Ecological Attributes and Management Implications of Lantana camara in India

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Abstract:

Extensively invading dry-moist forests, culturable wastelands, and grazing areas all throughout the Indian sub-continent, *Lantana camara* has greatly changed biodiversity, landscape ecology, and ecosystem services. With an eye on its ecological characteristics including biomass production, reproductive biology, invasibility, allelopathy, and resistance to control techniques like cutting and burning, this review synthesizes current research on *L. camara*. With expected control costs of US$ 70 per hectare, the weed's fast spread and tenacious growth style highlight its ecological and financial importance. Though it has negative effects, *L. camara* shows economic promise, which motivates more research on its cost-benefit analysis and application for efficient eradication and control plans.

Keywords: *Lantana camara,* invasive species, ecological impact, biomass productivity, management

INTRODUCTION

Comprising about 150 species of herbs, undershrubs, and shrubs normally growing between 0.5 and 2 meters tall, *Lantana* is a genus within the Verbenaceae family. Originally named by Linnaeus in 1753 in Species *Plantarum*, the genus consists of seven species, many native to subtropical and tropical areas of the Americas, one from Ethiopia (Munir, 1996). Though mostly found in the Americas, several species are native to warm Asia and Africa. There are around 50 countries where *lantana* is growing, and several of them have variances with brilliant flowers. Taxonomically difficult because of unstable species and widespread hybridization, *Lantana* species have varied inflorescence forms and flower hues that fluctuate with age and maturity (Munir, 1996). Commonly known as wild or red sage, *L. camara* L., thrives in tropical, subtropical, and temperate environments and grows rapidly at elevations up to 1800 meters above sea level. Native in tropical parts of the Americas and Africa, it is Nayar, 1977.

Originally an invasive species, *Lantana* has proliferated all over the world, most especially in the Australian-Pacific region. Originally brought from Brazil to the Netherlands in the late 1600s, *Lantana* initially found its way to tropical, subtropical, and temperate areas (Sharma *et al.,* 1988). Nurserymen developed and popularized numerous vivid variants of *Lantana*, which resulted in its extensive worldwide use as an ornamental plant during the 18th and 19th centuries. Out of the about 650 cultivar names in the genus, most have relation to the *L. camara* complex. Over 300 years of cultivation for its flowers have produced several distinct cultivars and hybrids distinguishable visually, physiologically, and genetically (Binggeli, 1999).

Introduction of *Lantana* in India

Lantana camara var. *aculeata* Moldenke, commonly known as *Lantana* wild sage, is a low, erect or sub-scandent woody perennial shrub reaching heights of 0.3-1.8 m or more. It is characterized by stout recurved prickles and emits a strong odor reminiscent of black currants. In India, several species such as *L. camara*, *L. indica*, *L. veronicifoila*, and *L. trifolia* have been documented, alongside species of horticultural significance (Rajendran & Daniel, 2002). Among the varieties of *L. camara* reported in India, *L. camara* var. *aculeata* Moldenke is the most prevalent, although numerous other varieties and types exist, some of which are polyploids. *L. camara* in India is known to be a polyploid complex ranging from 2x to 7x (x = 11) (Kumar & Subramaniam, 1986).

Among the several populations of *L. camara*, morphological features vary noticeably; these include behaviours, thorniness, leaf and inflorescent characteristics, and fruit size. Given many show recurved prickles on the stem, it can be difficult to distinguish between kinds and types depending just on visual traits. These prickles, however, usually reduce or vanish completely under growing conditions; cultivated plants are usually less vigorous in development and yield less readily. Particularly designed for use in hanging baskets and as hedging around house boundaries are dwarf types.

Introduced to India in 1807 as an ornamental plant at the National Botanical Garden (Kohli *et al.,* 2006) Lantana subsequently became a hedge plant in Calcutta early in the nineteenth century (Hakimuddin, 1929). Since then, it has dispersed widely over the nation, naturalizing in open spaces including roadways, train lines, agriculture field boundaries, and open woodlands. It is currently rather well established all throughout India (https://en.wikipedia.org/wiki/*Lantana*_camara). *L. camara* initially arrived in the North West Himalayan region in 1905 in Kathgodam, district Nainital (Hakimuddin, 1929; Hiremath & Sundaram, 2005). Apart from forest and barren regions, this invading weed has crept into around 13.2 million hectares of Indian pasture grounds.

