

Original Research Article

DIVERSITY OF INVASIVE ALIEN DICOT SPECIES IN PANTNAGAR, UTTARAKHAND, INDIA

ABSTRACT

Objective: Regular assessment of invasive species is essential to understand the status of flora in any area. The current study is the result of a floristic survey of wild dicotyledonous angiospermic plants of Pantnagar, Uttarakhand, India.

Method: For the study, field surveys were conducted from the year 2016-2022. Plant specimens were collected, dried, poisoned and herbarium were prepared. Specimens were identified with the help of various Floras.

Results: Anthropogenic stresses on the vegetation are on high in the area in the form of intensive agricultural farming, industrial activities, university campus activities, roads and traffic, parks and playgrounds and continuous removal of natural wild vegetation. The natural tarai vegetation of the region is nearly lost or found in patches while a major portion of the vegetation is composed of invasive alien plant species (IAPS). Two assessments of invasive alien angiosperm species have been carried out in the area during the last decade in 2011 and 2015. These assessments reported the presence of 52 species (Joshi and Rawat, 2011) and 85 species (Rastogi *et al.*, 2015) of invasive alien dicot plants. The current study, however, reveals the presence of 105 invasive alien dicot species (IADS) from the study region. This

large increment of more than 23 % in the IADS in such a short span of time reflects the poor state of natural vegetation and high degree of anthropogenic activities in the area. The nativity analysis revealed the dominance of South American elements (53.33%) in the invasive alien dicot flora of the study region, followed by Tropical American, African and North American elements.

Keywords: Wild flora; Dicots; Invasive alien dicot species; Pantnagar; Taxonomy.

1. INTRODUCTION

Floristic explorations, identification and documentation of flora of any small region is an important step to ascertain the biodiversity wealth of a larger landmass [1]. In the Holocene epoch, a high degree of anthropogenic activities have already marked humans influenced time period- 'anthropocene' in the geological time scale. Biological invasions in the form of invasive alien plant species (IAPS) constitute a significant element of environmental change driven by anthropogenic activities [2, 3, 4]. "Invasive alien plants are non-native or non-indigenous species that invade an ecosystem, acclimatize for survival and nutrition, and ultimately manipulate the local environment creating a negative pressure for native plants" [5]. With globalization in transport, trade and commerce, the problem of biological invasion by IAPS is expected to increase rapidly with serious repercussions in ecological and economic fields [6, 4]. A Strategic Plan for Biodiversity (2011-2020) was formulated in October 2010 by The Convention on Biological Diversity (CBD) in which invasive alien species and their pathways were to be traced, aggressive priority species were to be controlled and measures were to be taken to prevent their further introduction and establishment, all by the year 2020 [7]. There is substantial data of alien flora available at both regional and continental level [7, 8, 4], however there is data gap due to over representation of data from developed countries and under - representation of data from developing countries [7, 9, 4]. Apart from this, the data concerning distribution of invasive alien plant species is fragmented and deficient which is however required to be complete and up to date [9, 10, 4].

There are numerous studies on invasion of plants throughout India by various researchers. These studies signify the distribution and proliferation of alien species in India and their effects in alteration of native floral composition. In a study conducted by Khuroo *et al.*, (2012) on invasive alien flora of India, a compelling introduction of the non-native species was observed. The study reported the presence of 1,599 non native species, belonging to 842 genera under 161 families contributing 8.5% to the total Indian vascular flora. Sekar (2012) reported the presence of 190 invasive alien species under 112 genera, and 47 families from the Indian Himalayan Region [11]. Sekar *et al.*, (2012) conducted a study in Uttarakhand, where a total of 163 invasive alien species under 105 genera, belonging to 46 families were documented [12]. Negi and Hajra (2014) compiled a checklist of 436 alien species from Doon valley of North-West Himalaya, comprising 308 woody (45.69%) and 128 (19.4%) non- native herbaceous species [13]. Pathak *et al.*, (2019) reported 297 naturalized alien plant species belonging to 65 families from the Indian Himalayan Region [14]. Khuroo *et al.*, (2021) compiled an inventory of invasive alien flora of India. The study was based on an extensive review of scientific literature in the form of regional and state floras, regional weed floras, research papers, books, field guides, and flower manuals published between the year 1934 and 2018. In the study, a total of 145 invasive plant species belonging to 101 genera in 40 families were documented. The 5 dominant families in terms of number of invasive species were Asteraceae (27 species), Fabaceae (20 species), Solanaceae (12 species), Amaranthaceae (11 species), and Euphorbiaceae (8 species). With respect to nativity of the invasive alien species, the study reported the dominance of Southern American elements (60%) followed by Northern America (13%), Africa (9%), Asia-Temperate (5.5%) and Europe (5.5%) [4].

