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Studies on Different Mango Pests and their Bio-control Methods – A Review

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Abstract

Mango (*Mangifera indica* L.) is one of the most important fruit crops of India, commercially grown in South Konkan region. The fruit has characteristics like firm- fibreless pulp, typical flavour and good keeping quality. This fruit is exported in many countries, earning foreign exchange. Although the mango cultivation in Konkan region is vast, the productivity is very low in compared to national scenario. Insect pests are a major limiting factor in achieving full yield potential of mango varieties. The reason for low productivity of Alphonso in Konkan region is high incidences of pest and diseases due to hot and humid climate. Among insect pests, mango leaf hopper is most serious and destructive pest of mango. Climate change has also induced the emergence of new pests or it unintentionally encourages invasive species. Though scales, mealybugs, thrips, midges, mites, leaf webber, stem borer, white flies etc. were secondary pests, they have become serious problem in the recent years. To control pest infestation and plant damage, dependency on insecticides is inevitable. The use of synthetic organic insecticides in crop pest control has resulted in to damage of environment, pest resurgence, pest resistance to insecticides and lethal effects to non-target organism. In place of synthetic insecticides, biopesticides are Eco safe alternatives. Biologically active natural plant products may play a significant role in this regard. Present study therefore aims to evaluate the biocidal activities of locally available plants in south Konkan region against insect pests of mango, especially Mango leaf hopper and Thrips. Looking to the above-mentioned fact, it is proposed to study of potential herbal biocidals/ herbal extract against insect pests of mango.

***Key words*:** Botanicals, Mango leaf hopper, Mango thrips

Mango (*Mangifera indica* L.), belonging to the family Anacardiaceae, is one of the oldest cultivated fruit crops, with deep historical, cultural, and economic importance. Its origin and evolutionary history are equally fascinating [14]. While mango is believed to have originated in India and Southeast Asia, extensive studies in paleobotany and fossil evidence suggest that its ancestry is far more ancient. Researchers from the Birbal Sahni Institute of Palaeobotany (BSIP) have traced the origin of mango to the hilly regions of Meghalaya, India. Fossilized mango leaves discovered from this region date back nearly 65 million years, indicating that the mango has an evolutionary lineage stretching into the Cretaceous-Paleogene period. Earlier fossil records from northeastern India and other regions suggested mango's presence about 25–30 million years ago, but the Meghalaya findings push back the timeline significantly [42].

Alphonso is widely recognized as the most popular and delicious leading cultivar of mango, especially in India. It holds a prominent commercial value, being extensively grown in the South Konkan region of Maharashtra, particularly in the districts of Ratnagiri and Sindhudurg. These areas have become globally renowned for producing the Alphonso mango, which is often celebrated for its distinct aroma, rich flavor, vibrant saffron-yellow color, and superior keeping quality. Because of these characteristics, Alphonso is often referred to as the "King of Mangoes," symbolizing both luxury and cultural pride in India.

India today holds the richest genetic diversity of mango, with more than 1,000 locally recognized cultivars spread across various agro-climatic zones. This genetic diversity has not only contributed to the development of commercial cultivars like Alphonso but has also ensured mango's adaptation across different tropical and subtropical regions of the world. Extended anatomical and morphological studies of the genus *Mangifera*, along with fossil comparisons, strongly indicate that the center of origin of mango lies in northeastern India. Genetic evidence further supports that while the genus *Mangifera* itself is native to Southeast Asia, the cultivated mango (*Mangifera indica*) likely originated in the Assam-Burma region, from where it spread and became domesticated. Thus, the story of Alphonso is not just about a single celebrated cultivar but is deeply connected to the evolutionary history, biodiversity, and cultural heritage of mango in India. Its global recognition highlights the importance of India not only as the birthplace of mango but also as the center of its immense varietal richness, making mango a truly iconic fruit of the subcontinent.