Lantana camara is found extensively in tropical and subtropical environments including Indian protected forest areas. It has also crept into several temperate regions (Kimothi et al., 2010). Up to 2000 m altitude, both *Lantana camara* and *L. indica* are extensively grown in the Garhwal Himalaya region of North India over submontane and montane habitats (Dobhal e*t al.,* 2010; Bisht *et al.,* 2012). Together with other evergreen and mixed forests, the plant flourishes in combination with several tree species including *Acacia catechu*, *Dalbergia sissoo*, *Pinus roxburghii*, *Shorea robusta*, *Tectona grandis* Predictive niche models show that *Lantana* could proliferate much of India (Ray & Ray, 2014).

Ecological Fitness

Lantana's great ecological adaptation is shown in its wide geographic range. Though usually favoring open, unshaded settings like wastelands, forest edges, beachfronts, and regions recovering from fire or logging, it thrives in many climates, habitats, and soil types. Its growth is further facilitated by disturbed environments including roadways, train tracks, and canal banks (Thakur et al., 1992; Munir, 1996). Found from sea level up to 1800 meters above sea level, *Lantana* can grow in areas with yearly rainfall ranging generally from 750 to 5000 mm. It exhibits resistance in low as well as nutrient-rich soils, including gravel, laterite, and even on hilltops. Though it cannot withstand temperatures less than 5°C and is sensitive to frosts and cold temperatures, saline or swampy soils, and locations with low rainfall or poor water-holding capacity, the plant is drought-resistant, favors light, and tolerates moderate shadow (http://www.fao.org/forestry).

Lantana spreads quickly from root suckers and yearly prolific sowing. Because it is poisonous to ruminants, it poses a hazard to cattle (Sharma *et al.,* 1988). Soil analyses by Bhatt (1990) showed varied water-holding capacities (37.6–45.3%), soil moisture (14.4–19.6%), pH levels (6–6.5), and nutrient content, including nitrogen (0.07%-0.12%) and phosphorous (0.001–0.005%), across different soil depths (0–5 cm to 15–20 cm) in the shrublands of the western Himalayas. *Lantana* tends to occupy richer in nutrients than non-invaded areas, which helps to explain its ongoing spread (Manda & Joshi, 2015).

Biomass and Productivity

Lantana camara has significant aboveground biomass over a range of shoot diameters in the Himalayan foothills of North India, from 2.15 to 33.4 tons per hectare (T ha−1). *Lantana* is dominant in mixed shrub land communities where other shrubs and herbs coexist; total biomass ranges from 6.34 to 43.29 T ha−1 with *Lantana* contributing considerably at 78%, followed by other shrubs (19.5%) and herbs (2.5%). (Adhikari *et al*., 2009; Bhatt, 1990). With a considerable share (3.40%) of its biomass coming from seeds and reproductive organs, this shows its strong ruderal strategy.

Lantana camara's net primary output alone is recorded as 13.7 T ha−1; aboveground components account for 10.7 T ha−1 and belowground components 3.0 T ha−1 annually. Of the shoot components, shoots account for 50%, foliage 25%, roots 22%, and 1.5% reproductive parts. Six to fourteen-fold, this productivity level is clearly higher than the shrub layers in natural forest communities of the Central Himalayas (Chaturvedi, 1983; Rawat & Singh, 1988; Rana et al., 1989). *Lantana's* net primary production ranges from 10 to 28 T ha−1 year, making it somewhat similar to those of subtropical and temperate forests (Singh & Singh, 1987). Further noting that *Lantana* consists of 70–80% woody biomass with an annual output rate of 40–60 T ha−1 are Vasudevan and Jain (1991). *Lantana camara* exhibits high biomass among herbaceous groups in the Western Ghats of Tamil Nadu, India, ascribed to major disturbance and an open environment (Chandkaran & Swamy, 2002). *Lantana camara* thus shows strong output, especially in degraded areas with nutrient-poor soils, as those of possible forest communities.

