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From Neem to Dashparni: Exploring Plant-Based Pesticides for Crop Protection

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ABSTRACT: Biopesticides, often regarded as eco-friendly alternatives to synthetic chemicals, have long been a part of traditional farming practices in India. These natural pest control methods utilize locally available plants and microorganisms, offering sustainable solutions for small-scale and rural farmers. Before industrialization, farmers relied on biological approaches to manage crop pests due to their affordability, accessibility, ease of preparation, and minimal environmental impact. However, the rise of synthetic pesticides in the 19th century, driven by the demand for higher crop yields, introduced significant health and ecological concerns. In Maharashtra, the widespread use of chemical insecticides such as Rogar and Chlorpyriphos has not only proven costly but has also contributed to environmental degradation, pest resistance, soil and water pollution, and adverse health effects among farmers. These challenges have led to renewed interest in plant-based pest management strategies that are safer and more sustainable. Neem is among the most widely adopted biopesticides, with commercial formulations like Neem Gold and Neemazal often enhanced with natural additives such as cow urine, garlic, and chili. Other botanical compounds like pyrethrum, rotenone, and sabadilla also demonstrate strong pesticidal properties. Traditional preparations such as Agniastra, Brahmastra, Neemastra, Panchkavya, and Dashparni Arkk are commonly used by rural farmers. These involve fermented mixtures of plant leaves, cow dung, and spices to combat pests like aphids, borers, and caterpillars. This study explores the pesticidal potential of various plants and their bioactive compounds, including alkaloids, terpenoids, flavonoids, and saponins. These compounds disrupt pest physiology by targeting neural pathways, digestive enzymes, and reproductive systems. The findings highlight the importance of integrating traditional knowledge with modern agricultural practices to promote sustainable farming and reduce reliance on chemical pesticides. Plant-derived biopesticides offer a promising path for environmentally conscious pest control.

KEYWORDS: Biopesticides, Neem, Cow urine, Kashayam, Phytochemicals.

I. INTRODUCTION

Biopesticides have long played a vital role in traditional Indian agriculture, relying on locally sourced natural materials for pest control. These eco-friendly alternatives utilize biological agents to manage pest populations, offering a sustainable solution to chemical-intensive practices. With industrialization in the 19th century, synthetic pesticides became widespread, boosting crop yields but also triggering ecological and health concerns such as pest resistance, environmental degradation, and harm to beneficial soil organisms [1]. In Maharashtra, commonly used insecticides like Rogar, Nuwan, Coragen, and Chlorpyriphos cost ₹500–₹1500 per litre, creating financial strain for farmers. Prolonged exposure has been associated with adverse health effects, including respiratory issues and skin irritation, often worsened by limited awareness of safe handling [2]. In light of these challenges, attention has shifted toward plant-based biopesticides. Derived from botanical and microbial sources, these formulations are affordable, easy to prepare, and environmentally safe—aligning well with sustainable agricultural practices. This study explores the potential of plant-derived pesticides as viable substitutes for synthetic chemicals. By minimizing adverse effects on human health and the environment, these formulations support ecological balance, enhance soil biodiversity, and contribute to resilient agricultural systems.

II. RELATED WORK

Biopesticides, encompassing botanicals, microbial agents, and semiochemicals, are increasingly recognized as eco-friendly alternatives to synthetic pesticides due to their selectivity and compatibility with Integrated Pest Management systems (Copping and Menn, 2000; Kumar *et al*., 2011). India's traditional farming has long relied on plant-based preparations, with Neem being the most studied and commercialized, its azadirachtin compounds showing antifeedant and growth-regulatory effects (Schmutterer, 1990; Isman, 2020; Mohan *et al*., 2007; Mulla *et al*., 2014). Other botanicals such as pyrethrum, rotenone, and sabadilla have historical use though regulatory concerns limit some applications (Casida,

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1973; Isman, 2008). Indigenous formulations like Dashparni, Agniastra, Brahmastra, and Panchagavya combine multiple plants, cow derivatives, and spices, yielding synergistic effects through alkaloids, terpenoids, flavonoids, and saponins that disrupt pest physiology (Vivekanandan *et al*., 2013; Somasundaram *et al*., 2003; Gunti and Chowdary, 2018). Field trials report suppression of aphids, jassids, whiteflies, borers, and pathogens, with added benefits from microbial activity and induced plant defenses (Shetty *et al*., 2013; Renuka *et al*., 2016; Nene *et al*., 1999; Swain and Ray, 2019). Mechanistic studies confirm these compounds affect feeding, ecdysis, and reproduction, while fermentation enhances bioavailability and microbial synergy, with cow urine improving extraction efficiency (Isman, 2006; Pavela and Benelli, 2016; Chauhan *et al*., 2015). Despite variability in preparation and storage, neem-based products and traditional recipes show favorable economics and ecological outcomes, supporting their role for sustainable pest management (Koul and Wahab, 2004; Biondi *et al*., 2012; Pretty *et al*., 2018; Prakash and Rao, 1996).

