

Impact of Plant Invasions on Local Vegetation: An Indian Perspective

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Invasive species are key operators of worldwide ecological change causing the loss of biodiversity, modifying structure and functioning of bio-system, and disturbing establishment of ecosystem amenities throughout the world. About 8.6% of the overall flora of India is alien. A considerable rise in worldwide trade and travel is expected to accelerate entry, spreading and eventual establishment of foreign species in India. Whereas the systematic catalogue of non-native species incarnates the primary vital stage, however, more comprehensive investigations on description of alien species in India, study of their potential invasion environments, recognition of possible ways of invasion and their impact on local vegetation are still missing. The present study reports the incidence of 173 species of alien flora in India, their origins from different parts of the globe belonging to a diverse array of families with an emphasis on the adverse effect of important invasive species on the local vegetation so as to generate an understanding of plant invasions and develop policy framework for their management.

Keywords: Ecosystem; Invasive species; Management.

Invasive plants are the ones that have been deliberately or unintentionally brought to regions other than their natural habitats and cause serious implications to economy, environment, vegetation and humans in the invaded areas. These plants expand rapidly and threaten the local vegetation by competing for water, space and nutrients. The invasive species modify the light, temperature and solar radiation availability in the invaded area.

The access to food, shelter, and relaxing sites are modified for many animals as well. This can result in variations in local vegetation, rate of recurrence of fires, nutrient cycling, water accessibility and soil structure. However, a few cases have reported benefits of invasive plants^{1,2,3}. For instance, they can offer fire wood to local people or supplement resources for native animal species. However, these advantages do not outperform the negative

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detected in Pune, Maharashtra (1955). After that it was delineated taxonomically by Rao in 1956¹⁹. It has the potential of quick colonization with several other characteristics, such as wide adaptability, less number of natural niche enemies, drought tolerance, prolonged viability of seeds, high production of seeds, seeds with small size and light weight, long dispersal of seeds through air, water, birds and other carriers, strong competition and allelopathy makes it a successful invader of crop fields¹⁸. Besides that, it is also capable of causing human health problems like skin allergies, irritation of eyes with mild fever. It is unappetizing and harmful to farm animals. Various allelochemicals have been extracted from the roots, stem, leaves, inflorescence, spores and seeds. These include soluble phenolics and sesquiterpene lactones. The occurrence of plant growth suppressors in *P.hysteriphorus* was first reported by Rajan²⁰ and Kanchan²¹. Along with Parthenin, other inhibitors such as caffeic acid and p-coumaric acid were also found in the stem²¹ of this weed. The leaf leachates of *P. hysterophorus* show inhibitory effect on several agricultural and tree crops^{22,23}.

***Nicotiana plumbaginifolia* Viv.**

Nicotiana plumbaginifolia Viv. (*Solanaceae* family) a native of Cuba, South America and Caribbean is reported as a weed of wastelands and cultivated lands. It is considered as an agricultural weed as well²⁴. It is invasive in India and is regarded as an aggressive colonizer²⁵. This herbaceous plant also has some medicinal values²⁶. The allelochemicals isolated from its leaves are hexamethoxy 4,5,2 methylenedioxy flavone, exoticin, dimethylenedioxy 3,5,3,2 trimethoxy flavone and hexamethoxy 6,7 methylenedioxy flavone. Mushtaq *et al.*^{25,28} found the plant has serious growth inhibitory properties on other plants. Mushtaq and Siddiqui²⁹ have reported the negative growth effects of other members of Solanaceae family as well.

***Ageratum Conyzoides* L.**

Ageratum conyzoides L. is a member of Asteraceae family is reported as a noxious weed in agricultural fields and a colonizer of open degraded lands. It is native to South and Central America³⁰. It also serves as a host to pathogens including nematodes thus, affects crops³¹. Soon after its invasion on land, it suppresses the local vegetation

causing inadequacy of fodder. Its invasion to forests critically threatens many of essential medicinal and aromatic plants. *A. conyzoides* was identified in India before 1882³². *Ageratum* has been reported to suppress growth and yield of native crop species through the release of various phenolics and volatile oils³³. Besides its effect on crops, it also affects human health due to its strong pungent odor. Nausea, allergy and giddiness are some of the health problems caused by this weed in humans.

