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RESEARCH ARTICLE

TROPICAL AMERICAN VERBENACEAE SHRUB – A THREAT TO BIODIVERSITY IN PUNJAB (INDIA)

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ABSTRACT

Lantana camara, an ornamental plant and a member of family Verbenaceae, is a native to American tropics that has been expanding its boundaries in several regions of the world including India for over hundred years. The species was introduced as an ornamental plant in the Kolkata (India) initially, however it found an escape out into the agricultural and non-agricultural land in the country including Punjab. Due to various characteristic features of *Lantana* (high reproductive potential, prolonged persistence and viability of seeds and allelopathic interactions), the species has established itself strongly in various parts of Punjab threatening the existing biological diversity of the state. *Lantana* invasion has resulted in overall loss of forest cover in Punjab. Maximum Loss in forest cover due to *Lantana* invasion has been observed in the districts Hoshiarpur (40%) and Ropar (41%) followed by Gurdaspur (35%) in the state. The shrub is known to kill entire local forest fauna by causing massive fires or blocking natural reproductive cycle of forest trees. Introduction of various measures is the need of the hour to control the growth of the shrub in the state and protect the natural forest cover in the state.

Key words: Biodiversity, Punjab (India), *Lantana camara*, Invasive, Verbenaceae, Balhari, Pachrangi.

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INTRODUCTION

Punjab is a small northern state of India that has 84 % of its geographical area under agriculture. One of the premiere agricultural states in northwestern India is considered rich in terms of biological diversity, where a large number of flora and fauna have been recorded from its various forest (Shivalik, Mandand Bir). and agricultural regions. The state houses approximately 1939 species of Angiosperms, over 1000 species of invertebrates, approx. 6 100 species of vertebrates, 560 species of fungi, 397 species of Algae, 48 species of Pteridophytes, 34 species of Bryophytes and 21 species of gymnosperms (Jerath *et al.*, 2002 and 2006). Though biological diversity of the state is being impacted by several factors; (urbanization, unsustainable development, environmental pollution, climate change, and invasive alien species), invasive aliens are considered major threats to biodiversity of the region. World Conservation Union (IUCN) defines an invasive alien species as the species that become established in native ecosystems, proliferate and threaten native biodiversity. These alien species displace indigenous species and cause disruption of the important ecosystem processes. Several hundred invasive alien plant species have been identified in India, most of which have their origins in Tropical and South America.

The present article documents one of the worst terrestrial alien invasive of family verbenaceae in Punjab: *Lantana camara* (commonly known as Balhari, Pachrangi, Big Sage, Wild Sage, Red Sage, White Sage & Tickberry), its ecology and threats to regional biodiversity of Punjab (India).

Lantana camara

Lantana is considered one of the ten worst weeds of the world that is a native of South, Central America and Caribbean islands but has spread to several parts of the world including India (Figure 1, phylogenetic classification Table 1). *Lantana* was introduced in 1809 in India as an ornamental hedge at the Acharya Jagdish Chandra Bose Botanical Garden of Kolkata (erstwhile, Royal Botanical Garden, Calcutta) (Aravind and Rao, 2001; Nanjappa *et al.*, 2005). It soon entered the wild ecosystems of the country and successfully propagated throughout the length and breadth of the Indian subcontinent. Later, the species diffused into both the farm and forest lands, and became one of the most widespread terrestrial invasive species in India. Due to the lack of any management of the weed, it achieved the state of being "super abundant weed" in the country (Kannan, Shackleton, Shaanker, 2013; Batianoff and Butler 2002). The rapid proliferation of the weed can be owed to several of its characteristic features; be its adaptability to a diverse range of habitats and environmental conditions, and enormous seed production with effective seed dispersal or prolonged persistence of seeds and allelopathy.