III. OBSERVATIONS

Neem-based biopesticides, marketed under names like Neem Gold, Neemazal, Econeem, and Azathin, are widely used in pest control [3], either alone or blended with natural additives such as cow urine [4], dung, and plant extracts. Other botanical compounds in use include pyrethrum, rotenone, sabadilla, and ryania [5]. Maharashtra's agricultural landscape includes cereals (rice, jowar, bajra, wheat, maize), cash crops (cotton, sugarcane, groundnut, soybean), pulses (moong), and horticultural produce like mango, grapes, banana, cashew, and oranges. Vegetables such as brinjal, tomato, potato, cabbage, and onion—especially onion—are extensively cultivated. Coastal zones prioritize mango and cashew farming, which are susceptible to pests like *Nilaparvata lugens*, *Scirpophaga incertulas*, *Xanthomonas oryzae*, *Sitophilus zeamais*, *Spodoptera frugiperda*, and *Aspergillus niger*, leading to significant crop losses [6]. To combat these threats, farmers increasingly adopt traditional, affordable biopesticide formulations such as Agniastra, Brahmastra, Neemastra, Panchkavya, Dashparni Arkk, and 3G Arkk—prepared using ingredients like ginger, garlic, chili, and cow urine. Table 1 outlines common plants with pesticidal properties [7].

Table no 1: Plants with bio-pesticidal activity.

Name	Nature	Bioactive compound / Phytoconstituent	Mode of action	Acting on
Justicia adhatoda **Acanthaceae** Malabar Nut (Eng.), Vasaka (Hin.), Adulsa (Mar.)	Antifeedant Ovicidal, Fungicidal.	Vasicine, Vasicinone, Vasicinol	Antifertility is affected by blocking the oviduct of the pest.	*Spodoptera littoralis* (cotton leaf worm) on cotton, *Xanthomonas oryzae* in rice
Aegle marmelos **Rutaceae** Bael / Bengal Quince (Eng.) Bel (Hin., Mar.)	Insecticidal	Cumin aldehyde, Eugenol, Marmin, Citral, Citronellal, P-cymene	Reduces pest reproduction, hinders chemoreceptor s.	*Spodoptera exigua* on Onion, *Myzus Persicae* (peach aphids) on cabbage and tomato
Argemone mexicana **Papaveraceae** Mexican Poppy (Eng.) Satyanaashi (Hin.) Pivala Dhotra, (Mar.)	Nematicidal	Argemexirine, Allocryptopine, Reticuline	Immobilize larvae, has toxic effect.	*Meloidogyne incognita* (root-knot nematode)
Azadirachta indica **Meliaceae** Neem (Eng., Hin.), Kadunimb (Mar.)	Insecticidal	Azadirachtin, Salanin, Nimbin, Nimbidiol, Azadirachtin-D	Disrupts the growth of larvae, toxic towards pests' endocrine system	*Callosobruchus chinensis* (pulse beetle), *Mamestra brassicae* (cabbage moth)