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Mango cultivation faces challenges from a diverse range of insect pests, but reliance solely on chemical pesticides is neither sustainable nor safe. Studies have shown that biological control methods using predators, parasitoids, entomopathogens, and botanicals offer effective and eco-friendly solutions. Adoption of bio-control as part of Integrated Pest Management (IPM) not only ensures the production of safe, residue-free fruits but also conserves orchard biodiversity and maintains ecological balance. Future research should focus on mass production, field evaluation, and farmer adoption of bio-control agents to strengthen sustainable mango production systems.

Characteristics of alphonso and its export value

The fruit is orange yellow in colour, oval or oblique in shape with medium size, 11.6 cm in length and 9.3 cm in width, average weight is 390gm, skin is soft and thin, low in fibre, sweet in taste etc. [14]. According to the report of United States Department of Agriculture (USDA) Mango is highly nutritious fruit. It contains many vitamins, essential minerals, thiamine, niacin, calcium and iron [14]. This fruit is exported in many countries, thereby earning foreign exchange.

Global mango production: India's dominance and export potential

The major mango producing countries in the world are India, China, Pakistan, Thailand, Indonesia, Philippines, Viet Nam, Mexico, Brazil and Nigeria. The area under mango cultivation in India is 25.16 million with production of 184.3 million tons and productivity of 7.3 million tons per hectare. The States of Andhra Pradesh, Uttar Pradesh, Karnataka, Bihar, Gujarat and Maharashtra get major mango production of the country (Table 1). The Mango is internationally traded tropical fruit which ranks second in the international market. India is the largest producer of Mangoes in the world, with 65% of total production, and exports fresh mangoes to over 50 countries [33]. Alphonso is the main variety exported from Ratnagiri District solely. It is a cash crop forming significant part of agricultural economy. About 67,749 hectares of land is under Mango canopy [46]. The global environmental issues like climate change, adversely affect mango cultivation. India ranks first and accounts for about 50% of the world's mango production with 2.5 million hectares, annually producing 18.0 million tons. Among the various factors, insect pests and diseases are one of the major hindrances in achieving greater productivity. Irregular and erratic bearing followed by damage due to pests and diseases are considered to be the important constraints in mango production [43], [47], [54]. In Maharashtra Kesar and Alphonso varieties are cultivated by farmers. The reason for low productivity of Alphonso in Konkan region is high incidences of pests and diseases due to hot and humid climate. In addition, climate change has induced the emergence of new pests or it unintentionally encourages invasive species.

Table 1 Insect pests of mango

Insect	Scientific name	Order	Life cycle	Nature of damage	Control measures
Mango leaf hopper	*Idioscopus clypealis,* *Idioscopus nitidulus* *Amritodus atkinsoni*	Hemiptera: Cicadellidae	A single female lays about 100–200 eggs. The egg period varies from 4 to 7 days, nymphal period, 8–13 days total life cycle is completed in 15–19 days [26], [27].	Adults and nymphs feed on panicles and shoots, causing flower drop [55]. Honeydew secretion fosters sooty mold, darkening leaves and reducing photosynthesis. Heavy sap loss causes tissue curling and drying [9].	Pruning twice a year, post-harvest (September) and at blossom (December / January), improves sunlight and aeration. Imidacloprid effectively controls mango hoppers, while thiamethoxam,acetamiprid, and fipronil offer limited control [4], [20].
Mango thrips	*Thrips palmi*, *Thrips hawaiensis, Scirtothrips dorsalis, Thrips palmi* and *Scirtothrips dorsalis*	Thysanopter a: Thripidae	Thrips live about 20 days at 30°C. Females lay 50 bean-shaped, pale white eggs in leaf tissue. They undergo two larval and pupal instars. Adults are pale yellow or whitish with dark setae and a black line along their back from wing juncture. Females live 10–30 days, males 7–20. Adults are dark brown to black, 1 mm long, while nymphs are cream- yellow with two red bands.	Thrips colonize leaves, inflorescences, and fruit, lacerating tissues to suck sap [9]. They prefer feeding near the midrib on leaf undersides but attack fruit during severe infestations. Thrips weaken inflorescences, reduce fruit set, cause leaf silvering, fruit bronzing, and, in severe cases, browning and curling of leaf tips [3].	Young and adult thrips are light- sensitive; pruning creates an unfavorable environment. Neem oil (2%) effectively controls adults. Spraying midday minimizes pollinator impact [3]. Severe infestations may require imidacloprid or spinosad.
Mango mealy bug	*Drosicha mangiferae*	Hemiptera: Pseudococci dae	*Drosicha mangiferae* lasts 78–135 days, with nymphs hatching in December–January. Females lay 400–500 eggs and undergo three instars. On mango trees,	*Drosicha mangiferae* is a major pest of mango [15]. Nymphs and females suck sap from inflorescences, leaves, shoots, and fruit peduncles [18]. Their	It includes orchard ploughing, flooding, and trunk treatments with alkathene sheets, mud plaster, or chlorpyrifos dust. If nymphs ascend, spray carbosulfan