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Global Biogeographical (native & alien) Distribution of *Lantana camara*

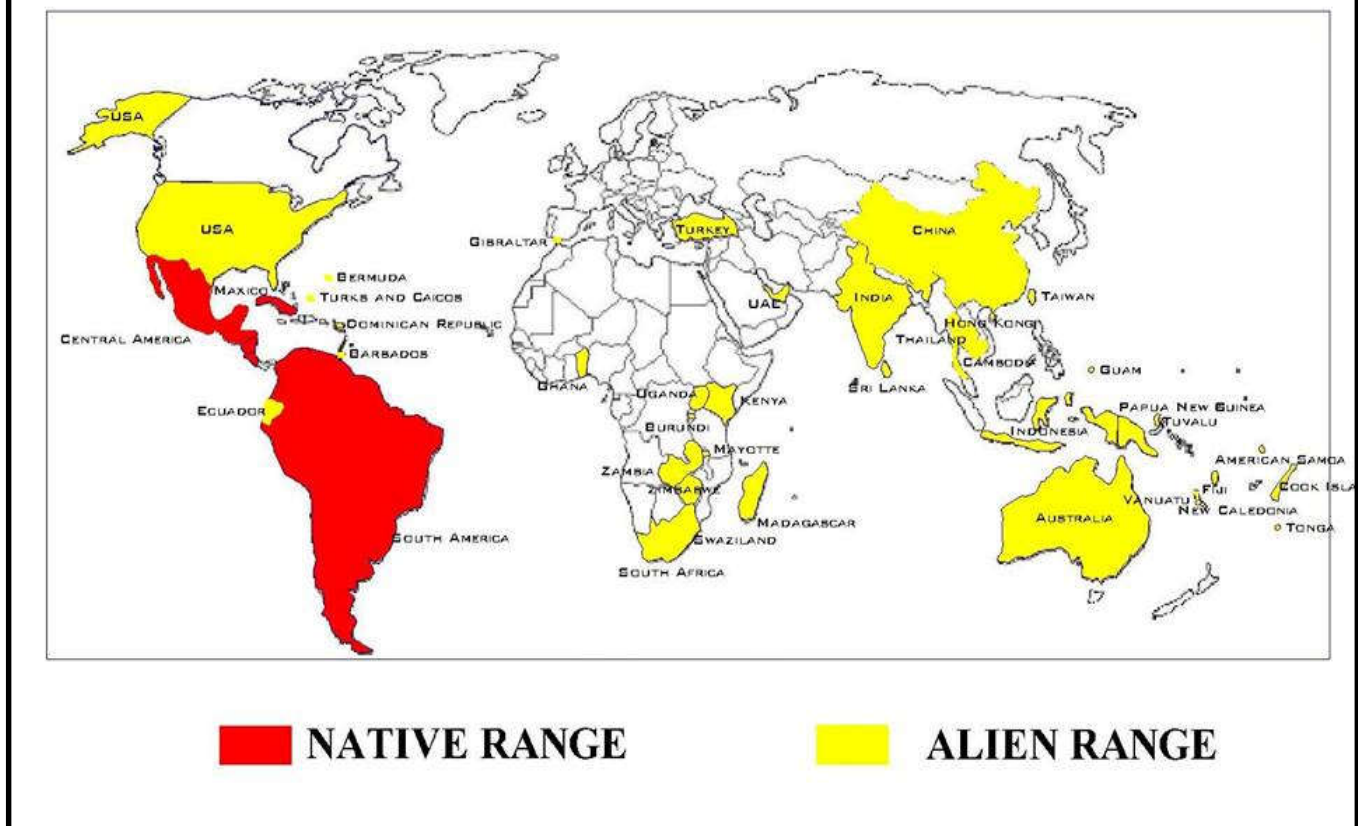


Figure 1. Biogeographic distribution of *Lantana camara* around the world

Among the various factors that has made *Lantana* flourish well in the plains of Punjab, its ability to grow well in diverse habitats under a variety of climatic conditions provides the invasive its long lasting strength to occupy diverse regions in the state . Having known that the species grows well under wet and warm conditions of latitudes between 45°N and 45°S (maximum altitude of up to 1400 m), the agricultural fields and non-agricultural land of Punjab provide the species the required niche for its existence. The only factors that can limit the growth of *Lantana* are low temperatures and shade that causes defoliation in the species. The species do not survive the temperature below 5°C (Day *et al.* 2003). Since, Punjab offers a good climate for its survival mostly, the species is found to grow well in agricultural fields, forest edges, beside roads or railway tracks, and also wastelands. An important characteristic feature of the species that has made it spread in several parts of the world around its native habitat is that each plant can produce a huge number of seeds (about 12,000 seeds) (Dickinson and Royer, 2014)). Flowering in the species peaks during the summer wet months. Each season, these huge number of *Lantana* seeds are then dispersed not only by butterflies and thrips but also by several species of animals (sheep, goats, cattle, foxes, jackals, monkeys and rodents) and birds. Furthermore, it's not necessary for *Lantana* seeds to germinate soon to keep their viability. *Lantana* seeds can remain dormant almost for 11 years without losing its viability. Once light and soil moisture conditions are met, seeds germinate. Apart from this, *Lantana* can also establish dense thickets by vegetative means as well.

These various characteristic features provide *Lantana* all the necessary strength to grow, survive and spread out in the plains of Punjab and threaten the biological diversity of the state with allelopathy (Day *et al.* 2003). In addition to the above mentioned factors (extensive seed production, vegetative reproduction, and plasticity) that has helped the species establish outside its native range, allelopathic interactions provide more strength to the species and pose a danger to the natural composition of plant community in the state. Several allelopathic compounds have been detected in the weed (salicylic acid, coumarin, ferulic acid, lantadene A and lantadene B etc.) that reduce the vigour of nearby plant species and productivity (Day *et al.