



INVASIVE ALIEN SPECIES OF ALLAHABAD AND KAUSHAMBI DISTRICTS OF UTTAR PRADESH, INDIA



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ABSTRACT:

Alien species refer to the non-native or exotic organisms that occur outside their natural adapted ranges and dispersal potential. They are recognized as the second largest threat to biological diversity, the first being habitat destruction. These species in absence of their natural antagonists cause unprecedented damage and tremendous adverse economic impact following interface with cultivation of crops, loss of biodiversity and ecosystem resilience. Loss of potentially productive land, grazing and livestock production, poisoning of humans and livestock, genetic corruption and genetic erosion in native species are some long lasting impacts. Besides, fires in heavily invaded areas, choking of navigational and irrigation canals and reduction of available water resources are other major consequences. The Convention on Biological Diversity (CBD), as an outcome of the 1992 Rio Summit, underlined the risk posed by the alien species and requests contracting parties to “prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or

species" (Article 8.h.). District Allahabad, commonly called as Prayag is among important cities of Hindu faith from ancient time because of the confluence of three rivers the Ganga, Yamuna and mythical Saraswati. The people from across the world come every year in the month of magh (January – February) for kalpvaas (one month stay) and take holy dips for their spiritual well being. For this reason the district Allahabad and adjoining district Kausambi are most prone to biological invasion. In last about three decades both the districts have become highly invaded by various alien species posing threats to native species and habitats. This paper is a current inventory of (106) invasive alien species of both the districts with their nativity and weed status that will serve as a ready reckoner for the weed control programs in the districts.

KEY WORDS: Alien species, biodiversity, exotic species, invasive species, weeds.

INTRODUCTION:

International Union for Conservation of Nature and Natural Resources (IUCN) defines Alien Invasive Species as an alien species which becomes established in natural or semi-natural ecosystems or habitat, an agent of change, and threatens native biological diversity. These invasive elements are widely distributed in all kinds of ecosystems throughout the world, and include all categories of living organisms. Nevertheless, plants, mammals and insects comprise the most common types of invasive alien species in terrestrial environments. Alien species are exotic biological elements that occur beyond their natural ranges of dispersal potential. A large number of alien species support our agriculture and horticulture systems in a wide way. However, some of the alien species become invasive when they are introduced deliberately or unintentionally outside their natural habitats into new areas where they express the capability to establish, invade and outcompete with native species.

The threat to biodiversity due to invasive alien species is considered second only to that of habitat destruction. Invasive species cause loss of biodiversity including species extinctions, and changes in hydrology and ecosystem function. Differences between native and exotic plant species in their requirements and modes of resource acquisition and consumption may cause a change in soil structure, its profile, decomposition, nutrient content of soil, moisture availability, etc. Invasive species are thus a serious hindrance to conservation and sustainable use of biodiversity, with significant undesirable impacts on the goods and services provided by ecosystems. Biological invasions now operate on a global scale and will undergo rapid increase in this century due to interaction with other changes such as increasing globalization of markets, rise in global trade, travel and tourism. For effective management of invasive species, knowledge about their ecology, morphology, phenology, reproductive biology, physiology and phytochemistry is essential.

Convention for Biological Diversity (1992) visualize biological invasion of alien species as the second worst threat after habitat destruction. A small percentage of alien species cause serious problems in their new environment and are collectively known as invasive species. Invasive species are introduced in a variety of ways. The means and routes by which they are introduced are called invasion pathways. Some non-native species, intentionally introduced for beneficial purposes, which later turn out to be invasive. Many invasive species are unintentionally introduced; they move as unknown stowaways and hitchhikers when people and their products are transported by air, water, rail, or road.

In biological invasion naturalization has been recognized as the first phase. A naturalized species is an introduced species that can consistently reproduce and sustain population over many generations without or despite direct intervention by humans (Richardson et.al, 2000; Pysek et.al, 2002). After successful local establishment, some naturalized species disperse and produce viable

offspring in areas distant from the sites of introduction. Such naturalized species are called invasive (Richardson et.al, 2000). Many invasive plant species cause economic and or environmental damage, and referred to as alien pests or weeds (Richardson et.al, 2000).