			females live 77–135 days, while males live 67–119 days [58]. Winged males are short-lived, die after mating, and do not harm trees.	honeydew promotes sooty mold, reducing photosynthesis. This polyphagous pest infests multiple plant species. On panicles, it causes fruit size reduction and premature dropping [9], [34], [35]	(0.05%) or dimethoate (0.06%) [18], [39].
Mango whitefly	*Aleurodicus disperses, Aleurothrixus floccosus, Aleyrodes proletella, Bemisia tabaci,*	Hemiptera: Aleyrodidae	The life cycle includes egg, four nymphal instars, pupal, and adult stages. Eggs hatch in 10–12 days, with the full cycle completing in 30–40 days depending on species and conditions [10].	Whiteflies feed on plant fluids, causing yellowing, stunted growth, and, in severe cases, honeydew and sooty mold, which reduce photosynthesis and crop value. Untreated infestations can lead to plant death.	Spray with Lambda-cyhalothrin or Duduthrin. Endosulfan was found to be most effective with 82.9% reduction in whitefly population [2].

To mitigate this problem, large quantities of insecticides have been used. Agricultural pesticides are deliberately released into the environment to control pests that harm crops. The use of synthetic organic insecticides in crop pest control programs around the world has resulted to damage of the environment, pest resurgence, pest resistance to insecticides and lethal effects to non-target organisms [1].

Importance of botanicals for pest control

In the year 2013-14, European countries have banned import of mango from India because of problem of fruit flies and mango stone weevils [44]. This has impacted on domestic market significantly. The prices of mango in the same year dropped down.This may be due to developing resistance towards the chemical pesticide [12]. It is worth mentioning here that if biopesticides are used the risk of developing resistance is reduced [38].

Unlike synthetic pesticides, plant-based pesticides have diverse pest control properties. Plant products affect different physiological processes in insects like metamorphosis including insect growth regulation, adult fertility, toxicity and have antifeedant and oviposition deterrent effects *Ageratum conyzoides* L. (AC) is an annual herbaceous plant with a long history of traditional medicinal uses in many countries in the world, especially in the tropical and subtropical regions. The weed has been known since ancient times for its curative properties and has been utilized for treatment of various ailments, such as burns and wounds, for antimicrobial properties, for many infectious conditions and bacterial infections, arthrosis, headaches and dyspnea, pneumonia, analgesic, anti-inflammatory, antiasthmatic, antispasmodic and haemostatic effects, stomach ailments, gynaecological diseases, leprosy and other skin diseases. A wide range of chemical compounds including alkaloids, cumarins, flavonoids, chromenes, benzofurans, sterols and terpenoids have been isolated from this species. Extracts and metabolites from this plant have been found to possess pharmacological and insecticidal activities. This contribution provides a comprehensive review of its ethnomedical uses, chemical constituents and the pharmacological profile as a medicinal plant. Particular attention has been given to analgesic and anti-inflammatory, antibacterial and wound healing properties, radioprotective, antifungal, anthelmintic and nematicidal, insecticidal effects presented in this review such that the potential use of this plant either in pharmaceutics or as an agricultural resource can be evaluated [28].