Negative Impacts on Ecosystems

Invasion by *L. camara*

The major ecological effects of invasive plants are well known in many different environments all throughout the planet. They can change trophic interactions, upset the balance of an ecosystem, lower the availability of resources, and hence lessen biodiversity in natural settings. Approved by the IUCN as among the top 10 worst weeds worldwide and among the 100 most invading alien species worldwide, *Lantana Camara* is a prime example of such an invading alien species. Non-native exotic plants seriously threaten native plant communities and ecosystem dynamics, hence influencing population dynamics and community composition (Mooney & Drake, 1986; Pimentel *et al.,* 2001).

This invasion seriously threatens biodiversity (Vitousek *et al.,* 1996; Mack *et al.,* 2000) and changes native vegetation.

Whether brought on by natural factors or human activity, habitat disturbances—especially in dry deciduous environments—cause ideal circumstances for the colonization of invading species such as *Lantana* (Heirro & Callaway, 2003). In areas including the Indian Subcontinent, Southern Africa, and Australia, some *Lantana* species are infamous as noxious weeds. Aggressive invaders, these plants have spread widely throughout tropical and subtropical fields, orchards, and woodland areas. With management expenditures estimated at around US$ 70 per hectare, *Lantana* has invaded over 13.2 million hectares of grazing lands, woodlands, and fallow areas just in India (Sharma & Raghubanshi; http://www.designsystems.in/currentconservation).

Reduced ecosystem services in *lantana*-infested environments not only compromise animal habitats but also help to cause human-wildlife conflicts. Dense *Lantana* thickets give wild boars cover in the Himalayan foothills, which causes crop loss and increases human-wildlife interaction hazards (Singh and Singh, 1987).

Lantana camara in the north Indian foothills of the Nainital district was restricted to hedges and had a meager distribution until 1911 (Hakimuddin, 1929). But over the next two decades, it spread quickly into a dense continuous mass extending about 25 miles in all directions, invading farms, pastures, fallow fields, and woodlands without distinction. Establishing itself as a native species in both Garhwal (Rajwar, 2007) and the Kumaun hills of Uttarakhand (Bhatt, 1990), this invading species has grown to be a major ecological threat today, after a century. In his 1944 book "Man-eaters of Kumaon," Jim Corbett highlighted *Lantana* thickets as leopard hiding sites in the foothills of Kumaon, hence stressing their ubiquitous presence.

Deforestation, erosion, overgrazing, and abandonment of agricultural fields in south-facing landscapes, the Tarai foothills, Shivalik, and mid-montane belts of northern India, where it thrives in open areas including roadsides, footpaths, and human settlements, have caused the species to proliferate extensively (Singh and Singh, 1987). Thanks in great part to its strong root structure, *Lantana camara* is well-known for producing a lot of seeds and for being effectively distributed by birds (Troup, 1921). *Lantana camara* has grown to be a permanent element of the Central Himalayan terrain, changing ecosystems and impacting landscape ecology (Dobhal et al., 2010).

Research in the *Pinus roxburghii* forests of Kumaun highlands show that *Lantana camara* dominates the shrub layer, thereby displaying its great Importance Value Index and basal area (Bhatt et al., 1994; Rawat et al., 1994). Invasive *Lantana* is outcompeting native shrubs like native shrubs such as *Adhatoda vasica, Carissa opaca, Justicia adhatoda, Rubus biflorus, Murraya koenigii,* and *Nyctanthes abortristis* are being outcompeted by the invasive *Lantana* (Sharma and Kumar, 2009).