During the floristic study of dicot plants of Pantnagar region from the year 2016 – 2022, the major portion of the flora was found to be composed of IADS. Invasive alien species can be considered as a scale to measure the loss of native vegetation of a region. These are the species that can survive on their own without any human interference. Pantnagar region is a highly disturbed habitat devoid of native vegetation with a high rate of anthropogenic activities. The increasing diversity of IAPS is a matter of serious concern since invasive species along with the loss of native vegetation are also responsible for extinction of native species and altered hydrology and ecosystem function [15]. The current study has tried to give an insight to the current status of invasive alien elements in the dicot flora of Pantnagar while comparing the data from the previous studies by Joshi and Rawat (2011) and Rastogi *et al.* (2015) [16, 17].

The climate of Pantnagar is distinctly humid-subtropical. Precipitation in the form of rainfall is dominated by the monsoon, which accounts for the maximum rainfall during the months of June to September. Table 1 summarizes the meteorological data of the study region during the course of field work. For the current work, invasive alien dicot species were collected from different localities of Pantnagar, Uttarakhand for herbarium preparation. Their photographs were taken to record habit and morphology of the plant. Regular field trips were made for the collection of plant specimens in different seasons and the places usually accessed for collection were the wastelands, marshy areas, partial forest area etc.

Table 1. Long term meteorological data of Pantnagar from 2016 -2021

Month	Average Temperature (⁰ C)		Average Rainfall (mm)
	Minimum	Maximum	
January	6.95	18.98	49.9
February	8.98	23.48	15.15
March	13.28	28.75	13.98
April	18.15	34.9	32.85
May	21.775	37.23	30.73
June	25.4	35.85	181.3
July	25.8	32.43	449.08
August	25.7	31.95	409.7
September	24.2	32.53	227.08
October	17.45	31.8	0.65
November	11.63	27.38	8.35
December	7.58	21.16	21.48

The collected specimens were identified with the help of various floras and by verification with the specimens housed at Botanical Survey of India - Northern Circle (BSD). The collected specimens have been submitted in G.B. Pant University Herbarium (GBPUH). For nativity analysis of the invasive alien plant species, various published literatures have been followed. The pertinent reference for nativity is also listed in the Table 2.

3. RESULTS AND DISCUSSION

Plant collections during 2016-2022 have resulted in the occurrence of 450 species under 311 genera of 79 families of dicotyledonous angiosperms in the Pantnagar area. Nature and activity of the species revealed that 105 are invasive alien species. These species with their families, nativity, habit, flowering and fruiting season are listed in the Table 2. These species belong to 79 genera, 30 families and 17 orders.

In the previous reports by Joshi and Rawat (2011) 52 species of invasive alien dicotyledonous angiosperms were found present in the Pantnagar area [16]. Later, after four years another report by Rastogi *et al.* (2015) demonstrated presence of 85 Invasive Alien Dicot Species (IADS) under 65 genera and 28 families [17]. However, the current study proves presence of 105 IADS from the region, belonging to 79 genera and 30 families. The results of present study are compared with earlier reports in the Figure 2. This comparison shows that the number of invasive alien species has increase clearly during last one decade. Though, this increase may partially be attributed to more intensive plant collection in the area.

