



Research article

## Diversity of invasive alien species in Pantnagar flora

Jyotsna Rastogi\*, D. S. Rawat and Satish Chandra

Department of Biological Sciences, College of Basic Sciences and Humanities  
G. B. Pant University of Agriculture and Technology, Pantnagar - 263145, Uttarakhand, India

\*Corresponding Author: [jyotsnarastogi2015@gmail.com](mailto:jyotsnarastogi2015@gmail.com)

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**Abstract:** Biological diversity faces many threats throughout the world and one of the major threats is caused by invasion of alien species. The present study proves presence of 94 invasive alien species in flora of Pantnagar, Uttarakhand, India. These 94 invasive alien species (IAS) belong to 72 genera, under 33 families 85 species are dicotyledons while 9 species are monocotyledons. On the basis of their nativity maximum IAS have their sourced region as American continents (74), followed by Africa (8), Europe (5), Mediterranean (3) and Asia & Australia (2). The taxonomic analysis of IAS reveals dominance of Asteraceae with 18 spp. followed by Fabaceae, Amaranthaceae, Convolvulaceae, Malvaceae, Solanaceae, Poaceae etc. Among these, 78 IAS are herbs followed by shrubs (8), grasses (4), sedges (2), trees (1), and climber (1). Such a large number of invasive alien species in small area of Pantnagar, indicate miserable condition of natural vegetation.

**Keywords:** Invasive alien species - Diversity - Biological invasion - Nativity - Pantnagar.

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### INTRODUCTION

The plants that has been introduced by humans intentionally or accidentally from one region to another are referred as exotic, introduced, foreign, non-indigenous or non-native (Reddy *et al.* 2008). Invasive alien species (IAS) are those that occur outside their natural range, spread rapidly and cause harm to other species, communities and entire ecosystem. Invasive alien species are one of the major causes of biodiversity loss in the world and impose high cost to agriculture, forestry, and aquatic ecosystem. The introduction of invasive alien species in the new habitat outside of their natural home range carries significant risk. Plant invasion is defined as the whole process from the arrival of a new species into a community, its establishment and maintenance in that community, to its further spread into neighbouring communities (Prieur-Richard & Lavorel 2000). Biological invasions are posing a great threat to biodiversity, which is already threatened by habitat destruction due to human population growth. Biological invasions have been recognized as one of the most serious global process impacting the structure, composition and function of natural and semi natural ecosystems (Mooney & Hobbs 2000, Vitousek *et al.* 1997).

The common characteristics of invasive species include rapid reproduction and growth, high dispersal ability, ability to adapt physiologically to new conditions, the ability to survive on various food types and in a wide range of environmental conditions and ability of association with humans. Many invasive alien species grow faster than native plants and reproduce quickly and thus replace indigenous plants and completely alter the composition of flora of the area they have colonized. The presence of invasive species in an area changes the soil structure, its profile, composition, nutrient content of soil, moisture availability etc. It has been reported that agriculture and grazing land, as well as protected areas, are threatened by rapidly growing species of plants that were introduced during colonialism as garden plants and wind breakers (Hall 2003).

The present study is conducted in the land area covered by G. B. Pant University of Agriculture and Technology Pantnagar in Udham Singh Nagar, district of Uttarakhand, India. The University campus at Pantnagar is spread in an area of 12,661 acre (51.24 K m<sup>2</sup>) between the latitudes N 28° 59' 36" – 29° 02' 34" and longitude E 79° 28' 33" – 79° 31' 12" with an altitude range of 213 to 238 m above the sea level. Geographically Pantnagar is situated in the Terai belt near the outer hills of Kumaon Himalaya. The soil is quite rich in nutrients and soil pH is around 6.85. In

Pantnagar area the landscape is completely devoid of natural vegetation and the land is mainly used for agricultural activities. Such an environment is congenial for invasion by invasive alien species and their presence in the area is sporadically reported earlier (Gaur & Rawat 2013, Joshi & Rawat 2011, Nisha *et al.* 2015). However, a complete account of invasive alien species of angiosperms is not yet available and therefore, attempted in this work.