Role of floods in plants invasions

Researchers believe that the prevalence of invasive plants is one of the most important environmental problems in Kerala India. Particularly after the floods, the prevalence of invasive plants in this area has increased. Seasonal flooding has a direct effect on plant invasion to new environments³⁴. Many plant species inhabiting mountain regions enter the plains and agricultural ecosystems through flood flows, and some of these species have a high potential for conversion into invasive weed species. These plants due to their specific biological, morphological and physiological characteristics and high adaptability to climatic conditions, has potential to rapidly grow and reproduction in new environments and compete with crops as invasive weeds³⁵. Shafroth *et al.*³⁶ evaluated the importance of flood events on the establishment of weeds and found that Saltcedar (*Tamarix ramosissima*) have potential to establish in new lands after floods. Floods can be considered as a seed carrier of plant species³⁷ which often transmits the seeds of invasive species to new environments depending on their biological status³⁸. Cuda *et al.*³⁹ studied the effects of floods on weed invasion in Europe regions and reported *Impatiens glandulifera* as an invasive weed due to floods and spreading through river corridors.

Management

Generally, the management of prolific invasive plant species is one of the most important agricultural and environmental challenges in India. These plants have potential for threaten ecosystems, capture the ecological niches in agricultural systems, and cause many problems in agricultural production. Therefore, it is very important to prevent the establishment and effective management of these plants. In order to prevent the entrance and establishment of invasive plants in new environments, all processes related

Table 1. Invasive alien plants in India

Family	Botanical name	Habit	Origin
Acanthaceae	<i>Peristrophepaniculata</i> (Forssk.) Brummitt	Herb	Tropical America
	<i>Ruelliatuberosa</i> L.		
Amaranthaceae	<i>Digeramuricata</i> (L.) Mart.	Herb	South-West Asia
	<i>Celosia argentea</i> L.		Tropical Africa
	<i>Alternantheraparonychioides</i> A. St. Hil		Tropical America
	<i>Alternantheraphiloxeroides</i> (Mart.) Griseb		
	<i>Alternantherapungens</i> Kunth		
	<i>Alternantheratenella</i> Colla		
	<i>Gomphrenaserrata</i> L.		
Apocynaceae	<i>Catharanthus pusillus</i> (Murray) Don	Herb	Tropical America
Arecaceae	<i>Borassusflabellifer</i> L.	Tree	Tropical Africa
Araceae	<i>Pistiastratiotes</i> L.	Herb	Tropical America
Asclepiadaceae	<i>Cryptostegiagrandiflora</i> R. Br.	Herb	Madagascar
	<i>Asclepiascurassavica</i> L.		Tropical America
	<i>Calotropisgigantea</i> (L.) R.Br.	Shrub	Tropical Africa
	<i>Calotropisprocera</i> (Ait.) R.Br.		
Asteraceae	<i>Echinopsechinatus</i> Roxb.	Herb	Afghanistan
	<i>Glossocardiabosvallea</i> (L. f.) DC.		East Indies
	<i>Sonchus asper</i> Hill		Mediterranean
	<i>Sonchusoleraceus</i> L.		
	<i>Dicomatomentosa</i> Cass.		Tropical Africa
	<i>Ageratinaadenophora</i> (Spreng.) King & Robinson		Tropical America
	<i>Ageratum conyzoides</i> L.		
	<i>Ageratum houstonianum</i> Mill.		
	<i>Bidenspilosa</i> L.		
	<i>Blainvilleaacmella</i> (L.) Philipson		
	<i>Blumeaeriantha</i> DC.		
	<i>Blumealacera</i> (Burm.f.) DC.		
	<i>Blumeaobliqua</i> (L.) Druce		
	<i>Chromolaenaodorata</i> (L.) King & Robinson		
	<i>Conyzabipinnatifida</i> Wall.		
	<i>Crassocephalumcrepidioides</i> (Benth) Moore		
	<i>Emilia sonchifolia</i> (L.) DC.		
	<i>Ecliptaprostrata</i> (L.) Mant.		
	<i>Galinosogaparviflora</i> Cav.		
	<i>Gnaphaliumcoarctatum</i> Willd.		
	<i>Gnaphaliumpensylvanicum</i> Willd.		
	<i>Gnaphaliumpolycaulon</i> Pers.		
	<i>Grangeamaderaspatana</i> (L.) Poir.		
	<i>Flaveriatrinervia</i> (Spreng.) C. Mohr.		Tropical Central America
	<i>Lagasceamollis</i> Cav.		
	<i>Tridaxprocumbens</i> L.		
	<i>Parthenium hysterophorus</i> L.		Tropical North America
	<i>Spilanthesradicans</i> Jacq.		Tropical South America
	<i>Xanthium strumarium</i> L.		
	<i>Youngia japonica</i> (L.) DC.		
	<i>Youngia japonica</i> (L.) DC.		
	<i>Mikaniamicrantha</i> Kunth	Climber	Tropical America
	<i>Synedrellanodiflora</i> (L.) Gaertn.	Herb	West Indies
Balsaminaceae	<i>Impatiens balsamina</i> L.	Herb	Tropical America
Brassicaceae	<i>Cardaminehirsuta</i> L.		