In India, comprehensive studies on invasive species and plant invasions are still missing. There is information gap on exact number of naturalized alien/exotic species in India. The number of such species may be around 2000 (Reddy, 2008). The flora of Allahabad district (including Kaushambi) comprises of 713 species belonging to 419 genera and 113 families of angiosperms. (Misra and Verma, 1989) but there is no authentic and clear record of invasive alien species in this flora. Therefore, the present study was conducted to compile a comprehensive inventory of 106 invasive alien plant species on the basis of literature survey and field observations. The nativity of the species has been provided based on Mathew, 1969; Maheshwari and Paul, 1975; Nayer, 1977; Sharma, 1984; Hajra and Das, 1982; Saxena, 1991; Pandey and Parmar, 1994; Negi and Hajra, 2007 etc.

MATERIAL AND METHODS

For the present study district Allahabad and adjoining district Kaushambi of U.P., India were selected as these two areas are highly prone for invasion due to their pilgrimage value since ancient times. Allahabad is popularly known as Prayag is among important cities of Hindu faith from ancient time because of the confluence of three rivers the Ganga, Yamuna and mythical Saraswati. The people from across the world come every year in the month of magh (January – February) for kalpvaas (one month stay) and take holy dips for their spiritual well being. District Kausambi was recently created from the parental district. District Allahabad is located at 25.45°N and 81.84°E in the southern part of the Uttar Pradesh at an elevation of 98 meters. Geographical area is 5482 Sq. Km. To its south and southeast is the Bagelkhand region, to its east is middle Ganges valley of North India, or Purvanchal, to its southwest is the Bundelkhand region, to its north and northeast is the Awadh region and to its west along with Kaushambi it forms the part of Doab. Allahabad features the typical humid subtropical climate and experiences three seasons: hot dry summer, cool dry winter and warm humid monsoon. The summer season lasts from April to June with the maximum temperatures ranging from 40°C (104°F) to 45°C (113°F). Monsoon begins in early July and lasts till September. The winter season lasts from December to February. The plain area of the district is situated in between Ganga and Yamuna so these rivers play a very pivotal role in the agriculture of the district. District Kaushambi is of great archaeological and historical importance. The geographical and agroclimatic conditions of both the districts are similar. In last about three decades both the districts have become highly invaded by various new alien species posing threats to native species and habitats.

This paper is a current inventory of (106) invasive alien species of both the districts with their nativity and weed status (Table 1) that will serve as a ready reckoner for the weed control programs in the districts.

Table 1: List of invasive alien plant species of district Allahabad and Kaushambi

S. N.	Botanical Name	Family	Status	Habit	Nativity	Vernacular Name
1.	<i>Acacia farnesiana</i> (L.) Willd.	Mimosaceae	PE	Tree	Trop. South America	Vilayti babool
2.	<i>Acanthospermum hispidum</i> DC.	Asteraceae	NI	Herb	Brazil	--
3.	<i>Aerva javanica</i> (Burn.f.) Juss.ex.Schult.	Amaranthaceae	NI	Herb	Trop. America	Dhulmundi