In place of synthetic insecticides biopesticides are an eco-protective alternative. Biologically active natural plant products may play a significant role in this regard as they are environmentally safe, biodegradable, and cost effective. A large number of investigators isolated and identified several chemical compounds from leaves and seeds of many plants and screened out many insects feeding deterrents and growth inhibitors.

Among them Neem based products have extensively been used and have proved their pest control efficacy against several insect pests. Many plants contain chemical compounds which are toxic to insects, the presence of such bioactive compounds appear to be a natural endowment [25]. Plants contain secondary metabolites like high content of phenols, alkaloids, flavanoids, terpenes, quinones, coumarins etc. which play a defensive role particularly against agricultural insect pests. They are deleterious to insects and other herbivores in diverse ways viz. acute toxicity, enzyme inhibition and interference with the consumption and/or utilization of food [36]. Similarly, the secondary metabolites present in biopesticide act as a feeding deterrent, ovicidal, oviposition deterrent and growth inhibitors against field insect pests. In the present review, an attempt has been made to congregate the traditional, phytochemical and pharmacological studies done on an important medicinal plant, *Ageratum conyzoides* L. (Family Asteraceae) which is widely spread all over the world, especially in the tropical and subtropical region. There are many reports on folk and traditional uses that include wound dressing, skin diseases, ophthalmic, colic, ulcers treatment, diarrhoea, dysentery, fever, gynecological diseases, sleeping sickness, mouthwash, anti-inflammatory, insecticides, etc. Phytochemical investigations have revealed that many components are bioactive due to the presence of broad range of secondary active metabolites such as terpenoids, flavonoids, alkaloids, steroids, and chromene. The plant has been examined on the basis of the scientific in vitro, in vivo or clinical evaluations possessing the major pharmacological activities that includes analgesic activity, antimicrobial activity, anti-inflammatory activity, spasmolytic effects, gamma radiation effects, anti-cancer and radical scavenging activity, antimalarial activity and others activities. The information summarized here is intended to serve as a reference tool to practitioners in the fields of ethnopharmacology, natural product chemistry and drug discovery related research [5]. The control of insect pests in agriculture, forestry, stores, animal husbandry, poultry and in human hygiene are still considered a challenge. Widespread use of chemical pesticides represents a potential risk to human and the environment.

Synthetic/chemical pesticides have inherent drawbacks like

- Loss of efficacy due to resistance development in insects
- Slow and gradual accumulation of some active compounds in soil, ground water and lakes
- Effects on non- target organisms
- Disruption of biological control by natural enemies
- Resurgence of stored product insect pests
- Human health concerns.

Therefore, the search for alternative strategies in pest control is an urgent need of time to overcome this problem. One of the most important groups among them are plant based active substances or mixtures of substances commonly known as „botanicals. Phytopesticides using locally available plants to control major mango pests like Mango leaf hopper, Mango Mealybug, Thrips, White flies, Aphids etc.

Biopesticides

Biopesticides are organic substances prepared by using environmentally safe technology to kill the pests. The results for effective destruction of pest from bio pesticides. Botanical pesticides are used in agriculture for near about 2000 years in Asia and in the Middle East. Bio pesticides can be oils and insecticides of plant origin. Pests are less susceptible to develop resistance towards bio pesticides because of presence of many active compounds. As we discussed above the hazardous impacts of the chemical pesticides need to avoid by adapting such environmentally safe technology to get control over the pests. Much more facts regarding existing bio-pesticides are discussed below.

Conventionally used bio pesticides

Till date there are so many bio-pesticides invented by scientists using environmentally safe materials such as herbal extracts, pathogens including Viruses, nematodes, fungi, protozoan etc. Bacterial insecticide like *Bacillus thuringenesis* [38]. Fungal insecticide by using fungus *Metarrhizium anisopliae* and *Beauveria bassiana* as a microbial control agent [13], [29]. Viruses are actually pathogenic but can be used to control harmful and damaging organisms, some species of arthropods and mites e.g. Baculoviruses used to kill Caterpillers, sawflies etc. Oryctes rhinoceros virus used to kill Rhinoceros beetle etc. [52].