	<i>Cardaminetrichocarpa</i> Hochst. ex A.Rich.		
	<i>Rorippadubia</i> (Pers.) Hara		
Cactaceae	<i>Opuntiastricta</i> (Haw.) Haw.	Herb	Tropical America
Caesalpiniaceae	<i>Cassia absus</i> L.	Herb	Tropical America
	<i>Cassia alata</i> L.	Shrub	West Indies
	<i>Cassia hirsuta</i> L.	Herb	Tropical America
	<i>Cassia obtusifolia</i> L.		
	<i>Cassia occidentalis</i> L.		Tropical South America
	<i>Cassia pumila</i> Lam.		Tropical America
	<i>Cassia pumila</i> Lam.		
	<i>Cassia rotundifolia</i> Pers.		Tropical South America
	<i>Cassia tora</i> L.		
	<i>Cassia uniflora</i> Mill.		
Cleomaceae	<i>Cleome monophylla</i> L.	Herb	Tropical Africa
	<i>Cleome gynandra</i> L.		Tropical America
	<i>Cleome rutidosperma</i> DC.		
	<i>Cleome viscosa</i> L.		
Convolvulaceae	<i>Euphorbia heterophylla</i> L.	Herb	Tropical America
	<i>Evolvulusnummularius</i> (L.) L.		
	<i>Ipomoea carnea</i> Jacq.		
	<i>Ipomoea eriocarpa</i> R. Br.		Tropical Africa
	<i>Ipomoea hederifolia</i> L.		Tropical America
	<i>Ipomoea obscura</i> (L.) Ker.-Gawl.		Tropical Africa
	<i>Ipomoea pes-tigridis</i> L.		Tropical East Africa
	<i>Ipomoea quamoclit</i> L.		Tropical America
	<i>Merremiaegyptia</i> (L.) Urban.		Tropical America
	<i>Ipomoea staphylina</i> Roem. &Schult.		Tropical Africa
Cyperaceae	<i>Cyperusdifformis</i> L.	Herb	Tropical America
	<i>Cyperusiria</i> L.		
	<i>Fuirenaciliaris</i> (L.) Roxb.		
Euphorbiaceae	<i>Chamaesyce hirta</i> (L.) Millsp.	Herb	Tropical America
	<i>Chamaesyceindica</i> (Lam.) Croizat		Tropical South America
	<i>Chrozophorarottleri</i> (Geis.) Spreng.		Tropical Africa
	<i>Croton bonplandianum</i> Boil.		Temperate South America
	<i>Euphorbia cyathophora</i> Murray		Tropical America
	<i>Phyllanthustenenellus</i> Roxb.		Mascarene Islands
	<i>Synadeniumgrantii</i> Hook. f.		Tropical America
Lamiaceae	Poit. <i>Leonotisnepetiifolia</i> (L.) R.Br.	Herb	Tropical Africa
	<i>Hyptissuaveolens</i> (L.)		Tropical America
	<i>Ocimumamericanum</i> L.		
Liliaceae	<i>Asphodelustenuifolius</i> Cav.	Herb	Tropical America
Malvaceae	<i>Malachracapitata</i> (L.) L.	Herb	Tropical America
	<i>Malvastrumcoromandelianum</i> (L.) Garcke		
	<i>Sidaacuta</i> Burm. f.		
	<i>Urenalobata</i> L.		Tropical Africa
Melastomataceae	<i>Clidemiahirta</i> (L.) D. Don	Herb	Tropical America
Mimosaceae	<i>Acacia mearnsii</i> De Wild.	Tree	South-East Australia
	<i>Acacia farnesiana</i> (L.) Willd.		Tropical South America
	<i>Leucaenaleucocephala</i> (Lam.) de Wit	Herb	Tropical America
	<i>Mimosa pigra</i> L.	Shrub	
	<i>Mimosa pudica</i> L.		
	<i>Prosopisjuliflora</i> (Sw.) DC.	Herb	Mexico
Nyctaginaceae	<i>Mirabilis jalapa</i> L.	Herb	Tropical America
Onagraceae	<i>Ludwigiaadscendens</i> (L.) Hara		
	<i>Ludwigiaoctovalvis</i> (Jacq.) Raven		Tropical Africa
	<i>Ludwigiaaperennis</i> L.		