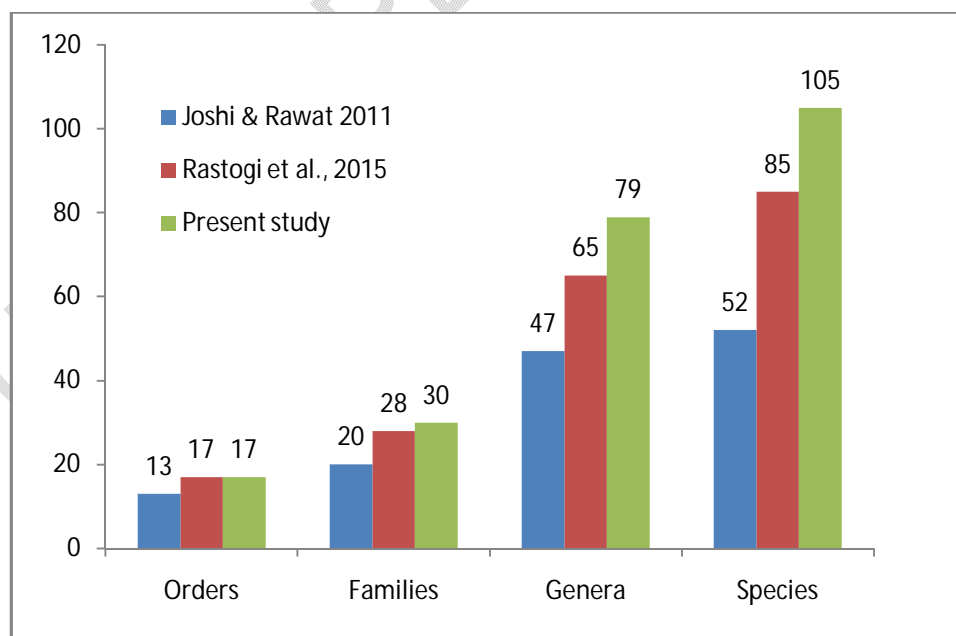


Figure 2. Invasive Alien Dicot Species in Flora of Pantnagar

Amongst the 30 families contributing to the invasive dicot flora, family Asteraceae dominates with 21 species under 18 genera constituting 20% of the total invasive flora, followed by Fabaceae (13 species under 19 genera, 12.38%), Amaranthaceae (11 species under 7 genera, 10.47%), Solanaceae (9 species under 4 genera, 8.57%), Convolvulaceae (8 species under 4 genera, 7.61%), Malvaceae (7 species under 6 genera, 6.66%) and Euphorbiaceae (5 species under 4 genera, 4.76%) (Figure 3). 16 families of invasive alien dicot flora are represented by single species.