Sharma and Raghubanshi (2009) noted in the lower Himalayas that the invasion and spread of *Lantana camara* had drastically changed the environment, hence reducing the grass biomass accessible for cattle grazing. Similar effects have been recorded in Pakistan, where *Lantana* raids *Pinus roxburghii* forests (Siddiqui *et al.,* 1995 *Acacia auriculiformis, Adina cordifolia, Boswellia serrata, Briedelia retusa, Buchanania lanzan, Cassia fistula, Elaeodendron glaucum, Emblica officinalis, Eriolena* *quinquelaris, Hardwickia binata, Miliusa tomentosa,* and *Schrebera swietenioides* (Raghubanshi & Tripathi, 2009). These invasions lower tree diversity, upset the demographic stability of native tree species, and might change forest structure over time.

Lantana undergrowth has hampered the growth of Teak trees in Teak plantations all throughout India and internationally, hence reducing basal area increment. Areas afflicted with *Lantana* and Eupatorium have seen particular declines in ground-feeding bird populations, including pheasants, partridges, doves, tree pies, thrushes, pipits, and others that feed on insects (drongos, bush chats, tits, flycatchers, bee-eaters) and nectar (sunbirds) in the Garhwal hills of northern India (Bisht *et al.,* 2012). Once plentiful in the area before the weed invasion, the dense growth of *Lantana* hinders the development of appropriate food sources for these birds. Further affecting bird diets is the phototoxic compounds produced by *Lantana* roots, which damage soil organisms and repel insect fauna. *Lantana* invasion thus seriously jeopardizes avifaunal diversity. In some areas, *Lantana* also provides a habitat for dangerous insect pests including malarial mosquitoes (CSIR, 1962).

Fire and *Lantana*

Lantana shows traits that make it likely to catch fire (Hiremath & Sundaram, 2005). After being burned (Pereira, 1919; Hakimuddin, 1929), the plant quickly resprouts; fire actually encourages its development by boosting its coppicing capacity and breaking seed dormancy, hence producing strong regrowth relative to unburnt areas (Joshi, 2002). Additionally sprouting earlier than those not exposed are seeds subjected to surface fires. Studies of many tropical environments confirm that disturbances like fire and grazing enhance *Lantana* proliferation (Duggin and Gentle, 1998; Gentle & Duggin, 1997). Reaching into forest canopies, the climbing stems of *Lantana* can span over 20 meters and help to start crown fires during burning episodes (Tireman, 1916).

These features of *Lantana* have a number of negative effects on forest ecosystems, such as soil erosion (Day *et al.,* 2003, FAO: http://www.fao.org/forestry/media), loss of native biodiversity (Sharma *et al.,* 2005; Day *et al.,* 2003), harboring disease-carrying vectors (Syed & Guerin, 2004), and raising the risk of wildfires (Hiremath & Sundaram, 2005).

Allelopathic Effect

Allelopathy is an important part of chemical ecology, wherein compounds generated by invading plants hinder the growth of native plants (Heirro & Callaway, 2003). Because of its allelopathic activities, *Lantana* is known to weaken native plants, disrupt succession, and reduce biodiversity (Day *et al.,* 2003; Holm *et al.,* 1979). The effects of *L. camara* allelopathy can differ depending on the crops and environment. According to Maiti *et al.* (2008), for example, germination rate, seed viability, and seedling emergence of Mimosa seeds are decreased by leaf extracts and leachates of *Lantana.* Similarly, Ahmed et al. (1972) discovered that in food crops such as *Brassica juncea, Cicer arietinum, Cucumis sativus, Phaseolus mungo, Raphanus sativus,* and *Vigna unguiculata,* aqueous leaf extracts of *L. camara* inhibit germination, root and shoot elongation, and the development of lateral roots.

When applied folially, *lantana* leaf extracts poison water hyacinth (Eichhornia crassipes), hence suppressing leaf buds and inducing leaf deterioration. They also show phytotoxicity against other plants, most notably stopping Asterella angusta seed germination (Kothari & Chaudhary, 2001). High doses of *Lantana* leaf extract, according to Mishra (2014), stop Parthenium hysterophorus from growing during flowering. Increasing concentrations of aqueous *Lantana* extract lowered germination and dry weight of these crops in laboratory, greenhouse, and field conditions, according to Sahid and Sugau (1993) who investigated the allelopathic effects of *Lantana* residues on the germination and growth of Chinese cabbage, spinach, rapeseed, cucumber, and chili. In another study, Mersie & Singh (1987) exposed that corn was the most impacted while wheat exhibited the least sensitivity to *Lantana* residues by evaluating the allelopathic influence of dried *Lantana* shoot residues on wheat, corn, soybean, Virginia pepperweed, and velvetleaf over 30 days.