## MATERIALS AND METHODS

Invasive alien species (IAS) were searched and collected from the different localities of study area (Pantnagar). Plant specimen with flower and fruits were collected from different gardens, parks, and research centres of the university regularly for further study. These localities were visited in different seasons to find out the exact flowering and fruiting time of IAS. Collected specimens contain information on locality, date, and other important information as suggested by Jain & Rao (1976). Plant specimen were identified with the help of different floristic work like Duthie (1903–29), Bailey (1949), Maheshwari (1963), Raizada (1976), Babu (1977), Sharma & Pandey (1984), Graf (1992), Gaur (1999), Khuroo *et al.* (2006), Negi & Hajra (2007), Reddy (2008), Chandra Sekar (2012), Mehra *et al.* (2014), Bajpai *et al.* (2015) and volumes of Flora of India by BSI (Sharma *et al.* 1993, Sharma & Balakrishnan 1993, Sharma & Sanjappa 1993, Hajra *et al.* 1995a,b, Hajra *et al.* 1997, Singh *et al.* 2000, Balakrishnan *et al.* 2012). Collected specimens were pressed and dried according to the standard method suggested by Jain & Rao (1976) and submitted in the herbarium of G. B. Pant University of Agriculture and Technology in the department of Biological Sciences, CBSH.

## RESULTS AND DISCUSSION

All the invasive alien species collected from Pantnagar area are enumerated in table 1. Each botanical name is followed by family name, source region (nativity), growth forms and wild/cultivated status.

**Table 1.** Invasive alien species of Pantnagar flora.

S. No.	Name of Species	Family	Nativity	Growth form	Cultivated or Wild
1.	<i>Acacia farnesiana</i> (L.) Willd.	Mimosaceae	Australia	Tree	Wild
2.	<i>Acanthospermum hispidum</i> DC.	Asteraceae	Brazil	Herb	Wild
3.	<i>Acmellaradicans</i> (Jacq.) R.K. Jansen.	Asteraceae	Trop. America	Herb	Wild
4.	<i>Ageratum conyzoides</i> L.	Asteraceae	Trop. America	Herb	Wild
5.	<i>Ageratum houstonianum</i> Mill.	Asteraceae	Trop. America	Herb	Wild
6.	<i>Alternanthera paronychioides</i> St. Hill.	Amaranthaceae	Trop. America	Herb	Wild
7.	<i>Alternanthera philoxeroides</i> (Mart.) Griseb.	Amaranthaceae	Trop. America	Herb	Wild
8.	<i>Alternanthera pungens</i> Kunth	Amaranthaceae	Trop. America	Herb	Wild
9.	<i>Alternanthera sessilis</i> (L.) DC.	Amaranthaceae	Trop. America	Herb	Wild
10.	<i>Amaranthus spinosus</i> L.	Amaranthaceae	Trop. America	Herb	Wild
11.	<i>Anagallis arvensis</i> L.	Primulaceae	Europe	Herb	Wild
12.	<i>Antigonon leptopus</i> Hook. & Arn.	Polygonaceae	Trop. America	Climber	Cultivated
13.	<i>Argemone mexicana</i> L.	Papaveraceae	South America	Herb	Wild
14.	<i>Argemone ochroleuca</i> Sweet	Papaveraceae	South America	Herb	Wild
15.	<i>Asclepias curassavica</i> L.	Asclepiadaceae	Trop. America	Herb	Cultivated
16.	<i>Bidens pilosa</i> L.	Asteraceae	Trop. America	Herb	Wild
17.	<i>Blainvillea acmella</i> (L. f) Philipson	Asteraceae	Trop. America	Herb	Wild
18.	<i>Blumea lacera</i> (Burm. f.) DC.	Asteraceae	Trop. America	Herb	Wild
19.	<i>Calotropis gigantea</i> (L.) R.Br.	Asclepiadaceae	Trop. Africa	Shrub	Wild
20.	<i>Calotropis procera</i> (Ait.) R.Br.	Asclepiadaceae	Trop. Africa	Shrub	Wild
21.	<i>Cannabis sativa</i> L.	Cannabaceae	Central Asia	Herb	Wild
22.	<i>Cassia alata</i> L.	Caesalpiniaceae	South America	Shrub	Wild
23.	<i>Cassia occidentalis</i> L.	Caesalpiniaceae	South America	Herb	Wild
24.	<i>Cassia tora</i> L.	Caesalpiniaceae	South America	Herb	Wild
25.	<i>Celosia argentea</i> L.	Amaranthaceae	Trop. Africa	Herb	Wild
26.	<i>Chenopodium album</i> L.	Chenopodiaceae	Europe	Herb	Wild
27.	<i>Chenopodium ambrosioides</i> L.	Chenopodiaceae	Trop. America	Herb	Wild
28.	<i>Cleome viscosa</i> L.	Capparaceae	Trop. America	Herb	Wild
29.	<i>Convolvulus arvensis</i> L.	Convolvulaceae	Europe	Herb	Wild
30.	<i>Conyza canadensis</i> (L.) Cronquist	Asteraceae	South America	Herb	Wild
31.	<i>Corchorus aestuans</i> L.	Tiliaceae	Trop. America	Herb	Wild