Advantages of bio-pesticides

The bio-pesticides are cost effective when produced with the help of locally available material but sometimes costlier when raw material is purchased from other locations. It is having low persistence value, with biodegradable value. All biopesticides are biodegradable in nature hence obeys sustainable development in agricultural sector The effect of crude methanolic extracts of *Adhatoda vasica* leaves on the feeding and performance of *Spodoptera littoralis* larvae was investigated in the laboratory. Feeding on fresh leaves resulted in 100% mortality of larvae after 26 days of unsubstantial growth. The extract exhibited strong antifeedant and toxic activity against the larvae when applied either on leaf discs or incorporated into artificial diet. Under choice conditions the antifeedant index calculated over 72 h for neonate larvae increased significantly (from 71.5 ± 3.2 to 92.1 ± 4.2) as the concentration of extract in the treated diet increased from 200 to 1000 ppm. Consumption by the sixth instar larvae of leaf discs dipped in 0.01, 0.1 and 0.2% extract solutions was significantly lower than consumption of control discs in both choice and no-choice tests. The latter two concentrations deterred feeding by 63.4 and 90.4%, respectively, under choice conditions, while only the 0.2% extract solution deterred feeding by 56.8% in the no-choice test. Toxicity of the extracts was manifested by a high mortality, reduced growth rates, and low weight gain by larvae fed on diets containing 200–2000 ppm of the extract. No larvae survived to pupation under the latter concentration. The time to pupation increased from 15.8 ± 0.4 to 37.9 ± 4.1 days as the extract concentration in diet increased from 0 to 1000 ppm. When fed to the fifth instar larvae, the crude extract significantly reduced consumption, growth, utilization of ingested and digested food, and approximate digestibility. The consumption-dependent growth efficiency of animals fed on extract-free diet was significantly higher than the growth efficiency of animals fed on extract-containing diets, suggesting both antifeedant and toxic activities of the extract. The effect of bio pesticides is usually delayed but definitely efficient. Liquid formulation of bio-pesticides is usually easy to apply on field. Bio-pesticides are less prone to development of resistance. Bio pesticides not affect beneficial species usually it is host specific in nature. The shelf life of the biological pesticides is less [23]. Bio pesticides are very species specific. Therefore, it is tedious to identify the exact effective ingredient for particular pest on the crop [24]. Although there are a few disadvantages they are negligible over of the advantages.

Existing botanical insecticides against mango leaf hopper

In the survey it is clear that mango leaf hopper (*Idioscopus clypealis* Leth) and Thrips are the major pests at the study area. There are huge numbers of biopesticides already tested against mango pests. The fresh leaf extract of Neem, Eucalyptus, Dhatura were taken separately and allowed to spray on mango tree. From this experiment it is observed that Neem leaf extract proved to be best bio-pesticide against mango mealy bugs [22]. The efficacy of five insecticides were analyzed against mango leaf hopper on field by [41]. Out of these five insecticides three were chemical insecticides viz. Acetamiprid 20SP, Q-fos 25EC and Confidor 75 WG with three different concentrations 0.001%, 0.00125% and 0.0025% and two were botanicals viz. Neem extract and Mahogani extract with three different concentrations such as 0.5%, 1.0%, 1.5%. The results revealed that chemical insecticide i.e. Confidor 70 WG effectively controlled Mango leaf hopper at 0.0025% concentration. On the other hand, Neem extract proved to be better insecticide at 1.5% concentration than mahogany extract at 1.5% [41]. The Mango leaf hoppers (*Idioscopus clypealis* Leth) were managed by using three synthetic insecticides viz. Imidacloprid 0.3%, Endosulfan 0.5%, Cypermethrin 0.4%.and phyto-insecticide used was Neem oil. The results revealed that, all four insecticides showed significant reduction in mango leaf hopper population as compared to control. Imidacloprid showed highest mortality i.e. 92.50 ± 9.02 at 72 hrs. Neem oil found effective against mango leaf hopper and it showed percent mortality of 48.35, 60.15 and 56.54 after 24hrs, 72 hrs, 168 hrs respectively. It was also observed that neem oil maintains higher numbers of natural enemies of mango leaf hopper such as spider, lacewing and ants [2]. The synthetic pesticides like Imidacloprid, thiomethoxam and malathione were analyzed for their effectiveness. Besides synthetic insecticides two botanicals Neem and pungam and entomopathogens also were tested for their effectiveness separately against mango leaf hopper. The results showed that, neem oil and pungam oil at 1% concentration found to be equally effective against mango leaf hopper and percent mortality observed was 79.71 at 1st spray. The entomopathogen used against mango leaf hopper i.e. *Lecanicillium lecanii* 1.15% WP was found to be excellent in controlling mango leaf hopper (86.04%) compared to other botanicals used in this study [8,11].