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4.	<i>Ageratum conyzoides</i> L.	Asteraceae	PE	Herb	Trop. America	Visadodi
5.	<i>A. houstonianum</i> Mill.	Asteraceae	PE	Herb	Trop. America	Gandhaura
6.	<i>Alternanthera paronychioides</i> St. Hil.	Amaranthaceae	PE	Herb	Trop. America	Giojihra
7.	<i>A. pungens</i> Kunth.	Amaranthaceae	PE	Herb	Trop. America	Khaki weed
8.	<i>A. tenella</i> Colla	Amaranthaceae	NI	Herb	Trop. America	-
9.	<i>Antigonon leptopus</i> Hook. & Arn.	Polygonaceae	PE	Climber	Trop. America	-
10.	<i>Argemone mexicana</i> L.	Papaveraceae	PE	Herb	Trop. Central and south America	Satyanashi
11.	<i>Bidens pilosa</i> L.	Asteraceae	NI	Herb	Trop. America	Phutum(guj)
12.	<i>Blainvillea acmella</i> (L.) Philipson	Asteraceae	PE	Herb	Trop. America	Kanghi
13.	<i>Blumea lacera</i> (Burm.f.) DC.	Asteraceae	NI	Herb	Trop. America	Kakranda
14.	<i>B. obliqua</i> (L.) Druce	Asteraceae	NI	Herb	Trop. America	-
15.	<i>Borassus flabellifer</i> L.	Arecaceae	NI	Tree	Trop. Africa	Trinaraaj
16.	<i>Calotropis gigantea</i> (L.) R.Br.	Asclepiadaceae	NI	Shrub	Trop. Africa	Aaak, ark
17.	<i>C. procera</i> (Ait.) R.Br.	Asclepiadaceae	NI	Shrub	Trop. Africa	Arka, Mandara
18.	<i>Cassia absus</i> L.	Caesalpiniaceae	NI	Herb	Trop. America	Bankulthi
19.	<i>C. obtusifolia</i> L.	Caesalpiniaceae	NI	Herb	Trop. America	-
20.	<i>C. occidentalis</i> L.	Caesalpiniaceae	PE	Herb	Trop. South America	Kasaunda
21.	<i>C. pumila</i> Lam.	Caesalpiniaceae	NI	Herb	Trop. America	-
22.	<i>C. tora</i> L.	Caesalpiniaceae	PE	Herb	Trop. South America	Chakavat
23.	<i>Catharanthus pusillus</i> (Murray) Don	Apocynaceae	NI	Herb	Trop. America	Sangkhi
24.	<i>Celosia argentea</i> L.	Amaranthaceae	NI	Herb	Trop. Africa	Sufaid murgha
25.	<i>Chloris barbata</i> Sw.	Poaceae	PE	Herb	Trop. America	-
26.	<i>Chrozophora rottlerii</i> (Geis.) Juss. ex Spreng.	Euphorbiaceae	NI	Herb	Trop. Africa	Suryavarti
27.	<i>Cleome gynandra</i> L.	Cleomaceae	NI	Herb	Trop. America	Hulhul
28.	<i>C. viscosa</i> L.	Cleomaceae	NI	Herb	Trop. America	Hurhur
29.	<i>Corchorus aestuans</i> L.	Tiliaceae	PE	Herb	Trop. America	Choncha
30.	<i>C. fascicularis</i> Lam.	Tiliaceae	NI	Herb	Trop. America	Hirankhori
31.	<i>C. tricularis</i> L.	Tiliaceae	NI	Herb	Trop. Africa	-
32.	<i>C. tridens</i> L.	Tiliaceae	NI	Herb	Trop. Africa	-
33.	<i>Croton bonplandianum</i> Baill.	Euphorbiaceae	PE	Herb	Temperate South America	Ban Tulsi
34.	<i>Cryptostegia grandiflora</i> R. Br.	Aclepiadaceae	PE	Herb	Madagascar	Vilayti vakhandi
35.	<i>Cuscuta chinensis</i> Lam.	Cuscutaceae	NI	Herb	Mediterranean	Amar Bel
36.	<i>C. reflexa</i> Roxb.	Cuscutaceae	NI	Herb	Mediterranean	Amar Bel
37.	<i>Cyperus difformis</i> L.	Cyperaceae	NI	Herb	Trop. America	Motha
38.	<i>C. iria</i> L.	Cyperaceae	NI	Herb	Trop. America	Motha