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Calotropis gigantea ***Apocynaceae*** Giant Milkweed (Eng.), Akoua / Madar (Hin.), Rui (Mar.)	Insecticidal, Fungicidal.	Cardenolides, Uscharidin, 15β-hydroxy-calactin, 16β-hydroxy-calactin, Calotropone	Toxic towards pests	*Henosepilachna elaterii* on potato, *Sapodoptera furgiiperda* (fall armyworm), *Helicoverpa armigera* (tomato fruit borer)
Cinnamomum camphora **Lauraceae** Camphor (Eng.), Kapoor (Hin., Mar.)	Insecticidal, Fungicidal.	Isoborneol, Camphene, *trans*-caryophyllene, d-camphor	Neurotoxic effect impacting cell membrane, stops mycelial growth of the fungi	*Lasioderma serricorne,* (cigarette beetle) *Aspergillus flavus, Aspergillus niger*
Cleistanthus collinus **Phyllanthaceae** Oduvan (Eng.), Garari (Hin., Mar.)	Insecticidal, Rodenticidal.	Lactone glycoside, Cleistanthin A, Octadecanoic acid, 9,10-Epoxy-18-(trimethylsiloxy)-	Inhibits the molting process, directly toxic against pest.	*Nymphula depunctalis* (rice caseworm) of paddy, *Plutella xylostella* (Diamond black moth) on cabbage, cauliflower, broccoli, mustard.
Clitoria ternatea **Fabaceae** Butterfly Pea/ Blue Pea (Eng.) Aparajita (Hin.), Gokarna (Mar.)	Insecticidal, Repellent.	Cyclotides, Ternatin, Taraxerone, Taraxerol	Disrupting the epithelial wall in gut and cell lysis, feeding deterrent	*Helicoverpa spp*. On cotton, *Callossobruchus maculatus* (cowpea seed beetle)
Curcuma aromatica **Zingiberaceae** Wild Turmeric (Eng.), Jangli Haldi (Hin.), Raanhalad (Mar.)	Antifeedant Repellent, Larvicidal.	Sesquiterpene, *ar*-turmerone, Curcumin, Curcumenol	Neurotoxic, Acetylcholinesterase inhibition	*Nilaparvata lugens* (brown plant hopper) on rice, and *Plutella xylostella* on radish
Datura metel **Solanaceae** Devil's Trumpet/Thorn Apple (Eng.), Dhatura (Hin.), Dhotra (Mar.)	Insecticidal Rodenticidal.	Hyoscine, Atropine, Tigloidine, Hyoscyamine-N-oxide, Hyoscyamine, Scopolamine.	Causes toxicity in the pests	*Maconellicoccus hirsutus* (pink hibiscus mealy bug) affects over 200 plant sps. including hibiscus, cotton, citrus, and vegetables, *Tribolium castaneum* in wheat and rice.
Derris elliptica Fabaceae Tooba Jad (Hin.), Tuba Mule (Mar.)	Insecticidal	Rotenone	Disrupts cellular metabolism , nerve and muscles malfunction	Aphids, bean leaf beetles, cucumber beetles, leafhoper, red spider mite.
Hedychium spicatum **Zingiberaceae** **Spiked Ginger lily (Eng.)**	Antifeedant Fungicidal, Larvicidal,	Camphene, 1,8 Cineole, Linalool, Isoborneol, Terpineol, Germacrene D, Curdione	Inhibits the growth of spores, causing paralysis of pest.	*Spilosoma obliqua* (hairy caterpillar) on cabbage, *Spodoptera littoralis* (Egyptian cotton leafworm),

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Kapoorkachri (Hin.), Kapurkachur (Mar.)				*Rhizoctonia solani a* potato pathogen
Hyptis suaveolens **Lamiaceae** Wild Spikenard / Bush Mint (Eng.), Vilayati Tulsi (Hin.), Jungli Tulas (Mar.)	Nematicidal	Suaveolic acid, Suaveolol, B-sitosterol glycoside, Oleanolic acid	Anticholinesterase activity	*Helicoverpa armigera* (cotton bollworm)
Pongamia pinnata **Fabaceae** Pongam tree (Eng.) Karanj (Hin., Mar)	Insecticidal Nematicidal	Karanjin, Pongamol, Pongapin, Glabrin, Pongaglabrone	Oviposition suppressor, repellant, reduced growth	Whiteflies in tomato, mustard aphids, diamond black moth of crucifers
Lantana camara **Verbenaceae** Lantana / Wild Sage (Eng.), Panga / Raimuniya (Hin.), Ghaneri (Mar.)	Insecticidal	Germacrene-D, β-elemene, γ -elemene, β-caryophyllene, α-copaene, α-cadinene, Lantadene,	Disrupts cellular respiration and trigger apoptosis	*Scirpophaga incertulas* (rice stem borer), *Sitophilus oryzae* (rice weevil)
Parthenium hysterophorus **Asteraceae** Congress Grass (Eng.), Gajar ghaas (Hin.), Gajar Gavat (Mar.)	Insecticidal	Parthenin	Irritability to the pest or causes toxicity in them	*Helicoverpa armigera* of cotton and maize
Persicaria hydropiper Polygonaceae Water pepper (Eng.), Jal Mirchi (Hin.), Sisori (Mar.)	Antifeedant, Ovicidal.	Polygodial, Epicatechin, Caffeic acid, Polygonone, Polygonolide	Prevents pests from eating thus starving them.	*Rhizoctonia solani* which cause sheath blight disease of rice. *Callosobruchus chinensis* (adzuki bean weevil) Major pest of stored legumes like chickpeas, mung beans, lentils, and pigeon peas.
Portulaca oleracea **Portulacaceae** **Purslane (Eng.), Kulfa** (Hin.), Kulfa Bhaji (Mar.)	Fungicidal	Portulacanone A, Portulacanone D, Oleraciamide, lupeol, Taraxerol, 15Z-13-hydroxyoctadeca-9	Damages the cell wall of fungi	*Aspergillus* sps. and *Trichophyton* sps.
Tagetes erecta **Asteraceae** Genda (Hin.), Jhendoo (Mar.)	Nematicidal	Ocimenes, Limonene, Tagetones, Dihydro-tagetone, β-ocimene, β-caryophyllene, Piperitone,	Intercropping , suppressing the formation of root knots	*Lygus hesperus*, *Meloidogyne incognita* galls on soyabean,