Insect pest management

The insect pest management has very long history. Sulphur was used for pest control before 4500 years ago by Sumerians. Various minerals and organic chemicals were used by Egyptians. Chinese used to treat crop seeds with plant toxins from last 3000 years ago also burn toxic plants to fumigate insect pest. They also allowed treating the roots of rice plant before replanting with by-product of copper (Cu) smelting [57]. Chemical pesticides and organic pesticides are two extremities of the agriculture.

Local plants with pesticidal property found at the study area

There are several plants with insecticidal activity are already reported on official website of FAO (www.fao.org 17/08/2015). Out of these following are some dominant plants found at Ratnagiri district viz. Neem (*Azadirachta indica* A. Juss.), Nirgundi (*Vitex negundo* L.), Karanj (*Millettia pinnata* L.), Tulsi (*Oscimum sanctum* L.), Tobacco (*Nicotiana tobacum* L.), Lemon (*Citrus limon* L.), Turmeric (*Curcuma longa* L.), Kajra (*Strychnos nux vomica* Linn), Sunflower (*Helianthus annuus* L.), Mustard (*Brassica juncea* L.), Castor (*Ricinus communis* L.), Ground nut (*Arachis hypogaea* L.), Soya bean (*Glycine max* L.), Maize (*Zea mays* L.), Coconut (*Cocos nucifera* L.) etc. Ratnagiri district is located in middle Konkan region and above-mentioned plants are widely available. Some plants are agricultural crops. Therefore, it is difficult to use it for preparation of insecticide on field. Because, such plants will increase cost of the ingredients of the insecticides. The Ratnagiri district is located in middle Konkan region.

In Konkan area weeds such as *Ageratum and Eupatorium are* widely available. Therefore, locally available weeds, *Chomoleana odorata*, *Ageratum conyzoides* are selected for the preparation of herbal extracts to control insect pests on *Mangifera indica* in present research work.

Ageratum conyzoides L.

Ageratum conyzoides L. is an annual, invasive aromatic herb from the Asteraceae family, widely distributed in tropical and subtropical regions. It has a long history of traditional medicinal use for treating ailments such as leprosy, skin disorders, sleeping sickness, rheumatism, headaches, dyspnea, toothaches, and pneumonia [59]. However, it is also known to be toxic to rabbits due to the presence of hydrocyanic acid (HCN) and coumarin [49]. This species contains a wide array of phytoconstituents, including alkaloids, flavonoids, chromenes, benzofurans, terpenoids, sterols, and coumarins, which contribute to its pharmacological and insecticidal properties [30, 37]. The concentration of these bioactive compounds, particularly in its essential oil, varies based on geographical location [56]. Extracts from *A. conyzoides* have demonstrated antimicrobial, anti-inflammatory, antioxidant, anticancer, antidiabetic, and wound-healing properties [59]. Additionally, antifungal compounds derived from this plant are being explored as eco-friendly alternatives to conventional fungicides [7]. The *Ageratum* genus, comprising over thirty species, is known for its rapid spread and has become a major concern for environmentalists, ecologists, and farmers. Several studies have focused on controlling its growth as a weed, with *A. conyzoides* being the most extensively researched species [30,59]. Its plant extracts interfere with pest metabolism by disrupting key digestive enzymes, leading to metabolic imbalances and insect mortality [53]. Moreover, plant- derived bioactive metabolites serve as natural defense mechanisms [53]. Commonly referred to as "Chick Weed," *A. conyzoides* is prevalent in West Africa, Asia, and parts of South America [17]. Given its invasive nature and significant bioactive potential, this plant continues to be a subject of extensive scientific investigation.