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39	<i>Datura innoxia</i> Mill.	Solanaceae	PE	Shrub	Trop. America	Dhatuira
40.	<i>D. metel</i> L.	Solanaceae	PE	Shrub	Trop. America	Dhatuira
41.	<i>Digera muricata</i> (L.) Mart.	Amaranthaceae	PE	Herb	SW Asia	Latmahuria
42.	<i>Echinochloa colomum</i> (L.) Link	Poaceae	NI	Herb	Trop. South America	Sanwank
43.	<i>E. crusgalli</i> (L.) Beauv.	Poaceae	NI	Herb	Trop. South America	Sanwanki
44.	<i>E. stagnina</i> Retz.	Poaceae	PE	Herb	Trop. South America	Sanwank
45.	<i>Echinops echinatus</i> Roxb.	Asteraceae	NI	Herb	Afghanistan	Gokhru
46.	<i>Eclipta alba</i> (L.) Hassk.	Asteraceae	PE	Herb	Trop. America	Bhringaraj
47.	<i>Eichhornia crassipes</i> (Mart.) Solms	Pontederiaceae	PE	Herb	Trop. America	Jalkumbhi
48.	<i>Euphorbia heterophylla</i> L.	Euphorbiaceae	PE	Herb	Trop. America	Badi duddhi
49.	<i>Evolvulus nummularius</i> (L.) L.	Convolvulaceae	PE	Herb	Trop. America	Vishnukranta
50.	<i>Fuirena ciliaris</i> (L.) Roxb.	Cyperaceae	NI	Herb	Trop. America	Pitt papara
51.	<i>Galinosoga parviflora</i> Cav.	Asteraceae	PE	Herb	Trop. America	--
52.	<i>Gnaphalium pennylvanicum</i> Willd.	Asteraceae	NI	Herb	Trop. America	Dhanwara
53.	<i>G. polycaulon</i> Pers.	Asteraceae	NI	Herb	Trop. America	Dhaanri
54.	<i>Grangea maderaspatana</i> (L.) Poir.	Asteraceae	NI	Herb	Trop. South America	Bhediachim
55.	<i>Heliotropium indicum</i> L.	Boraginaceae	PE	Herb	America	Bichchhu buti
56.	<i>H. peruvianum</i> L.	Boraginaceae	PE	Herb	Peru	Bichchhu buti
57.	<i>Hyptis suaveolens</i> (L.) Poit.	Lamiaceae	NI	Herb	Trop. America	Vilaiti Tulsi
58.	<i>Imperata cylindrica</i> (L.) Beauv.	Poaceae	NI	Herb	Trop. America	Ghora ghas
59.	<i>Indigofera linifolia</i> (L.f.) Retz.	Fabaceae	NI	Herb	Trop. South America	Bhangra
60.	<i>I. linnaei</i> Ali	Fabaceae	PE	Herb	Trop. Africa	Leel
61.	<i>I. trita</i> L. f.	Fabaceae	PE	Shrub	Trop. Africa	Lilhi
62.	<i>Ipomoea eriocarpa</i> R.Br	Convolvulaceae	NI	Herb	Trop. Africa	Buta Nakhari
63.	<i>I. hederifolia</i> L.	Convolvulaceae	NI	Herb	Trop. America	Ghanti lata
64.	<i>I. obscura</i> (L.) Ker.-Gawl.	Convolvulaceae	NI	Herb	Trop. Africa	Pan Bel
65.	<i>I. pes – tigridis</i> L.	Convolvulaceae	NI	Herb	Trop. East Africa	Latri
66.	<i>Lantana camara</i> L.	Verbenaceae	PE	Herb	Trop. America	Raimuniya
67.	<i>Leucaena leucocephala</i> (Lam.) de Wit	Mimosaceae	PE	Herb	Trop. America	Devi chandan
68.	<i>Ludwigia adscendens</i> (L.) Hara	Onagraceae	NI	Herb	Trop. America	Kessara
69.	<i>L. octovalis</i> (Jacq.) Raven	Onagraceae	NI	Herb	Trop. Africa	Kessarua
70.	<i>L. perennis</i> L.	Onagraceae	NI	Herb	Trop. Africa	Kessarua
71.	<i>Malvastrum coromandelianum</i> (L.) Garcke	Malvaceae	PE	Herb	Trop. America	Atibala
72.	<i>Martynia annua</i> L.	Martyniaceae	PE	Herb	Trop. America	Baghnakh
73.	<i>Melilotus alba</i> Desr.	Fabaceae	PE	Herb	Europe	Tipatiya
74.	<i>Melochia corchorifolia</i> L.	Sterculiaceae	NI	Herb	Trop. America	Bundava

