

Botanical Name	Common Name	Family	Part used	Major phytochemical constituents	Insecticidal activity
<i>Moringaoleifera</i> Lam.	Drumstick tree	Moringaceae	Seeds	Isothiocyanates	Insecticidal
<i>Prosopisfulflora</i> (Sw.) DC.	Mesquite	Fabaceae	Leaves	Alkaloids	Insecticidal
<i>Nerium oleander</i> L.	Oleander	Apocynaceae	Leaves	Cardiac glycosides	Insecticidal
<i>Clerodendrumindicum</i> (L.) Kuntze	Glory bower	Lamiaceae	Leaves	Terpenoids	Repellent
<i>Ipomoea carnea</i> Jacq.	Bush morning glory	Convolvulaceae	Leaves	Alkaloids	Insecticidal
<i>Ryaniaspeciosa</i> Vahl	Ryania	Salicaceae	Roots	Ryanodine	Insecticidal
<i>Jatrophaacurcas</i> L.	Physic nut	Euphorbiaceae	Seeds	Phorbol esters	Insecticidal
<i>Euphorbia tirucalli</i> L.	Pencil tree	Euphorbiaceae	Latex	Diterpenes	Insecticidal
<i>Nicotianatabacum</i> L.	Tobacco	Solanaceae	Leaves	Nicotine	Insecticidal
<i>Lantana camara</i> L.	Lantana	Verbenaceae	Leaves	Lantadenes	Repellent
<i>Aloe vera</i> (L.) Burm.f.	Aloe	Asphodelaceae	Leaves	Aloin	Insecticidal
<i>Menthaarvensis</i> L.	Mint	Lamiaceae	Leaves	Menthol	Repellent
<i>Allium cepa</i> L.	Onion	Amaryllidaceae	Bulb	Sulfur compounds	Repellent
<i>Allium sativum</i> L.	Garlic	Amaryllidaceae	Bulb	Allicin	Insecticidal
<i>Capsicum annum</i> L.	Chilli	Solanaceae	Fruits	Capsaicin	Repellent
<i>Sabadillaofficinarium</i> L.	Sabadilla	Melanthiaceae	Seeds	Veratrine	Insecticidal
<i>Putranjivaroxburghii</i> Wall.	Putranjeeva	Putranjivaceae	Seeds	Putranjivin	Insecticidal
<i>Calotropisprocera</i> (Aiton) Dryand	Aak / Madar	Apocynaceae	Latex, leaves	Calotropin	Insecticidal
<i>Acacia nilotica</i> (L.) Delile	Babool	Fabaceae	Bark, pods	Tannins	Repellent
<i>Vitexnegundo</i> L.	Nirgundi	Lamiaceae	Leaves	Essential oils	Repellent
<i>Ocimum sanctum</i> L.	Tulsi	Lamiaceae	Leaves	Eugenol	Insecticidal
<i>Cymbopogoncitratatus</i> (DC.) Stapf	Lemongrass	Poaceae	Leaves	Citronellal	Repellent
<i>Chrysanthemum cinerariifolium</i> (Trevir.) Vis.	Pyrethrum	Asteraceae	Flowers	Pyrethrins (I & II), cinerins, jasmolins	Contact insecticide, knock-down effect
<i>Simaroubaglauca</i> DC.	Simarouba	Simarouba ceae	Seeds	Quassinoids	Antifeedant, growth inhibitory
<i>Ricinuscommunis</i> L.	Castor	Euphorbiaceae	Seeds	Ricinoleic acid	Repellent, oviposition deterrent
<i>Ocimum sanctum</i> L.	Tulsi	Lamiaceae	leaf	Eugenol, methyl chavicol	Repellent, insecticidal

Workdone by ICFRE-AFRI, Jodhpur

Studies conducted at the ICFRE-Arid Forest Research Institute (AFRI), in CAMPA Funded project of Biopesticides evaluated the efficacy of selected botanicals against major insect pests of forestry and agroforestry tree species of Rajasthan and Gujarat. The investigation revealed that *Balanites aegyptiaca* seed oil and *Capparis decidua* stem extract at 1% concentration exhibited significant insecticidal and antifeedant activity against defoliators and storage insect pest.



Caryedonserratus infesting seeds and pods of *Prosopis cineraria*



Atteva fabricella infesting *Ailanthus excelsa*

The botanical treatments effectively reduced pest incidence and feeding damage, indicating their potential as eco-friendly alternatives to synthetic chemical pesticides in forestry nurseries and plantations.The findings



Patalustecomellae infesting *Tecomella undulata*



Plecoptera reflexa infesting *Dalbergia sissoo*

suggest that these plant-based formulations can be integrated into sustainable pest management strategies in arid and semi-arid forestry systems.

