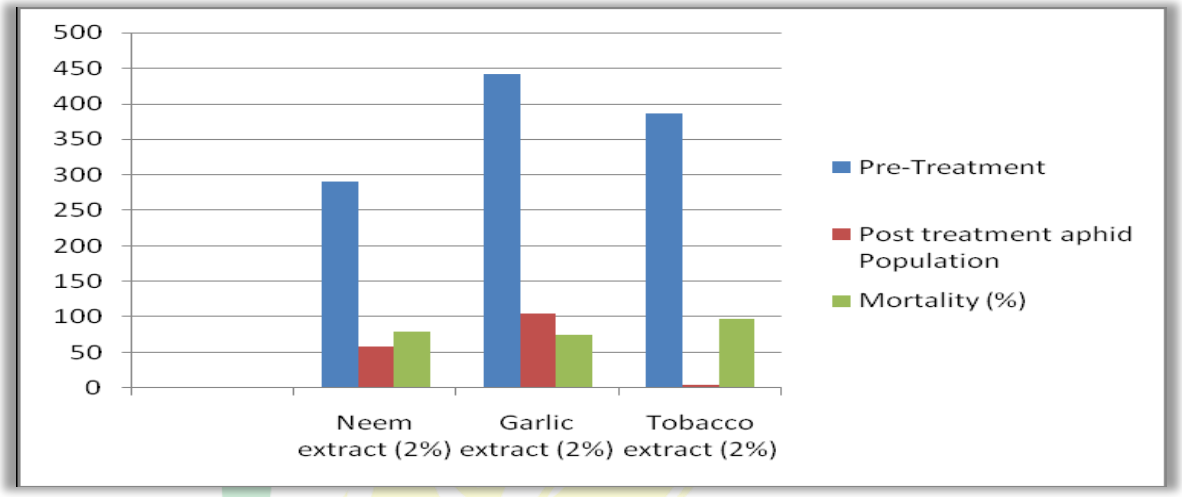

Fig: 1. Efficacy of various botanical pesticides after 24 hours spray interval presented in graph for comparison.

Fig. 1. indicated that the spraying tea cutting with tobacco extract (2%) caused highest mortality (98%) of aphid, where its population reduce to 5% treatment over pre-treatment population of 386. Neem extract (2%) ranked second in relation to efficacy against aphid with insect mortality 80%. Garlic extract (2%) was least effective against aphid with mortality of 75%.

4. Rotenone

Rotenone is a flavonoid extracted from the roots of two plants: *Derris* spp. (Fabaceae) and *Lonchocarpus* spp. (Fabaceae). The first one gives up to 13% of rotenone while the second only about 5%. *Derris* spp. is a native to Eastern tropics, while *Lonchocarpus* spp. is native to western hemisphere. Rotenone is a contact and ingestion compound, which acts as a repellent too. Its mode of action involves the inhibition of the electron transport at the mitochondrial level, thus blocking phosphorylation of ADP to ATPthereby inhibiting insect metabolism. Insects poisoned with Rotenone show the following symptoms of intoxication: a drop in

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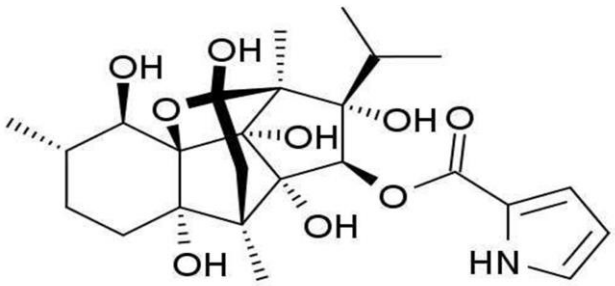
oxygen consumption, respiratory depression and ataxia leading to convulsions and finally to paralysis and death by respiratory arrest.

5. Sabadilla

This is a compound that can be obtained from seeds of a plant of South American origin known as *Schoenocaulon officinale* (Liliaceae). Seeds of this plant have been shown to have high concentrations of alkaloids which impart its toxic properties. The mode of action is disruption of neuron cell membranes causing reduction of nerve activity, paralysis and death. The ground seeds are one of the plant insecticides with the lowest mammal toxicity but that is not the case with their isolated alkaloids which are both highly toxic and skin irritants.

6. Ryania

This compound is obtained from the roots and stems of a plant native to South America known as *Ryania speciosa* (Flacourtiaceae). From this plant may be obtained a series of alkaloids, of which the most important is ryanodina. This alkaloid is effective as a contact or stomach poison and directly prevents muscles from contraction, causing paralysis.



Environmental impact of Botanical pesticides

They are environment friendly, biodegradable and very less residue problem, target specific and safe to beneficial organisms like pollinators, predators, parasites, growth of natural enemies of pests is not affected and thus reducing the pesticide application.

Effect on non-target organisms

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The results of a number of studies have been revealed that botanical pesticides are relatively safe to non-target organisms, natural enemies, pollinators, fish, bird and fish, predators, parasitoids, pollinators, secondary insect pests, wild relatives of crops, and soil biota.

Scope of Botanical Pesticide in India

The use of botanical pesticide plays an important part of IPM program over the synthetic pesticides. Naturally occurring botanical pesticide exerts a wide range of behavioral and physiological effects on insects and it is difficult for insect to develop resistance to these pesticides. Village cooperatives can take up formulation of locally available plants and thus, farmer will be saved from spending large sums of money for the purchase of costly synthetic agrochemicals. There is a great demand in international market for residue free cotton, fruits, vegetables, and beverages.

Conclusion:

Botanical insecticides are natural chemicals extracted from plants with insecticidal properties and used as an excellent alternative to synthetic or chemical pesticides for crop protection to avoid negative or side effects of synthetic insecticides. Botanical pesticides (such as Pyrethrum, Neem, nicotine etc..) have various chemical properties and modes of action and effect on insects in different ways namely; repellents, feeding deterrents/antifeedants, toxicants, growth retardants, Chemosterilants, and attractants. So it is preferable to use the botanical insecticides instead of synthetic insecticide and these botanical insecticides are recognized by organic crop producers in industrialized countries. So, we recommended using botanical insecticidal and being promoted and research is being conducted to find new sources of botanical insecticides.