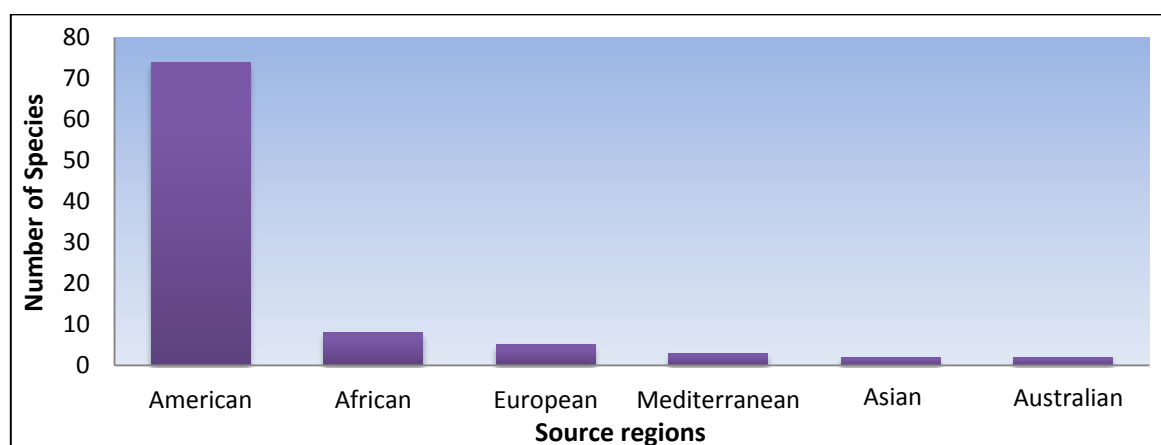
32.	<i>Corchorus olitorius</i> L.	Tiliaceae	Trop. Africa	Herb	Wild
33.	<i>Croton bonplandianum</i> Baill.	Euphorbiaceae	South America	Herb	Wild
34.	<i>Cuscuta reflexa</i> Roxb.	Cuscutaceae	Mediterranean	Herb	Wild
35.	<i>Cyperus difformis</i> L.	Cyperaceae	Trop. America	Sedges	Wild
36.	<i>Cyperus iria</i> L.	Cyperaceae	Trop. America	Sedges	Wild
37.	<i>Datura metel</i> L.	Solanaceae	Trop. America	Shrub	Wild
38.	<i>Datura stramonium</i> L.	Solanaceae	Trop. America	Shrub	Wild
39.	<i>Echinochloa colona</i> (L.) Link.	Poaceae	South America	Grass	Wild
40.	<i>Echinochloa crusgalli</i> (L.) P. Beauv.	Poaceae	South America	Grass	Wild
41.	<i>Eclipta prostrata</i> (L.) L.	Asteraceae	Trop. America	Herb	Wild
42.	<i>Eichhornia crassipes</i> (C.Martius) Solms	Pontederiaceae	Trop. America	Herb	Wild
43.	<i>Emilia sonchifolia</i> (L.) DC.	Asteraceae	Trop. America	Herb	Wild
44.	<i>Euphorbia cythophora</i> Murray	Euphorbiaceae	Trop. America	Herb	Wild
45.	<i>Euphorbia heterophylla</i> L.	Euphorbiaceae	Trop. America	Herb	Wild
46.	<i>Euphorbia hirta</i> L.	Euphorbiaceae	Trop. America	Herb	Wild
47.	<i>Evolvulus nummularius</i> (L.) L.	Convolvulaceae	Trop. America	Herb	Wild
48.	<i>Gnaphalium pensylvanicum</i> Willd.	Asteraceae	Trop. America	Herb	Wild
49.	<i>Gomphrena celosioides</i> Mart.	Amaranthaceae	South America	Herb	Wild
50.	<i>Grangea maderaspatana</i> (L.) Poir.	Asteraceae	Trop. America	Herb	Wild
51.	<i>Hyptis suaveolens</i> (L.) Poit.	Lamiaceae	Trop. America	Herb	Wild
52.	<i>Impatiens balsamina</i> L.	Balsaminaceae	Trop. America	Herb	Cultivated
53.	<i>Imperata cylindrica</i> (L.) Raeusch.	Poaceae	Trop. America	Grass	Wild
54.	<i>Ipomoea eriocarpa</i> R.Br.	Convolvulaceae	Trop. Africa	Herb	Wild
55.	<i>Ipomoea fistulosa</i> Mart. ex Choisy	Convolvulaceae	Trop. Africa	Herb	Wild
56.	<i>Ipomoea hederifolia</i> L.	Convolvulaceae	Trop. America	Herb	Wild
57.	<i>Ipomoea pes-tigridis</i> L.	Convolvulaceae	Trop. E. Africa	Herb	Wild
58.	<i>Ipomoea quamoclit</i> L.	Convolvulaceae	Trop. America	Herb	Wild
59.	<i>Lantana camara</i> L.	Verbenaceae	Trop. America	Herb	Wild