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IV. PREPARATION OF BIOPESTICIDES

Traditional biopesticides in rural India are commonly referred to as 'Kashayam' or 'Arkk,' especially in southern regions. These formulations typically combine plant materials with cow dung and cow urine.

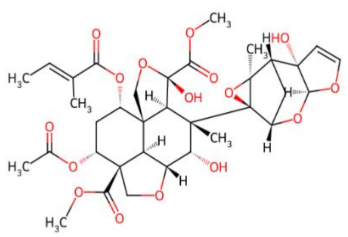
Dashaparni Kashayam: Select any 10 of the following and chop into small pieces: 5 kg neem leaves, 2 kg papaya leaves, karanja, castor, dhatura, vilvam, Krishna tulsi, marigold, Calotropis procera, oleander, mango, hibiscus, moringa, jujube, babul stem and leaves, turmeric, ginger, bougainvillea (leaves and flowers), sicklepod, and pomegranate leaves [8]. Combine the chopped leaves with 200 liters of water. Add 20 liters cow urine, 2 kg cow dung, 200 g turmeric powder, 500 g ginger paste, and 10 g asafoetida. Stir well and let sit overnight. The next day, add 1 kg tobacco powder, 1 kg green chili paste, and 500 g garlic paste. Allow to ferment overnight again. On the third day, stir thoroughly and store the mixture in a dark, dry place for 40 days, stirring daily for one minute. After fermentation, the extract can be diluted and used for up to six months. **Application**: Mix 200 ml of Dashaparni Arkk with 10 liters of water and apply as a foliar spray every 15 days, either before or after flowering, in the morning or evening. **Uses**: Effective against sucking pests, borers, and aphids (e.g., caterpillars, green aphids) across crops such as cotton, rice, pulses, vegetables, and fruits [9].

Agniastra: Agniastra is formulated by boiling 20 liters of cow urine with 5 kg neem leaves, 2 kg green chilies, 1 kg garlic, and 1 kg tobacco leaves in a mud pot. After boiling, the mixture is rested for two days. For use, it is diluted with 100 liters of water and 3 liters of cow urine. The extract remains effective for 3 to 6 months. **Application**: Mix 2.5–3 liters of Agniastra in 100 liters of water and apply as a foliar spray every 10–15 days, particularly on young or pest-affected plants. It effectively controls sucking pests, leaf rollers, stem borers, and fruit borers [10].

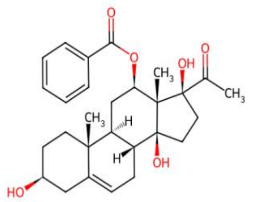
Brahmastra: Brahmastra is prepared by boiling a mixture of 10 liters cow urine, 3 kg neem leaves, and 2 kg each of custard apple, papaya, pomegranate, and guava leaves. The mixture is boiled five times at intervals and then left to rest for 48 hours. For use, 2 liters of the extract are diluted in 100 liters of water. The formulation remains effective for 4 to 6 months. **Application**: Applied to leaves and stems during early growth or initial pest infestation. Effective against sap feeders and hairy caterpillars in crops such as wheat, sugarcane, mango, brinjal, and okra [11, 12].

Handikhata: In an earthen pot, mix cow dung, cow urine, and jaggery thoroughly. Add 1 kg each of chopped neem, karanja, and rui leaves. Cover and ferment in a shaded area for one week, then filter the liquid. This extract can be stored for up to six months. To continue extraction, add 5 liters of cow urine to the same pot weekly without adding other ingredients. Repeat the process for up to four months, yielding approximately 60–70 liters of formulation. **Application**: Dilute 20 ml of extract in 1 liter of water for foliar spray, especially to manage viral infections like yellow mosaic virus in okra. The same dilution can be used for seed treatment prior to sowing [13].