Oxalidaceae	<i>Oxalis corniculata</i> L.	Herb	Europe
Papaveraceae	<i>Argemonemexicana</i> L.	Herb	Tropical Central & South America
Papilionaceae	<i>Aeschynomeneamericana</i> L.	Herb	Tropical America
	<i>Crotalaria pallida</i> Dryand		
	<i>Crotalaria retusa</i> L.		
	<i>Cytisusscoparius</i> (L.) Link		Europe
	<i>Indigoferaastragalina</i> DC.		Tropical America
	<i>Indigoferaglandulosa</i> Roxb. exWilld.		
	<i>Indigoferalinifolia</i> (L.f.) Retz.		Tropical South America
	<i>Indigoferalinnaei</i> Ali		Tropical Africa
	<i>Indigoferatrita</i> L.f.		
	<i>Stylosantheshamata</i> (L.) Taub.		Tropical America
	<i>Ulexeuropaeus</i> L.	Shrub	Western Europe
	<i>Macroptiliumatropupureum</i> (DC.) Urban	Climber	
	<i>Macroptiliumlathyroides</i> (L.) Urban		Tropical Central America
	<i>Melilotus alba</i> Desv.	Herb	Europe
	<i>Sesbaniabispinosa</i> (Jacq.) Wight	Shrub	Tropical America
	<i>Echinochloacolona</i> (L.) Link	Herb	Tropical South America
<i>Echinochloacrusgalli</i> (L.) Beauv.			
<i>Imperatacylindrica</i> (L.) Raensch.		Tropical America	
<i>Pennisetumpurpleum</i> Schum.			
<i>Rhynchelytrumrepens</i> (Willd.) C.E. Hubb.			
<i>Saccharumpontaneum</i> L.		Tropical West Asia	
Passifloraceae	<i>Passiflorafoetida</i> L.	Herb	Tropical South America
Pedaliaceae	<i>Martyniaannua</i> (Houstoun&Martyn) L.	Herb	Tropical America
	<i>Petalium murex</i> L.		
Piperaceae	<i>Peperomiapellucida</i> (L.) Kunth	Herb	Tropical South America
Pontederiaceae	<i>Eichhorniacrassipes</i> (C. Martius) Solms-Loub.	Herb	Tropical America
	<i>Monochoriavaginalis</i> (Burm. f.) C. Presl.		
Portulacaceae	<i>Portulacaoleracea</i> L.	Herb	Tropical South America
	<i>Portulacaquadrifida</i> L.		Tropical America
	<i>Spermacocehispida</i> L.	Herb	Tropical America
Rubiaceae	<i>Salviniamolesta</i> D. S. Mitch.	Herb	Brazil
Scrophulariaceae	<i>Mecardoniaprocumbens</i> (Mill.) Small	Herb	Tropical North America
	Scrophulariaceae		
	<i>Scopariadulcis</i> L.		Tropical America
	<i>Toreniafourrieri</i> Linden ex E. Fournier		Australia
Solanaceae	<i>Daturainnoxia</i> Mill.	Shrub	Tropical America
	<i>Daturametel</i> L.		Tropical America
	<i>Nicotiana plumbaginifolia</i> Viv.	Herb	Tropical America
	<i>Physalisangulata</i> L.		
	<i>Physalispruinosa</i> L.		
	<i>Solanumamericanum</i> Mill.		
	<i>Solanumseforthianum</i> Andrews	Climber	Brazil
	<i>Solanumtorvum</i> Sw.	Shrub	West Indies
	<i>Solanumviarum</i> Dunal	Herb	Tropical America
Tiliaceae	<i>Corchorustridens</i> L.	Herb	Tropical Africa
	<i>Corchorustrilocularis</i> L.		
	<i>Triumfettarhomboides</i> Jacq.		Tropical America
	<i>Corchorusaestuans</i> L.		
	<i>Corchorusfascicularis</i> Lam.		
Turneraceae	<i>Turnerasubulata</i> J. E. Smith	Herb	Tropical America
Typhaceae	<i>Typhaangustata</i> Bory. and Choub.	Herb	Tropical America
Urticaceae	<i>Pileamicrophylla</i> (L.) Liebm.	Herb	Tropical South America
Verbenaceae	<i>Lantana camara</i> L.	Herb	Tropical America