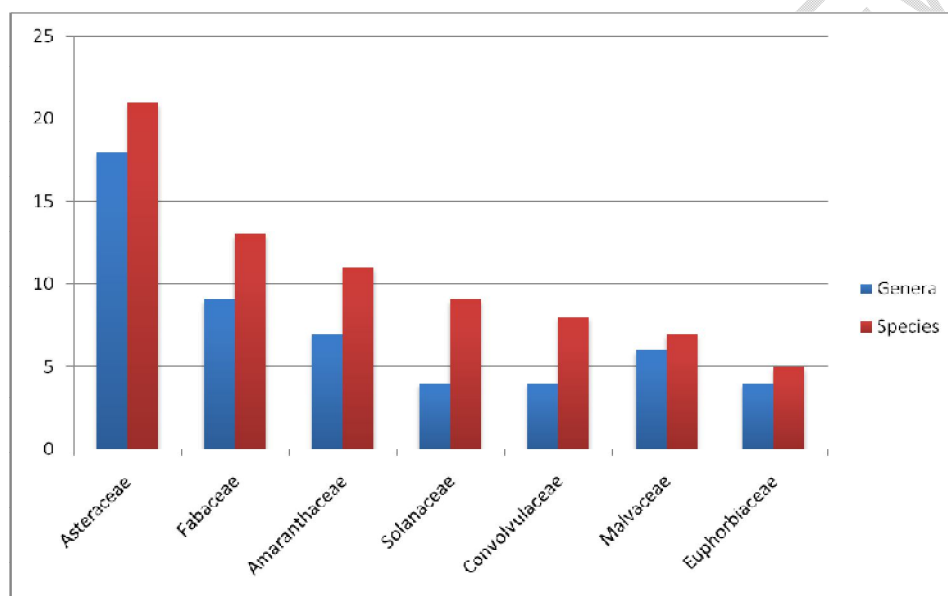


Figure 3. Dominant invasive alien dicot families of Pantnagar, Uttarakhand

Habit wise analysis of invasive flora shows dominance of herbaceous form over other life forms. Herbs with 75 species constitute 71.43% of the total invasive dicot flora of Pantnagar, followed by Shrubs (16 species; 15.24%), Climbers (9 species; 8.57%) and Trees (5 species; 4.76%) (Figure 3). These results indicate dominance of herbs as also shown by Reddy (2008), Singh *et al.*, (2010), Sekar *et al.*, (2012) [18, 19, 12]. Since, herbaceous species can survive better than other growth forms in disturbed habitat, therefore in the present study they are seen to dominate the habit of invasive alien flora. The herbaceous species were found

abundantly along the roads, wastelands, parks, crop fields and gardens. The other life forms were often found in the wastelands and along forest margins (figure 4).

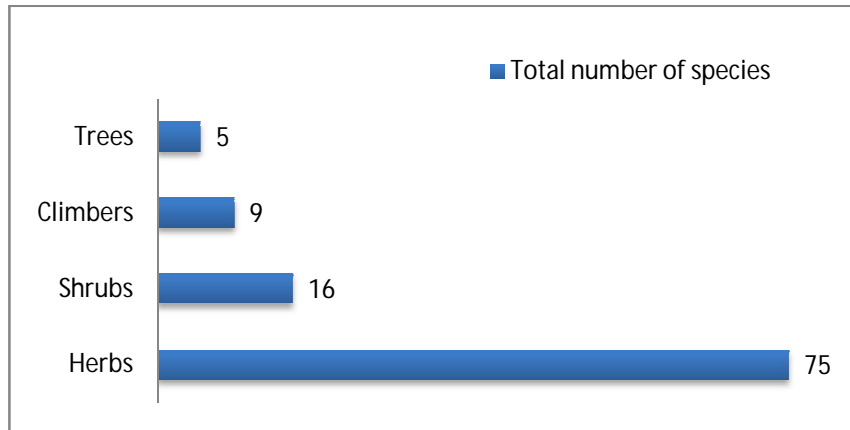


Figure 4. Total number of species representing growth forms in invasive alien dicot flora of Pantnagar

A total of 7 different geographic regions are recorded in terms of nativity in the present study. These geographic regions are Africa, Asia, Europe, Mediterranean, North America, South America and Tropical America. On the basis of nativity, IADS of South American nativity with 56 species are found to dominate the invasive alien flora of Pantnagar, contributing a total of 53.33 %, followed by Tropical American (13 species; 12.38 %), African (12 species; 11.43 %), North American (11 species; 10.48 %), Asian (8 species; 7.62 %), European (5 species; 4.76 %) and Mediterranean (3 species; 2.86 %). The results reveal the dominance of American continents contributing 76.19 % to the invasive alien dicot flora of Pantnagar (Figure 5). These results resonates with Reddy (2008), Singh *et al.*, (2010), Sekar *et al.*, (2012) where Tropical American elements are recorded as the dominant part of invasive alien flora [18, 19, 12]. 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.

