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Botanicals (Neem, Garlic, Pongamia) as Eco-friendly Alternatives for Horticultural Pest Management

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Horticultural crops are highly vulnerable to a wide range of pests, including sucking insects, borers, mites, caterpillars, and fungal pathogens. Traditionally, chemical pesticides have been widely used for pest control; however, their indiscriminate use has resulted in ecological imbalance, pest resistance, residue problems, and adverse health effects. Botanical pesticides extracted from plants such as Neem (Azadirachta indica), Garlic (*Allium sativum*), and Pongamia (*Pongamia pinnata*) are gaining popularity as eco-friendly, biodegradable, and safe alternatives in horticultural pest management. These botanicals possess insecticidal, repellent, antifeedant, and antimicrobial properties. The article discusses their importance, bioactive compounds, mechanisms of action, applications, benefits, and future prospects in sustainable horticultural production.

Introduction

Horticulture plays a crucial role in ensuring nutritional security, farmers' income enhancement, and overall agricultural development. However, pests and diseases cause **20–40% yield losses** in fruits, vegetables, and ornamental crops. The heavy reliance on synthetic pesticides has created numerous challenges such as:

- Pesticide residues in food items
- Groundwater contamination
- Decline in pollinators and natural enemies
- Pest resistance and resurgence
- Soil toxicity and human health hazards

Therefore, there is an urgent need to shift towards **eco-friendly pest management strategies.** Botanical pesticides, extracted from medicinal and aromatic plants, offer a sustainable alternative to chemical pesticides. They are a major component of **Integrated Pest Management (IPM)** and **organic farming systems**.

What Are Botanical Pesticides?

Botanical pesticides are naturally derived plant extracts, oils, or powders possessing pesticidal or repellent properties. They are:

✔ Biodegradable
✔ Safe to non-target organisms
✔ Environmentally compatible
✔ Suitable for organic certification

Common botanicals used in horticulture include **Neem, Garlic, Pongamia, Pyrethrum, Tobacco, Lantana, Eucalyptus, and Lemon grass.** Among these, Neem, Garlic, and Pongamia are the most widely used and researched.

Importance in Horticultural Pest Management

- Reduce chemical pesticide dependency
- Promote sustainable and organic cultivation

- Protect pollinators like honeybees and butterflies
- Improve soil microbial activity
- Prevent pest resistance problems
- Enhance export quality due to low residue levels
- Provide cost-effective pest control solutions

Major Botanicals Used in Horticulture

Neem (*Azadirachta indica*)

Active Compounds

- **Azadirachtin** – major insecticidal compound
- **Nimbin**
- **Salannin**

Mode of Action

- Acts as **Insect Growth Regulator (IGR)**
- Blocks **ecdysone hormone** responsible for molting
- Anti-feedant and repellent effect
- Inhibits oviposition in female insects

Target Pests

Pests	Crops
Aphids	Okra, Brinjal
Whiteflies	Tomato, Chilli
Mites	Rose, Beans
Caterpillars	Cabbage, Potato
Mealybugs	Fruits, Ornamentals

Advantages

✔ Completely biodegradable
✔ Harmless to beneficial insects
✔ Safe for human health
✔ Encourages plant growth (Neem cake as fertilizer)

Garlic (*Allium sativum*)

Active Compound

- **Allicin** – responsible for strong repellent and antimicrobial action.

Mode of Action

- Damages nervous system of insects
- Disrupts feeding, mating, and egg-laying
- Exhibits antifungal and antibacterial activity

Target Pests

Pest	Effect
Thrips	Repellent
Borers	Growth disruption
Aphids	Reduced feeding
Fungal infections	Anti-pathogenic

Advantages

✔ Low-cost and easily available
✔ No residue issues
✔ Suitable for small farmers
✔ Compatible with IPM practices

Pongamia (*Pongamia pinnata* / Karanja)

Active Compounds

- **Karanjin**
- **Pongamol**

Mode of Action

- Acts as insecticidal and repellent
- Disrupts feeding of chewing and sucking pests
- Shows mild antifungal activity

Target Pests

Pest	Crop
Leafhoppers	Cotton, Mango
Whiteflies	Vegetables
Caterpillars	Cole crops
Mites	Floriculture crops

Advantages

✔ Safe for mammals
✔ Biodegradable
✔ Compatible with biofertilizers & IPM tools

Preparation of Botanical Formulations (Simple Farmers' Method)

Neem Extract (5%)

- Neem leaves – 1 kg
- Water – 10 liters
- Grind + Soak for 12 hrs
- Filter and spray

Garlic + Chili Extract

- Garlic – 250 g
- Green chili – 200 g
- Water – 1 liter
- Soak + Grind + Filter

Pongamia Oil Spray

- Pongamia oil – 50 ml
- Water – 1 liter
- Soap solution – 5 g (as emulsifier)

Advantages of Botanicals

✔ Eco-friendly & biodegradable
✔ Reduce chemical pesticide dependence
✔ Lower chances of pest resistance
✔ Safe for human health and applicators
✔ Enhance soil biodiversity
✔ Increase export potential of horticultural produce

Limitations and Challenges

Problem	Explanation
Short shelf life	Difficult to store
Slow action	Not as quick as chemical pesticides
Lack of awareness	Farmers prefer chemicals
Lesser commercial availability	Limited industries
Standardization issue	Concentration varies

Future Prospects

- Need for **nano-botanical formulations**
- Development of commercial plant-based pesticides
- Stronger government support and subsidies
- Training of farmers under **PM-KISAN, PKVY & NMSA**

- Integration with **AI-based spraying drones**
- Scope for **export-oriented organic horticulture**

Conclusion

Botanicals such as Neem, Garlic, and Pongamia offer eco-friendly, residue-free, and cost-effective solutions for horticultural pest management. They are highly suitable for organic farming, IPM systems, and sustainable agriculture. Government subsidy, farmer training, and commercialization efforts can promote their large-scale adoption. A shift from chemical to botanical pesticides is not only essential for environmental security but also crucial for human health and future agricultural sustainability.

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