	<i>Stachytarphetajamaicensis</i> (L.) Vahl		
	<i>Stachytarphetaurticaefolia</i> (Salisb.) Sims		
Zygophyllaceae	<i>Tribuluslanuginosus</i> L.	Herb	Tropical America
	<i>Tribulusterrestris</i> L.		

to the import of seeds and reproductive organs of new plants, planting and transfer of plants in new areas should be carefully monitored and prevented from introduction of suspected plant species. Where preventive strategies are not successful, the rapid detection of areas occupied by these plants and complete eradication in the early stages of their establishment is very important. In the case of established invasive plants, preventing the distribution and transmission of seeds and reproductive organs can lead to manage the development of plant invasion. Srivastava *et al.*¹⁶ reported 149 invasive plants from North-Eastern Uttar Pradesh, India, and concluded that early identification and reporting of infestation and spread of these plants is very important for their effective management. Biological control method is one of the most effective methods for managing invasive plant species. The most important advantage of the biological control method for invasive plant species is that, after the establishment of biological control agents, a sustainable and long-term management of invasive species is achievable. Wheeler *et al.*⁴⁰ reported biological control as a successful method for management of invasive weed *Schinus terebinthifolia*.

CONCLUSIONS

Invasive species form the second most serious threat to biodiversity after habitat destruction. Some invasive weed species make a dramatic impact on the processes of ecosystems and biodiversity when they invade. Invasion of an alien species is habitat-dependent. Generally the habitats that are nutrient-rich witness more conquests compared to poor habitats. High reproductive potential, short life cycle and production of many seeds/propagules are some characteristic traits associated with successful invaders. Our analysis summarises the evidences for the impact of alien plant species on many ecological variables. Recently, the negative effects of alien species on resident crops and the mechanisms for these

effects have attracted the focus of researchers. The decrease in local plant species due to invasive species and their development was the main focus of this review.

From the available literature it becomes evident that invasive species have both positive as well as negative impacts. This dual cost nature of many invasive species creates conflict of interests among stakeholders. Therefore, during the management of invasive alien species a uniform management policy cannot be adopted. The invasion of many weed species harmed Indian native flora e.g. *Lantana camara* invasion to India proved dreadful. Currently this invasive weed occupies 13 million hectares of land and further continues to expand its establishment because of its high invasive potential. The control of these invasive weeds may help in protection and restoration of biodiversity. Because of the fast economic globalization and increased trade with other countries, India has become a good recipient for alien invasive species. There is a need to inventorize the alien flora of India so that the research on invasion biology can be geographically understood. These inventories will act as scientific baselines to understand the pattern, impact and management of invasive plant species in India.

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