75.	<i>Mimosa pudica</i> L.	Mimosaceae	PE	Herb	Brazil	Chui Mui
76.	<i>Monochoria vaginalis</i> (Burm.f.) C. Presl.	Pontederiaceae	NI	Herb	Trop. America	
77.	<i>Nicotiana plumbaginifolia</i> Viv.	Solanaceae	PE	Herb	Trop. America	Ban Tamaku
78.	<i>Ocimum americanum</i> L.	Lamiaceae	NI	Herb	Trop. America	Kali Tulasi
79.	<i>Opuntia dellenii</i> (Ker-Gawl.) Haw.	Cactaceae	PE	Shrub	South America	Naagphani
80.	<i>O. elatior</i> Mill.	Cactaceae	PE	Shrub	South America	Naagphani
81.	<i>O. vulgaris</i> Mill.	Cactaceae	PE	Shrub	North America	Naagphani
82.	<i>Orthosiphon pallidus</i> Royle ex Benth.	Lamiaceae	NI	Herb	Arabia	Saadi tulsi
83.	<i>Oxalis corniculata</i> L.	Oxalidaceae	PE	Herb	Europe	Khatti buti
84.	<i>Parthenium hysterophorus</i> L.	Asteraceae	PE	Herb	Trop. North America	Gajar ghas
85.	<i>Passiflora foetida</i> L.	Passifloraceae	PE	Herb	Trop. South America	Rakhi Phool
86.	<i>Pedaliium murex</i> L.	Pedaliaceae	NI	Herb	Trop. America	Bara Gokhru
87.	<i>Peperomia pellucida</i> (L.) Kunth	Piperaceae	PE	Herb	Trop. South America	Varshabhoo,
88.	<i>Pistia stratiotes</i> L.	Araceae	NI	Herb	Trop. America	Gangavati
89.	<i>Portulaca oleracea</i> L.	Portulacaceae	PE	Herb	Trop. South America	Lunia
90.	<i>P. quadrifida</i> L.	Portulacaceae	NI	Herb	Trop. America	Loni
91.	<i>Prosopis juliflora</i> (Sw.) DC.	Mimosaceae	PE	Shrub	Mexico	Vilayti Keekar
92.	<i>Rorippa dubia</i> (Pers.) Hara	Brassicaceae	NI	Herb	Trop. America	Khukhala
93.	<i>Ruellia tuberosa</i> L.	Acanthaceae	PE	Herb	Trop. America	Tapas
94.	<i>Saccharum spontaneum</i> L.	Poaceae	NI	Herb	Trop. West Asia	Kaans
95.	<i>Scoparia dulcis</i> L.	Scrophulariaceae	PE	Herb	Trop. America	Mithi Patti
96.	<i>Sida acuta</i> Burm.f.	Malvaceae	NI	Herb	Trop. America	Baraira
97.	<i>Sonchus asper</i> (L.) Hill.	Asteraceae	NI	Herb	Mediterranean	Dudhi
98.	<i>S. oleraceus</i> L.	Asteraceae	PE	Herb	Mediterranean	Dudhi
99.	<i>Spermacoce hispida</i> L.	Rubiaceae	NI	Herb	Trop. America	Booka
100.	<i>Torenia fournieri</i> Lind. ex Fournier	Scrophulariaceae	PE	Herb	Australia	--
101.	<i>Tribulus terrestris</i> L.	Zygophyllaceae	NI	Herb	Trop. America	Gokhru
102.	<i>Tridax procumbens</i> L.	Asteraceae	PE	Herb	Trop. Central America	Khal-muriya, Tal-muriya
103.	<i>Typha angustata</i> Bory & Choub.	Typhaceae	NI	Herb	Trop. America	Gond
104.	<i>Urena lobata</i> L.	Malvaceae	PE	Shrub	Trop. Africa	Bala
105.	<i>Xanthium strumarium</i> L.	Asteraceae	PE	Herb	Trop. America	Chota dhatura
106.	<i>Zephyranthes aurea</i> Baker	Amaryllidaceae	PE	Herb	Peru	Lily