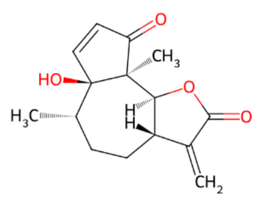
Structures in (S-series) of some important phytochemicals (Courtesy @ chemspider.com) [14]



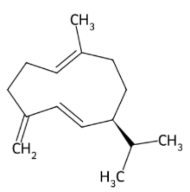
S.1. Azadirachtin (Neem)



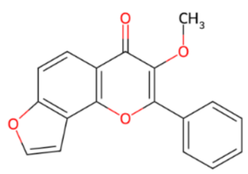
S.2. Calotropone (*Calotropis gigantea*)



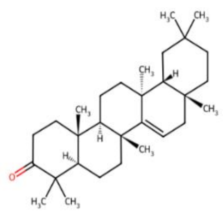
S.3. Parthenin (*Parthenium hysterophorus*)



S.4. Germacrene D (*Lantana camara***)**



S.5. Karanjin (*Pongamia pinnata*)



S.6. Taraxerone (*Clitoria ternatea***)**

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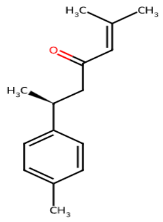
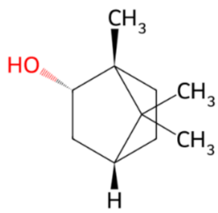
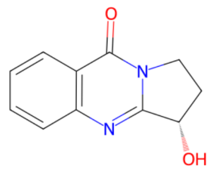


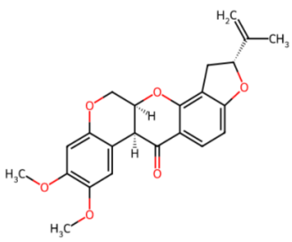
S.7. Turmerone (*Curcuma longa*)



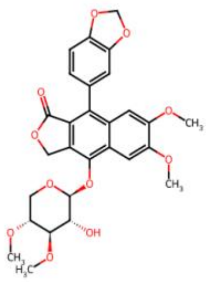
S.8. Isoborneol (*Cinnamomum camphora***)**



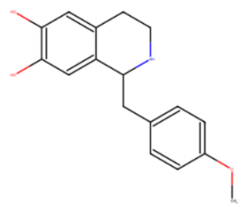
S.9. Vasicinone (*Justicia adhatoda***)**



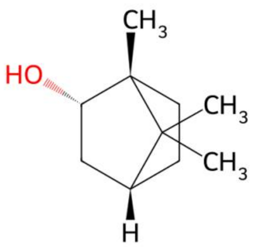
S.10. Rotenone (*Derris elliptica*)



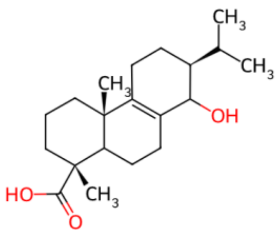
S.11. Cleistanthin-A (*Cleistanthus collinus***)**



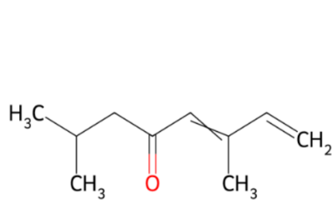
S.12. Argemexirine (*Argemone mexicana*)



S.13. Isoborneol (*Hedychium spicatum***)**



S.14. Suaveolic acid (*Hyptis suaveolens*)



S.15. Tagatone (*Tagetes erecta***)**

Some insects on plants

Fig.1 Early blight in Tomato

Fig.2 Fall Armywork on Maize

Fig.3 White fly on cotton leaf

V. RESULTS AND CONCLUSION

This study confirmed the efficacy of traditional biopesticide formulations and plant-based extracts in managing agricultural pests across diverse cropping systems in Maharashtra. Preparations such as Dashaparni Kashayam, Agniastra, Brahmastra, and Handikhata demonstrated reliable control of common pests including aphids, borers, caterpillars, and viral pathogens. These formulations, with shelf lives ranging from three to six months, were found to be cost-effective, environmentally safe, and compatible with routine farming practices. Extracts derived from plants such as *Hyptis suaveolens*, *Aegle marmelos*, *Polygonum hydropiper*, *Allium cepa*, *Jatropha curcas*, *Derris elliptica*, and *Tagetes erecta* showed targeted pest suppression, particularly against jassids, whiteflies, aphids, and fungal infections. Field-level observations indicated reduced pest pressure, improved crop health, and increased farmer interest in adopting these natural alternatives. Overall, the findings support the integration of biopesticides into pest management strategies as a sustainable approach to reducing chemical pesticide dependency. These formulations are cheap and affordable, promote ecological balance, protect farmer health, consumer health, and enhance the resilience of agricultural systems.

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