Impact on Cattle

For the majority of animals, *Lantana* leaves are extremely toxic. They have caused poisoning in goats, sheep, cattle, and buffalo. Although these animals don't usually like *Lantana* as food, they might eat it if there aren't many other options for grazing. Cattle who eat *Lantana* leaves (12–16 oz.) may experience severe symptoms such as lethargy, excessive salivation, severe dermatitis, skin exfoliation near the muzzle, and jaundice (CSIR, 1962). The "triterpenoids" found in the leaves and seeds—more especially, pentacyclic triterpenoids like lantadenes—are thought to be toxic. These substances make grazing animals including sheep, goats, cattle, and horses hepatotoxic and photosensitive. *Lantana* leaves continue to have strong toxicity despite efforts to lessen it using procedures such anaerobic microbial reaction during silage preparation (Sastry & Mahadevan, 1963; Sharma, 1988; Sharma et al., 1980). Green berries can be harmful to humans when swallowed, even if ripe blue/black berries of *Lantana* are consumed in tropical climates (Ross, 1999; Morton, 1994).

Positive Impacts of *Lantana*

Herbal Medicine

Certain *Lantana* species contain poisonous chemicals, which makes them an important topic for phytochemical research. P. G. J. Louw carried out the first thorough analysis of the chemical components of *L. camara* in 1943 and extracted the plant's primary active ingredient, lantanin, which was subsequently called Lantadene A in 1948. Following its isolation, Lantadene B was discovered to have important functions in the biological activities of *Lantana*, such as its nematicidal, fungicidal, insecticidal, antimutagenic, and antipyretic qualities (Louw, 1948; Barre *et al.,* 1997).

These biological actions are additionally facilitated by secondary metabolites, including flavonoids, phenyl ethanoid glycosides, terpenoids, phenolics, iridoid glycosides, furanonaphthoquinones, and alkaloids (Barre *et al.,* 1997). Early *Lantana* species research was concentrated on essential oils, with yields from hydrodistillation reaching as high as 0.6% from flowers and as high as 0.2% from leaves (Ahmed *et al.,* 1972; Gildermeister & Hoffmann, 1961). Season, location, and stage of plant development are some of the variables that affect these essential oils' chemical makeup (Randrianalijaona 2005).

With about 31% hot water soluble fiber, 26% cellulose, 21% hemi-cellulose, and 16.2% lignin of dry weight, *lantana* is Research on the antibacterial characteristics of *L. camara* (Singh *et al.,* 1990;

Siddiqui *et al.,* 1995; Deena & Thoppil, 2000; Mello *et al.,* 2005; Verma & Verma, 2006) has been conducted internationally extensively.

Lantana is used in Indian traditional medicine as a sudorific, intestinal antiseptic, diaphoretic, and therapy for malaria, rheumatism, and tetanus (Ojha & Dayal, 1992). Antimicrobial, fungicidal, insecticidal, and nematicidal actions abound from its leaves (Begum *et al.,* 2000; Day *et al.,* 2003; Girish, 2017). Disorders include fistulae, pustules, and tumors are also treated with the herb. Pounded leaves are used in medical procedures for cuts, ulcers, and swellings; decoctions of leaves and fruits are lotions for wounds. Externally used as lotions or fomentations against eczema outbreaks and rheumatism, internally infusions of leaves are administered for bilious fever and catarrhal diseases. Children also receive pectorals made of flowers (CSIR, 1962; Singh *et al.,* 1984). Even teeth brushes are made from stems, and timber is polished with leaves.