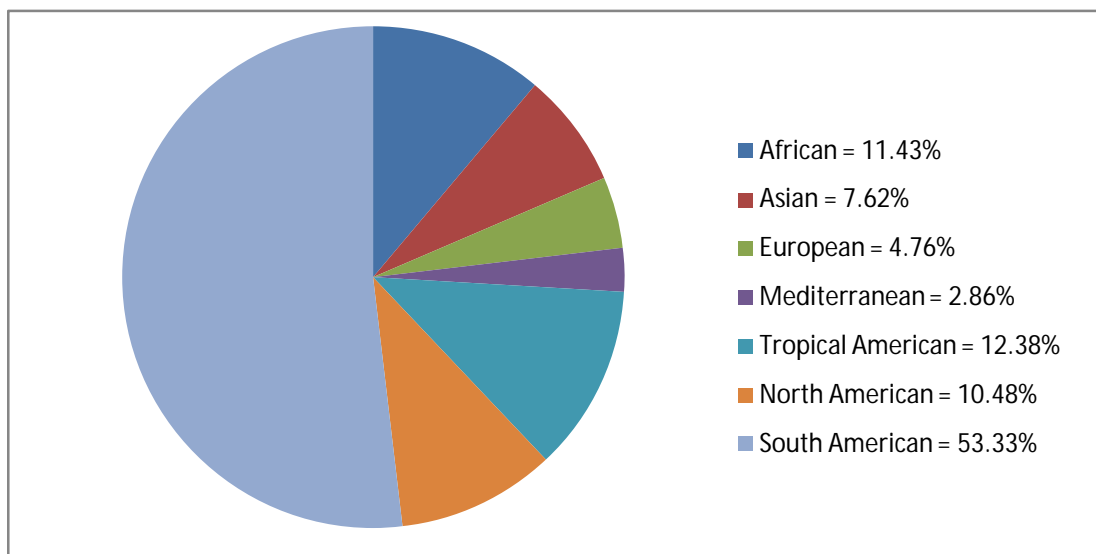


Figure 5. Percent contribution of different geographic regions to the invasive alien dicot flora of Pantnagar.

Table 2. Checklist of IADS of Pantnagar region of Uttarakhand.

S. No.	Plant Name,	Family	Nativity	Habit	Flowering & Fruiting Time	Reference
1	<i>Acanthospermum hispidum</i> DC.	Asteraceae	South America	Herb	March - April	[4]
2	<i>Ageratum conyzoides</i> L.	Asteraceae	South America	Herb	Throughout the year	[4]
3	<i>Ageratum houstonianum</i> Mill.	Asteraceae	North America	Herb	Throughout the year	[4]
4	<i>Alternanthera ficoidea</i> (L.) P.Beauv.	Amaranthaceae	South America	Herb	March - December	[4]
5	<i>Alternanthera paronychioides</i> A. St-Hil.	Amaranthaceae	South America	Herb	March - January	[4]
6	<i>Alternanthera philoxeroides</i> (Mart.) Griseb.	Amaranthaceae	South America	Herb	Throughout the year	[4]
7	<i>Alternanthera pungens</i> Kunth	Amaranthaceae	South America	Herb	May - August	[4]
8	<i>Alternanthera sessilis</i> (L.) R.Br.	Amaranthaceae	Tropical America	Herb	Throughout the year	[5]