60.	<i>Leucaena latisiliqua</i> (L.) Gilli.	Mimosaceae	Trop. America	Herb	Wild
61.	<i>Ludwigia perennis</i> L.	Onagraceae	Trop. America	Herb	Wild
62.	<i>Malvastrum coromandelianum</i> (L.) Garcke	Malvaceae	Trop. America	Herb	Wild
63.	<i>Mecardonia procumbens</i> (Mill.) Small	Plantaginaceae	Trop. America	Herb	Wild
64.	<i>Melilotus albus</i> Medik. ex Desr.	Fabaceae	Europe	Herb	Wild
65.	<i>Melochia corchorifolia</i> L.	Sterculiaceae	Trop. America	Herb	Wild
66.	<i>Mimosa pudica</i> L.	Mimosaceae	Brazil	Herb	Wild
67.	<i>Mirabilis jalapa</i> L.	Nyctaginaceae	Peru	Herb	Wild
68.	<i>Nicotiana plumbaginifolia</i> Viv.	Solanaceae	Trop. America	Herb	Wild
69.	<i>Ocimum americanum</i> L.	Lamiaceae	Trop. America	Herb	Cultivated
70.	<i>Opuntia vulgaris</i> Miller	Cactaceae	South America	Shrub	Wild
71.	<i>Oxalis corniculata</i> L.	Oxalidaceae	Europe	Herb	Wild
72.	<i>Parthenium hysterophorus</i> L.	Asteraceae	North America	Herb	Wild
73.	<i>Peperomia pellucida</i> (L.) Kunth	Piperaceae	South America	Herb	Wild
74.	<i>Physalis angulata</i> L.	Solanaceae	Trop. America	Herb	Wild
75.	<i>Physalis minima</i> L.	Solanaceae	Trop. America	Herb	Wild
76.	<i>Pistia stratiotes</i> L.	Araceae	Trop. America	Herb	Wild
77.	<i>Portulaca oleracea</i> L.	Portulacaceae	South America	Herb	Wild
78.	<i>Portulaca quadrifida</i> L.	Portulacaceae	Trop. America	Herb	Wild
79.	<i>Prosopis juliflora</i> (Sw.) DC.	Mimosaceae	Mexico	Shrub	Wild
80.	<i>Rorippa dubia</i> (Pers.) Hara	Brassicaceae	South America	Herb	Wild
81.	<i>Saccharum spontaneum</i> L.	Poaceae	Trop. W. Asia	Grass	Wild
82.	<i>Scoparia dulcis</i> L.	Plantaginaceae	Trop. America	Herb	Wild
83.	<i>Sida acuta</i> Burm. f.	Malvaceae	Trop. America	Herb	Wild
84.	<i>Solanum nigrum</i> L.	Solanaceae	Trop. America	Herb	Wild
85.	<i>Sonchus asper</i> (L.) Hill	Asteraceae	Mediterranean	Herb	Wild
86.	<i>Sonchus oleraceus</i> L.	Asteraceae	Mediterranean	Herb	Wild
87.	<i>Torenia fournieri</i> Linden ex Fourn.	Linderniaceae	Australia	Herb	Wild
88.	<i>Tribulus terrestris</i> L.	Zygophyllaceae	Trop. America	Herb	Wild
89.	<i>Tridax procumbens</i> L.	Asteraceae	C. America	Herb	Wild
90.	<i>Triumfetta rhomboidea</i> Jacq.	Tiliaceae	Trop. America	Herb	Wild