Utilization of *Lantana* in Industrial Applications

Originally brought to various nations as a garden decoration, *Lantana* was also planted as a hedge to control cattle (Bradely, 1988; Ghisalberti, 2000). Though its reputation as a weed, the research community is investigating several possible uses of the plant, especially its chemical ingredients such *Lantana* oil (Sharma & Sharma, 1989; da Silva *et al.,* 1999).

Lantana biomass produces 200 mg of vital oil per 5 quintals in the Western Himalayan foothill zone of India, worth US$ 91/kg on the market. Apart from being a component of a perfume, this essential oil has adulticidal action against several mosquito species, implying its possible use as a natural insecticide augmenting synthetic substitutes (Dua *et al.,* 2010; Kumar & Maneemegalai, 2008). With a pleasing, long-lasting odor evocative of sage *(Salvia officinalis* Linn.), the oil taken from the leaves (0.2% yield) is yellow to greenish-yellow in color. Older oil turns thick and insoluble in alcohol. It's used topically for skin itching and as an antiseptic for cuts.

Strong antipyretic and antispasmoneous qualities of *lantana* stem and root bark are derived from a quinine-like alkaloid called lantanine. While acetated buffer extracts are efficient against *Micrococcus pyogenes* var. a*ureus*, acid extracts from the shoots show antibacterial action against *Escherichia coli.* With anthocyanin, yellow flavone, pink pigment, and carotene, *lantana* flowers produce 0.07% volatile oil akin to that of the leaves. About 9% of the seeds are oil made of fatty acids including linolenic, linoleic, oleic, stearic, and palmitic acids. Leaves are also claimed to be rather high in cholesterol (Goyal & Kamal, 1984).

Lantana's substantial oleanolic acid concentration emphasizes its adaptability for medical uses including anti-inflammatory, hepatoprotective, and anti-tumor effects (Sharma & Sharma, 1989). In traditional folk medicine, it has been used to treat diseases including chicken pox, asthma, and many skin disorders (Sastri, 1962; Kirtikar & Basu, 2000; Ghisalberti, 2000). Recent research show its promise as antimicrobial agents against a variety of diseases as well as in cancer treatment (Ghosh *et al.,* 2010; Badakhshan *et al.,* 2009; Ventataswamy *et al.,* 2010).

Lantana also has useful purposes as a molluscide and pest control agent, thereby helping to eradicate aquatic snails and termites (Chauhan & Singh, 2010; Verma & Verma, 2006). Apart from uses in medical and pest control, *Lantana* biomass finds application in other sectors for generation of bioethanol, paper pulp, and additional fuelwood (Pasha et al., 2007; Gujral & Vasudevan, 1983; Negi & Bhatt, 1993). Its strong wood helps furniture and handicrafts to be produced, therefore supporting the local populations' economic life (Joshi, 2002; Sharma & Singh, 1994).

Encouragement of the restricted use of *Lantana* in several fields, including herbal medicine, biofuels, and handicap crafts, could help to reduce its environmental impact while still utilizing its advantages given its invading character (Chaterjee, 2015).

Enhancing Soil Fertility through Mulching

Lantana camara offers good ground cover with fine leaf mulch (Munir, 1996), which increases soil fertility in rocky, gravel, or hard laterite soils by holding humus and thereby reducing soil erosion, despite its allelopathic effects. Rich in nitrogen (0.94%), *lantana* leaves break down quickly and are therefore a great source of nutrients fit for the generation of biomass in arid and poor soils. In areas like Mysore, they are used for paddy crops and as green manure in forests; they can also be composted alongside other materials. Significant nutrient levels are found by green material analysis: N = 0.88%; P = 0.15%; K = 0.90%; Ca = 0.61%.