* 2003) making the species outcompete the native pastures and displace native biota (Gooden *et al.*, 2009). *Lantana* infestation is potentially capable of altering the structural and floral composition of native communities (Sharma and Raghubanshi, 2010) as documented in various studies around the world. In India, invasion of *Lantana* in Velliangiri Hills (Western Ghats, India) has lead to the degradation of typical structure of valuable flora in the Hills in terms of richness, diversity and composition of native species (Aravindhan and Rajendran, 2014). In Australia, *L. camara* has caused allelopathic suppression of two indigenous tree species (Gentle and Duggin, 1997). The reason *Lantana* invasion can bring economic damages to Punjab's agriculture is that its leachates not only can inhibit seed germination and seedling growth in some terrestrial plants but also inhibit growth of important vegetable crops like tomato, radish and cucumber (Mishra, 2014).

Table1. Phylogenetic classification of *Lantana Camara* of Punjab (India)

Classification	<i>Lantana Camara</i>
Kingdom	Plantae
Phylum	Magnoliophyta
Class	Magnoliopsida
Order	Lamiales
Family	Verbenaceae



Figure 2. Morphological features of *Lantana camara*. The woody shrub (1-2 m height) with stout prickles can grow individually or as dense thickets, bears simple opposite leaves attached by a short hairy petiole (2 to 3 mm long). The blade of the leaves is small, oval in shape that can be 10 to 12 mm long and 6-8 mm wide. The margins of the leaves are toothed. The stem is four angled that is covered with stiff hairs and recurved prickles. Flowers are approx. 2-6 cm in diameter that are rounded in shape. Compact, flat-topped inflorescences are supported by a peduncle (3 to 7 cm long). The first flower is often white that turns yellow, orange or pink with age. Fruit is small, fleshy, purplish black berries. The artificial hybrid has about 600 varieties throughout the world that can be distinguished morphologically and genetically

The invasive can suppress the growth of other species while promoting its spread in the region. Since *L. camara* is toxic to cattle, it blocks the movement of grazers by poisoning. The seeds and leaves of Lantana contain tri-terpenoids that makes it poisonous to cattle and the species proliferates quickly