91.	<i>Typha angustifolia</i> L.	Typhaceae	Trop. America	Herb	Wild
92.	<i>Urena lobata</i> L.	Malvaceae	Trop. Africa	Shrub	Wild
93.	<i>Xanthium indicum</i> Koenig	Asteraceae	Trop. America	Herb	Wild
94.	<i>Youngia japonica</i> (L.) DC.	Asteraceae	South America	Herb	Wild

In the present study 94 invasive alien species under 72 genera, belonging to 33 families have been recorded in Pantnagar area. In IAS flora of Pantnagar dicotyledons are represented by 85 species under 65 genera, and 28 families, whereas monocotyledons are represented by 9 species under 7 genera and 5 families (Table 2). On the basis of their source regions IAS can be broadly categorized into six major groups *viz.*, American, African, European, Asian, Mediterranean, Australian. Almost 78% (74 spp.) IAS were introduced from the American continent followed by African continent 8.5% (8 spp.), Europe 5.3% (5 spp.), Mediterranean 3.1% (3 spp.), Asian and Australian by 2.1% (2 spp). These results are in tune of Reddy (2008), Singh *et al.* (2010), Chandra Sekar *et al.* (2012) where Tropical American elements are recorded as the dominant part of IAS flora. Pantnagar is a hot and moist subtropical habitat where, tropical American plants have found climatic conditions similar to their native habitats and thus flourish well (Fig. 1).

**Table 2.** Families, Genera and species of IAS diversity in Pantnagar area.

	Families		Genera		Species	
	Number	%	Number	%	Number	%
<b>Dicots</b>	28	84.84	65	90.28	85	90.42
<b>Monocots</b>	5	15.15	7	9.72	9	9.57
<b>Total</b>	33	100.00	72	100	94	100



**Figure 1.** Source regions of Invasive Alien flora of Pantnagar.

Family Asteraceae dominates the invasive alien flora with 18 species in 16 genera, followed by Fabaceae (8 spp., 6 genera), Amaranthaceae (7 spp., 4 genera), Convolvulaceae (7 spp., 3 genera), Malvaceae (7 spp., 6 genera), Solanaceae (6 spp., 4 genera), Poaceae (4 spp., 3 genera), Euphorbiaceae (4 spp., 2 genera) constituting the eight dominant families of IAS (Fig. 2). In other regions IAS flora also have the dominance of family Asteraceae (Singh *et al.* 2010, Wagh & Jain 2015). The IAS flora of Uttarakhand and India also recorded the highest member of species from family Asteraceae (Reddy 2008). The dominance of family Asteraceae may be attributed to its prolific seed production and efficient seed dispersal mechanism. Habit wise analysis showed that the herbs (78 species) were dominant, followed by shrubs (8 species), grasses (4 species), Sedges (2 species) trees (1 species), and climbers (1 species) (Fig. 3). Herbs, shrubs and trees may have equal chances of dispersal to non-native lands of these species but since herbs have shortest life cycle their further proliferation in non-native land is easier. This seems to be the reason behind large percentage of herbs in IAS flora in Pantnagar and elsewhere. The genera with the highest number of invasive alien species in Pantnagar region are *Ipomoea* (5 species), *Alternanthera* (4 species) and *Cassia* (3 species). These genera are also recorded having many species in Reddy (2008), Chandra Sekar *et al.* (2012). In the recent years IAS have gained considerable notoriety as being major threats to native species and ecosystem. These IAS proliferates easily because they find no natural enemies in their new habitat and produce large numbers of propagules. Presence of IAS in any area be it