NI-New Invasive PE – Preexisting

RESULTS DISCUSSION

The present study embodies a comprehensive inventory of invasive alien species in the flora of Allahabad. Species are discussed with their family, habit, nativity and vernacular name if any. Total 106 invasive alien species were listed. While listing an effort was taken on history, species origin, and species behaviour based on earlier works and field observation. Most of the invasive species were

introduced from Neotropics; Tropical America (32) and Tropical Africa (11) followed by tropical South America (4). Analysis shows that herbaceous species share 93 species, followed by shrubs (10), climbers (1), and trees (2). Out of total 41 angiosperm families; largest family Asteraceae share 18 species, second largest Amaranthaceae/Poaceae 06 each, third largest Caesalpinaceae/Convolvulaceae 05 each, Fabaceae/Mimosaceae/Tilaceae 04 each. In last about 30 years 55 New Invasive (NI) species have been recorded which out compete the Preexisting (PE) 51 species. Present list is helpful to form better plan to detect the alien species of this area and their monitor and control before spread. It's not all but a first step in invasive alien species management.

Sharma and Pandey (1984) published Exotic Flora of Allahabad which included 51 weeds (taken as preexisting PE) however; in recent work besides those PE, 55 New Invasive (NI) elements were recorded on field observation and reference taken from Flora of Allahabad by Mishra and Verma (1989). This underlines that in the last about three decades 55 new exotic weeds invaded to the Flora of Allahabad, which is an alerting signal that on an average about 2 exotic weeds per annum are introduced. The problem never ends here, because invasion of one weed is simultaneously associated with the invasion of at least three animal species and number of microbial entities such as; viruses, bacteria, fungi etc. which further exaggerate the problem in new territory. These invasive associates may turn pests and pathogen and usually prove fatal to the native biodiversity, agriculture, horticulture, livestock as well as human health.

Every ecosystem has an accomplished genetic makeup in agreeable genomic and allelochemic balance with all the constituent genomes and allelochemicals of species grandness. The species interaction in an ecosystem is thus multidimensional beyond mere physical and physiological spheres. Invasion on a non native species should actually be observed as introduction of a new genome which affects the entire existing gene pool of the system by inserting a foreign genetic system. This new arrival usually lacks natural enemies and starts to proliferate unbridled and further corrupts the soil conditions by releasing allelochemicals, sharing rather snatching available pools, inviting or deterring pollinators, insect pests and thus by creating physiological and reproductive hunger for the natives make the situation grim (Pandey, 2013).

In higher species there exist two genetic families in terms of their expression and regulation: (1) constitutive or housekeeping family; which is usually not affected by the environmental conditions or other situations unless contrary to the life of the species itself, and regulated through feedback mechanism and (2) temporal or luxury family; which is time and space specific and expression is controlled by environmental conditions. The latter category of genes in natives gets more affected by invasive species because they create adverse situations, and tempest arises in this system for adaptability. It is generally agreed that certain genes in species are switched off during their developmental and evolutionary processes that plays key role in the adaptation. But when these off genes become on, they specially prove fatal to the sustenance of the species causing rarity and extinction (Pandey, 2013). Thus scientists, academics, leaders of industry and land managers are realizing that invasive species are one of the most serious environmental threats of the 21st century (Mooney and Hobbs 2000).

The ecological risks of invasive species are floundering, as invasive species typically have high reproductive and dispersion potential, and can tolerate a wide range of agroclimatic conditions. Often, they lack natural enemies in their new environments. They may also prey upon native species, spread pathogens and parasites, or alter the genetic makeup of allied species. These species wage a biochemical war against native species often referred to as allelopathy, and also dramatically modify habitats to such an extent that the original community structure is fundamentally changed. However,

to determine whether a non-native species is invasive requires a context-specific analysis, because ecosystems are dynamic and their vulnerability to invasion changes over time. It is therefore, impossible to develop a definitive or complete list of invasive species at the national level but at local level such inventories and their environmental risk assessment is relevant and practicable for the management of invasive alien species and minimize the loss below injury level.

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