Limitations of Botanicals

- ❖ Short residual effect due to rapid degradation
- ❖ Variable efficacy under field conditions
- ❖ Need for repeated applications
- ❖ Lack of standardized formulations in some cases.
- ❖ Lack of awareness among the farmers about the usefulness of botanical pesticides in managing insect- pests.

Advantages of Botanicals over Synthetic Pesticides

Botanicals offer multiple ecological, economic and social benefits, making them ideal tools for sustainable agriculture and forestry.

- ❖ Eco-friendly and biodegradable
- ❖ Low toxicity to humans, livestock and non-target organisms
- ❖ Minimal pesticide residues in food and environment
- ❖ Reduced risk of pest resistance
- ❖ Compatibility with biological control agents and pollinators
- ❖ Locally available and cost-effective for small farmers
- ❖ Suitable for organic and low-input farming systems

In the pursuit of climate-resilient pest management, integrating botanicals with biological control agents, cultural practices and host plant resistance can enhance the effectiveness and sustainability of Integrated Pest Management (IPM) strategies.

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Botanicals: Nature-Based Solutions for the Management of Insect Pests

“Protect crops, protect nature, protect life – choose botanicals.”



ICFRE-ARID FOREST RESEARCH INSTITUTE (AFRI) JODHPUR

INDIAN COUNCIL OF FORESTRY RESEARCH & EDUCATION, DEHRADUN

(AN AUTONOMOUS BODY OF MOEF & CC, GOVT. OF INDIA)

Introduction

Returning to Nature for Pest Management



Insect pests pose a major threat to agriculture, forestry, horticulture and stored products worldwide. For decades, synthetic chemical pesticides have been widely used to protect crops. While effective in the short term, indiscriminate and repeated use of chemical pesticides has led to serious concerns such as pesticide resistance, pest resurgence, environmental contamination, biodiversity loss and adverse effects on human and animal health.

In this context, botanicals which are plant-derived substances used for pest management have re-emerged as sustainable, eco-friendly alternatives. Botanicals are natural products obtained from leaves, seeds, bark, roots, flowers or oils of plants that possess insecticidal, repellent, antifeedant, growth-regulating or ovicidal properties.

Traditional farming systems across India and many parts of the world have long relied on botanicals such as neem, tobacco, garlic, chilli and various aromatic plants to manage insect pests. Botanicals represent a powerful nature-based solution for insect pest management. Modern scientific research has validated many of these practices, highlighting botanicals as key components of nature-based solutions (NbS) and Integrated Pest Management (IPM).

By combining traditional knowledge with modern scientific innovation, botanicals can play a pivotal role in ensuring sustainable agriculture, forest health, environmental safety and food security for future generations.



Definition of Botanicals

Botanical pesticides are the naturally occurring secondary metabolites (phytochemicals) extracted from the plant sources which can reduce the insect pests infestation thus helping in the pest management. They are generally safer to humans and the environment than conventional chemical

pesticides (Dimetry, 2014). Compared with synthetic chemical pesticides, they are typically considered more environmentally friendly and less hazardous to human health. These compounds may act directly by killing insects or indirectly by altering their feeding, growth, reproduction or behavior. They are highly compatible with IPM and organic systems.

The botanicals can be used in following forms:

1. Plant Extracts

Crude or refined extracts prepared from plant parts such as neem seeds, leaves or bark using water, alcohol or organic solvents.

2. Essential Oils

Volatile aromatic oils extracted from plants like eucalyptus, citronella, clove, lemongrass, peppermint and basil known for repellent and fumigant properties.

3. Fixed Oils

Non-volatile oils such as neem oil, karanja oil, castor oil and cottonseed oil that act mainly by suffocation and repellency.

4. Plant Powders

Dried and powdered plant materials (e.g., neem leaf powder, tobacco dust) used directly or mixed with stored grains.

5. Purified Plant Compounds

Isolated bioactive molecules like azadirachtin, nicotine, pyrethrins, rotenone etc.

Botanicals may be used singly or in combination, depending on the pest, crop and agro-ecosystem.