	ex DC.					
9	<i>Amaranthus spinosus</i> L.	Amaranthaceae	South America	Herb	July - December	[4]
10	<i>Antigonon leptopus</i> Hook. & Arn.	Polygonaceae	South America	Climber	February - July	[4]
11	<i>Argemone mexicana</i> L.	Papaveraceae	South America	Herb	February - June	[4]
12	<i>Argemone ochroleuca</i> Sweet.	Papaveraceae	North America	Herb	March - May	[4]
13	<i>Asclepias curassavica</i> L.	Apocynaceae	South America	Shrub	February - June	[4]
14	<i>Bidens pilosa</i> L.	Asteraceae	South America	Herb	March - October	[4]
15	<i>Blumea lacera</i> (Burm. f.) DC.	Asteraceae	Tropical America	Herb	April - June	[5]
16	<i>Calotropis gigantea</i> (L.) W.T.Aiton	Apocynaceae	Tropical Africa	Shrub	February - June	[5]
17	<i>Calotropis procera</i> (Aiton) W.T.Aiton	Apocynaceae	Tropical Africa	Shrub	December - June	[5]
18	<i>Cannabis sativa</i> L.	Cannabaceae	Asia temperate	Herb	March - October	[4]
19	<i>Celosia argentea</i> L.	Amaranthaceae	South America	Herb	September - January	[4]
20	<i>Chenopodium album</i> L.	Amaranthaceae	Africa, Asia - tropical	Herb	July - December	[4]
21	<i>Cissampelos pareira</i> L.	Menispermaceae	South America	Herb	March - October	[4]
22	<i>Cleome viscosa</i> L.	Cleomaceae	South America	Herb	March - September	[4]
23	<i>Convolvulus arvensis</i> L.	Convolvulaceae	Europe	Climber	September - October	[5]
24	<i>Corchorus aestuans</i> L.	Malvaceae	South America	Herb	April - October	[4]
25	<i>Corchorus olerius</i> L.	Malvaceae	Tropical America	Herb	July - October	[5]
26	<i>Crassocephalum crepidioides</i> (Benth.) S. Moore	Asteraceae	Africa	Herb	January - March	[4]
27	<i>Crotalaria pallida</i> Aiton.	Fabaceae	Tropical America	Herb	February - April	[5]

28	<i>Croton bonplandianus</i> Baill.	Euphorbiaceae	South America	Herb	April - June	[4]
29	<i>Cuscuta reflexa</i> Roxb.	Convolvulaceae	Mediterranean	Climber	June - November	[5]
30	<i>Cyclospermum leptophyllum</i> (Pers.) Sprague ex Britton & P. Wilson	Apiaceae	South America	Herb	March-May	[4]
31	<i>Datura metel</i> L.	Solanaceae	South America	Herb	April - October	[4]
32	<i>Datura stramonium</i> L.	Solanaceae	South America	Herb	April - September	[4]
33	<i>Digera muricata</i> (L.) Mart.	Amaranthaceae	Asia	Herb	July - November	[5]
34	<i>Dysphania ambrosioides</i> (L.) Mosyakin & Clemants	Amaranthaceae	South America	Herb	January - April	[4]
35	<i>Eclipta prostrata</i> (L.) L.	Asteraceae	South America	Herb	Throughout the year	[4]
36	<i>Emilia sonchifolia</i> (L.) DC.	Asteraceae	Tropical Africa	Herb	Throughout the year	[5]
37	<i>Erigeron bonariensis</i> L.	Asteraceae	Asia temperate	Herb	March - September	[4]
38	<i>Erigeron canadensis</i> L.	Asteraceae	North America	Herb	May-August	[4]
39	<i>Euphorbia heterophylla</i> L.	Euphorbiaceae	North America	Herb	February - August	[4]
40	<i>Euphorbia hirta</i> L.	Euphorbiaceae	South America	Herb	Throughout the year	[4]
41	<i>Evolvulus nummularius</i> (L.) L.	Convolvulaceae	South America	Herb	August-November	[4]
42	<i>Galinsoga parviflora</i> Cav.	Asteraceae	South America	Herb	January-March	[4]
43	<i>Gamochaeta pensylvanica</i> (Willd.) Cabrera	Asteraceae	Tropical America	Herb	January-March	[5]
44	<i>Gomphrena celosioides</i> Mart.	Amaranthaceae	South America	Herb	January - April	[5]
45	<i>Grangea maderaspatana</i> (L.) Poir.	Asteraceae	South America	Herb	March-June	[5]
46	<i>Impatiens balsamina</i> L.	Balsaminaceae	Tropical America	Herb	March-September	[5]