country, state, district or local, indicates the disturbance in the vegetation of that area. More disturbed is the vegetation more are the chances of occurrence of invasive alien species in the area.

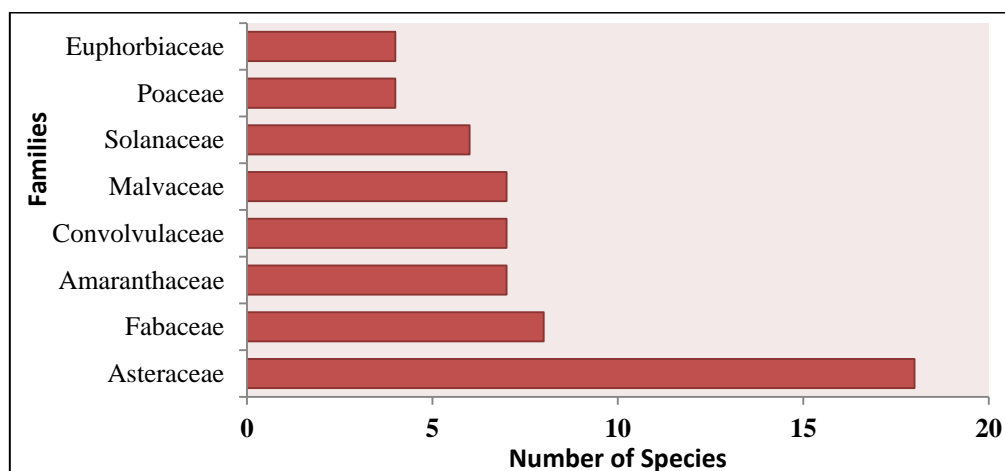


Figure 2. Eight dominant families of Invasive Alien flora in Pantnagar.

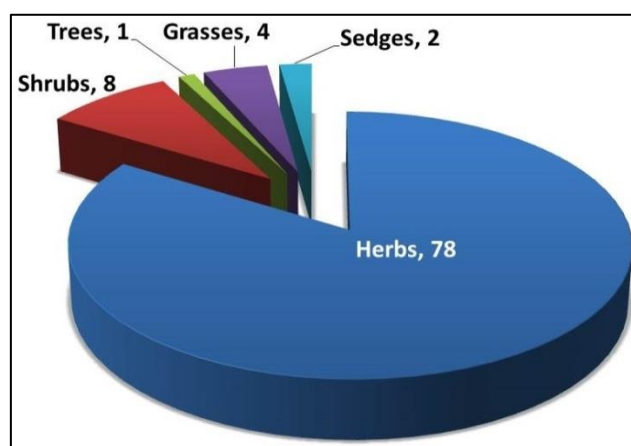


Figure 3. Life forms of IAS in Pantnagar region

Pantnagar is a small land area devoid of natural stands of vegetation and suffer from continuous agricultural operations and human activities, which seems to be the reasons behind the presence of large number of IAS flora here. The challenge now is to find ways to manage the invasive aliens that are firmly entrenched in the area. Though prevention is suggested as the most effective and feasible method for controlling the Invasive species it cannot be applied after invasion. Rather, now steps should be taken to ensure no further spread of these weedy species through planting materials, seeds carried from the university to adjacent areas.

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