(buffalo, sheep and goats) (Day *et al.* 2003). This furthermore reduces any check on its growth in the fields. Hence, once introduced, Lantana can be damaging to agriculture. Mostly, very few factors can limit the growth of Lantana a) its inability to survive under dense, intact canopies of taller native forest species; b) its susceptibility to frosts and low temperatures; c) its low tolerance to saline soils d) its tendency to rot in boggy or hydromorphic soils. In the absence of most of these factors in the state of Punjab, the weed has easily spread to most of the parts in Punjab. Lantana is threatening the forest range in Shivalik thereby causing destruction of forest flora and fauna. The Shivalik Forest in the districts of Ropar, Gurdaspur and Hoshiarpur have been specifically affected by the invasion of *lantana camara*. In the district Ropar (Punjab), Siswan-Dulwan area has a spread of 2044 hectares in Shivalik. It's a high biodiversity area where proliferation of various species of Lantana is a major problem. In Gurdaspur district, 34.9 per cent loss in forest cover has been attributed to Lantana invasion. According to an initial survey, a forest area of over 500 square kms have been lost in Punjab due to *lantana camara* invasion (TERI, 2015). The reason that Lantana invasion is a matter of concern in Punjab is that the species can become the dominant understorey species and disrupt succession (Murali and Setty, 2001) and the shrub can provide shelter to several serious pests; Malarial mosquitoes (India) and Tse-Tse flies (Rwanda, Tanzania, Uganda and Kenya) (Day *et al.* 2003). The presence of Lantana in the agricultural and non-agricultural land of the state is a threat to biological diversity, crop production and health of grazing animals that makes the management of the species important for the ecological and economic health of the agricultural state of Punjab.

Management

Constant vigilance is the key to good management of Lantana. The species can expand its range during good seasons, therefore control of new infestations is necessary that can be achieved through mechanical or biological agents. Mechanical clearing and hand pulling can be used to clear small areas however, fire might be a useful practice in large areas. Biocontrol agents decrease the volume of individual plants making other control methods considerably easier. Unfortunately, none of the over 40 agents trialed have resulted in total control of the invasive but some have been partially successful [*Teleonemiascrupulosa* Stål (Hemiptera), *Octotomascabripennis* (Coleoptera), *Uroplatagirardi* Pic (Coleoptera) and *Ophiomyialantanae* (Froggatt) (Diptera)] (Day *et al.* 2003). *L. camara* was the first weed ever targeted for classical biological control at the turn of the century, and since then 36 insect species have been released in 33 countries throughout the exotic range. Despite these efforts, control of the weed has generally been disappointing. For the twenty nine biotypes of Lantana that exist in Australia alone (Thomas and Ellison 2000), none of the insect agents released to date could cause a significant damage to the very important Common Pink biotype (Thomas and Ellison, 2000). Many reasons have been suggested for this failure: the great genetic diversity of the plant, its ability to hybridise, and its origin as a hybrid ornamental plant complicates the search for its centre of origin and thus for potential agents (Thomas and Ellison 2000; Day *et al.* 2003). Several fungal pathogens have also been examined as potential biological control agents of Lantana (*Prospodiumtuberculatum*, *Puccinialantanae* and *Ceratobasidi umlantanae-camarae*) (Barreto *et al.* 1995). A strain of the rust *Prospodiumtuberculatum* from Brazil was screened as a

potential biocontrol agent against 40 Australian *Lantana camara* forms and 52 closely related, non-target plant species. *P. lantanae* is a rust of tropical origin that is pathogenic to a wider range of weedy cultivars of *lantana* than *P. tuberculatum* (a rust limited to the tropical and subtropical regions of North and South America) that is pathogenic to two major weed biotypes in Australia: the Common Pink (a highly invasive biotype) and Pink-edged Red (extremely toxic to cattle).

Conclusion

Punjab, a northwestern state of India, is renowned for its biological diversity and agricultural production of several crops. However, invasive/ non-indigenous species are posing a threat to the ecology, agriculture and economy of the state. Considering the potential ability of the *Lantana camara* to promote monoculture in the state, it is advisable that comprehensive information on the invasive plant species be compiled, economic impacts be estimated, awareness and management programs be initiated in the region. A more complete information on the biological and ecological attributes be disseminated in general public so as to manage the *Lantana* spread more effectively in the state. Several physiological and ecological features of the species have helped in successful invasion into the state and its growing range need serious efforts on the part of government and public to eradicate the weed from the state and protect the agricultural economy of the state.

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