Mode of Action of Botanicals

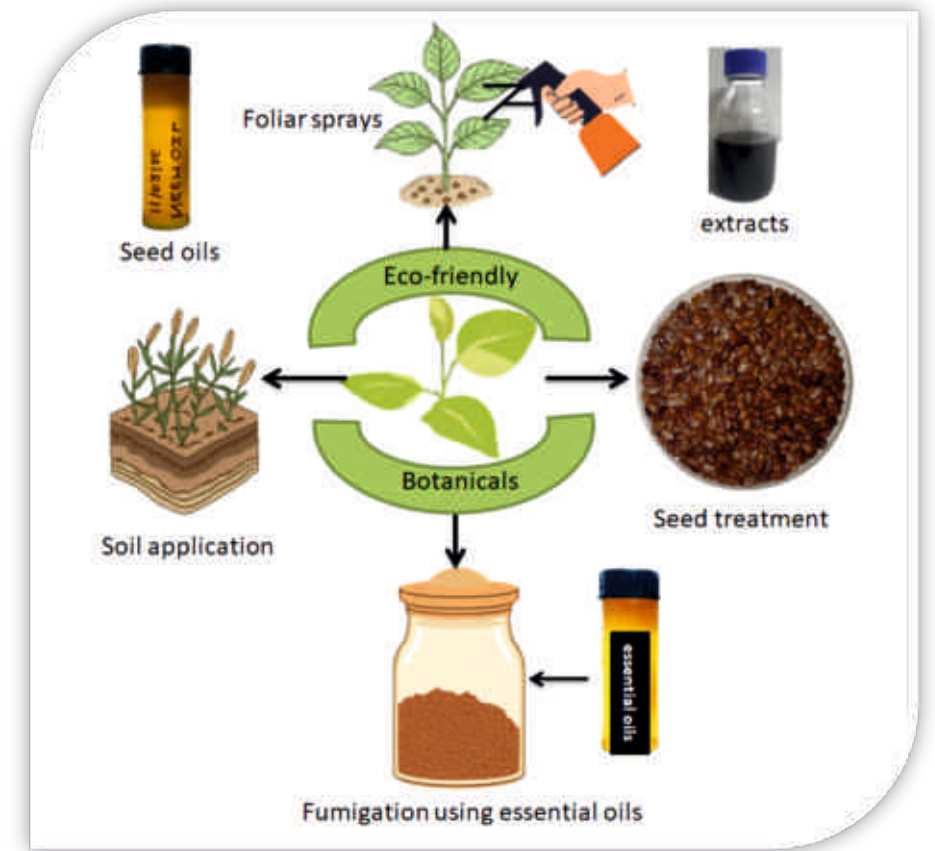
Unlike synthetic pesticides that often target a single physiological site, botanicals usually act through multiple mechanisms, making it difficult for insects to develop resistance.

Key Modes of Action

Antifeedant	• Prevents insects from feeding on treated plant surfaces
Repellent	• Drives insects away from crops due to strong odours or taste
Insecticidal	• Causes direct mortality by disrupting nervous, respiratory or metabolic systems
Growth Regulation	• Interferes with molting, metamorphosis and reproduction
Ovicidal and Larvicidal	• Prevents egg hatching or kills immature stages

Methods of Application of botanicals

- ❖ Foliar sprays (aqueous or oil-based formulations)
- ❖ Seed treatment
- ❖ Soil application
- ❖ Storage grain protection
- ❖ Fumigation using essential oils



Some Important Botanical Plants Used in Pest Management

Botanical Name	Common Name	Family	Part used	Major phytochemical constituents	Insecticidal activity
<i>Azadirachta indica</i> A. Juss.	Neem	Meliaceae	Seeds, leaves	Azadirachtin, salannin	Insecticidal, antifeedant
<i>Balanitesaegyptiaca</i>	Desert date	Zygophyllaceae	Seeds	Saponins, steroidal glycosides	Insecticidal, antifeedant, larvicidal
<i>Capparis decidua</i> (Forssk.) Edgew.	Kair	Capparaceae	Stem	Alkaloids, Flavonoids, Tannins, Saponins, Glucosinolates, Phenolic compounds	Insecticidal, antifeedant, larvicidal
<i>Meliaazedarach</i> L.	Chinaberry	Meliaceae	Fruits, seeds	Meliatoxins	Insecticidal
<i>Pongamiapinnata</i> (L.) Pierre	Karanja	Fabaceae	Seeds	Karanjin	Insecticidal
<i>Annonasquamosa</i> L.	Custard apple	Annonaceae	Seeds	Acetogenins	Insecticidal
<i>Madhucaindica</i> Macbr.	Mahua	Sapotaceae	Seeds	Saponins	Insecticidal
<i>Derris chinensis</i>	Derris	Fabaceae	Roots	Rotenone	Insecticidal
<i>Quassiaamara</i> L.	Quassia	Simaroubaceae	Wood	Quassin	Insecticidal
<i>Ailanthus excelsa</i> Roxb.	Tree of heaven	Simaroubaceae	Bark	Quassinoids	Insecticidal
<i>Eucalyptus globulus</i> Labill.	Blue gum	Myrtaceae	Leaves	Eucalyptol	Repellent