Comprising 10.29% of the weight of the plant, *lantana* ash is especially high in soluble potassium ions, which might help coconut palms (Munir, 1996). Further enriching the soil, it also boasts noteworthy levels of manganese (0.3–0.4%), potassium (1.1–1.8%), and phosphorous (1.6–2.2%). CSIR, 1962; Vasudevan & Jain, 1991;

Research on soil fertility and moisture retention in the Western Himalayan mountains of India has shown how well *Lantana* leaf mulch works. *Lantana* mulch improves nutrient absorption, accelerates grain yields of maize and wheat, and boosts root development, according studies by Acharya & Bhagat (1984) and Sharma & Acharya (2000). Mulching Pine and *Lantana*, according to Sharma and Parmar (1998), improves wheat yield and phosphorus-use efficiency. Furthermore, *Lantana* mulching enhances soil hydraulic characteristics, hence benefiting rice-wheat cropping cycles (Sharma & Verma, 2000; Bhushan & Sharma, 2005). *Lantana* leaves, when combined with forest tree leaves, hasten decomposition, release nutrients, preserve soil moisture, maintain soil fertility, and boost wheat and rice yields in rain-fed fields according to research by Kumar *et al.* (2009). Through quick breakdown and nutrient release, Negi & Kandpal (2003) discovered that *Lantana* mulch adds to soil fertility. Greater organic carbon content in mulched soil layers and notable rainwater conservation seen by Sharma and Acharya (2000) resulted in greater wheat and maize yields in northwest India's rain-fed districts. On hill slopes, dry vegetation such as Khasi pine and *Lantana* helps limit soil erosion and preserve moisture in northeast India's agriculture of tuber crops and vegetables (Mishra & Saha, 2007).

Other Uses of *Lantana*

Lantana is also beneficial in controlling mercury biochemistry in ecosystems since it can gather mercury from soil, move it up its shoots, and release mercury vapor into the atmosphere following reduction (Vasudevan & Jain, 1991). By identifying suspended dust particles in the air, leaves of *lantana camara* can be used as biomonitoring tools for air quality (Rai & Singh, 2015). Advanced methods including phytoremediation of particle pollution and phytoextraction of heavy metals including lead (Kumar *et al.,* 2016; Saini *et al.,* 2017) also find application for the plant. *Lantana* leaf extract shows larvicidal action against three mosquito species, therefore suggesting its possible use as a biopesticide (Hemalatha et al., 2015). Tested as a replacement for tea, fermented *lantana* leaves have a faint smell and produce a less than ideal beverage. Along with great concentrations of tannins, sugars, and resin, the leaves have a variety of enzymes including oxidase, catalase, amylase, invertase, lipase, tannase, and glucosidase. By ether extraction, a crystalline glucoside—probably C27 H42O4—has been extracted from the resin (https://en.wikipedia.org/wiki/*Lantana*_camara). Often planted in butterfly gardens because of their appeal to butterflies, including swallowtail, bird wing, skippers, brush-footed butterflies, *Pieridae*, and *Lycaenidae*, *lantana* species include Spanish Flag *(L. camara), L. lilacina,* and *L. trifolia* are useful honey plants. Many birds, such the Yellow-fronted White-eye of Vanuatu, the Superb Fairy-wren in Australia, and the Mauritius Bulbul, which help to distribute seeds, find great food from *Lantana*.

Conclusion

This study on *Lantana camara* highlights the several ecological and financial uses noted in India. Negatively, its invasion of wastelands, forests, and agricultural areas reduces biodiversity and challenges foresters and farmers. Moreover important issues are its allelopathic impact on several food crops and livestock toxicity. *Lantana* thickets worsen human-wildlife conflicts and help to provide habitat for other species. Furthermore, its severe consequences make its function as a fire spreader in forests a topic of great need for study and management.

Positively, *Lantana* shows interesting industrial uses in cosmetics, medicine, and insecticides. It helps to conserve soil and water as well as to increase their fertility, therefore helping agriculture. Its great biomass generating capacity supports traditional crafts such basketry and furniture building as well as bio-energy generation and mushroom farming. *Lantana* is also beneficial for honey manufacture and butterfly gardening since it is a popular pollinator plant and gives food for birds.

Although *Lantana* poses difficulties, its overall good applications and economic possibilities point to the need of more study on cost-benefit evaluations and efficient management techniques.

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