Chromolaena odorata (L.) R. M. King & H. Rob

Chromolaena odorata (L.) King and Robinson, also known as *Eupatorium odoratum*, is a fast-growing, scrambling perennial shrub belonging to the Asteraceae family. When its leaves and flowers are crushed, they emit a distinctive pungent odour. Despite being an invasive species that threatens native vegetation, *C. odorata* has demonstrated beneficial applications in agriculture and medicine [21]. Phytochemical studies have identified various secondary metabolites in C. odorata, including phenols, flavonoids, quinones, terpenoids, and coumarins [50], [16]. These compounds contribute to its anti-inflammatory, antipyretic, analgesic, antimicrobial, antioxidant, antihyperglycemic, cytotoxic, and antispasmodic properties [32].

Additionally, has been recognized as a rich source of phenolics and flavonoids with potential therapeutic effects against bacterial infections, diabetes, and oxidative stress in humans [6]. Native to tropical and subtropical regions of the Americas, *C.odorata* has spread extensively to southern and western Africa, tropical eastern and southern Asia, and Australia, where it has become a dominant agricultural weed [19], [40], [60]. The plant's bioactive compounds have been studied for their significant therapeutic potential in managing various pathological conditions [31], [48]. Research has also highlighted its effectiveness in treating parasitic diseases, particularly malaria. In Nigeria and other parts of West Africa, *C. odorata* has been traditionally used as a natural remedy for malaria treatment [51].

Thus, the review of literature may reveal that work on combination of other plants material along with *Ageratum* and *Eupatorium* to control mango leaf hopper (*Idioscopus clypealis* Leth.) has not been carried out by any other scholar. There is much scope to say that the present work may contribute the knowledge of bio- pesticides and the relevance of replacing chemical pesticides by active ingredient. Present study therefore aims to evaluate the biocidal activities of locally available plants like Ageratum and Eupatorium species against insect pests of mango. Looking to the above-mentioned fact, it is proposed to study of potential herbal biocidals against insect pests of mango.

CONCLUSION

After an extensive review of the existing literature, it is evident that the Alphonso mango, a globally renowned and commercially vital cultivar from India's Konkan region, faces significant threats to its cultivation, primarily from insect pests. While India leads the world in mango production, the widespread use of synthetic chemical pesticides to combat pests like the mango leaf hopper and mealy bug has led to detrimental consequences. These include the development of pesticide resistance in insects, environmental contamination, harm to beneficial organisms, and human health concerns. The European Union's ban on Indian mango imports due to pest issues further underscores the urgent need for a more sustainable approach. This review highlights the critical importance of transitioning from synthetic pesticides to biopesticides, particularly those derived from local botanical sources. Plant-based insecticides, or "botanicals," offer a promising eco-friendly and biodegradable alternative. Unlike their chemical counterparts, they contain a diverse array of active compounds such as alkaloids, flavonoids, and terpenoids—that target pests in multiple ways, making the development of resistance less likely. The existing research, including studies on neem and other plant extracts, has shown their efficacy in controlling major mango pests. However, a significant gap remains in the research, particularly regarding the use of combinations of locally available, invasive weeds like *Ageratum conyzoides* and *Chromolaena odorata* (Eupatorium). Given their wide availability in the Konkan region and their known pesticidal properties, these plants represent a cost-effective and environmentally sound resource for developing new biopesticides. Therefore, this study is a timely and crucial effort to evaluate the biocidal potential of these specific herbal extracts against key mango pests. The findings will contribute valuable knowledge to the field of integrated pest management and may pave the way for effective, sustainable, and economically viable pest control strategies for Alphonso mango cultivation, ultimately benefiting farmers, consumers, and the environment.

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