47	<i>Indigofera linifolia</i> (L.f.) Retz.	Fabaceae	South America	Herb	May - October	[5]
48	<i>Indigofera linnaei</i> Ali.	Fabaceae	Tropical America	Herb	February-March	[5]
49	<i>Ipomoea carnea</i> Jacq.	Convolvulaceae	South America	Shrub	July - November	[4]
50	<i>Ipomoea hederifolia</i> L.	Convolvulaceae	South America	Climber	September-December	[4]
51	<i>Ipomoea nil</i> (L.) Roth.	Convolvulaceae	North America	Climber	March - December	[5]
52	<i>Ipomoea pes-tigridis</i> L.	Convolvulaceae	Tropical Africa	Climber	July-September	[5]
53	<i>Ipomoea quamoclit</i> L.	Convolvulaceae	South America	Climber	July - September	[4]
54	<i>Lagascea mollis</i> Cav.	Asteraceae	North America	Herb	March-April	[4]
55	<i>Lantana camara</i> L.	Verbenaceae	South America	Shrub	Throughout the year	[4]
56	<i>Lepidium didymum</i> L.	Brassicaceae	South America	Herb	January - May	[4]
57	<i>Leucaena leucocephala</i> (Lam.) de Wit.	Fabaceae	Tropical America	Tree	March - May	[28]
58	<i>Ludwigia octovalvis</i> (Jacq.)P.H. Raven	Onagraceae	Tropical Africa	Herb	April - October	[5]
59	<i>Ludwigia perennis</i> L.	Onagraceae	Tropical Africa	Herb	April - October	[5]
60	<i>Lysimachia arvensis</i> (L.) U.Manns & Anderb.	Primulaceae	Europe	Herb	February - May	[5]
61	<i>Malvastrum coromandelianum</i> (L.) Garcke	Malvaceae	South America	Herb	March - December	[4]
62	<i>Martynia annua</i> L.	Martyniaceae	South America	Shrub	July-October	[4]
63	<i>Mecardonia procumbens</i> (Mill.) Small	Plantaginaceae	South America	Herb	Throughout the year	[4]
64	<i>Melilotus albus</i> Medik.	Fabaceae	Europe	Herb	March - May	[5]
65	<i>Melochia corchorifolia</i> L.	Malvaceae	Tropical America	Herb	June-December	[5]

66	<i>Mesosphaerum suaveolens</i> (L.) Kuntze	Lamiaceae	South America	Herb	March-May	[4]
67	<i>Mikania micrantha</i> Kunth	Asteraceae	South America	Climber	January-February	[4]
68	<i>Mimosa pudica</i> L.	Fabaceae	South America	Herb	January - April	[4]
69	<i>Mirabilis jalapa</i> L.	Nyctaginaceae	South America	Shrub	April-September	[4]
70	<i>Nicotiana plumbaginifolia</i> Viv.	Solanaceae	South America	Herb	March - September	[4]
71	<i>Oxalis corniculata</i> L.	Oxalidaceae	Europe	Herb	April-September	[4]
72	<i>Oxalis debilis</i> Kunth	Oxalidaceae	South America	Herb	February - April	[4]
73	<i>Parthenium hysterophorus</i> L.	Asteraceae	South America	Herb	Throughout the year	[4]
74	<i>Passiflora foetida</i> L.	Passifloraceae	South America	Climber	July - December	[4]
75	<i>Peperomia pellucida</i> (L.) Kunth	Piperaceae	South America	Herb	August-September	[4]
76	<i>Physalis angulata</i> L.	Solanaceae	North America, South America	Herb	July - September	[4]
77	<i>Physalis pruinosa</i> L.	Solanaceae	North America	Herb	July-September	[4]
78	<i>Pilea microphylla</i> (L.) Liebm.	Urticaceae	South America	Herb	August-October	[4]
79	<i>Pithecellobium dulce</i> (Rox.) Benth.	Fabaceae	South America	Tree	March - June	[4]
80	<i>Portulaca oleracea</i> L.	Portulacaceae	Africa, Europe	Herb	March - September	[4]
81	<i>Portulaca quadrifida</i> L.	Portulacaceae	Africa, Asiatic, Pacific, Southern America	Herb	Throughout the year	[4]
82	<i>Prosopis juliflora</i> (Sw.) DC.	Fabaceae	North America, South America	Tree	April - January	[4]
83	<i>Ricinus communis</i> L.	Euphorbiaceae	Africa	Shrub	Throughout the year	[4]

84	<i>Rorippa indica</i> (L.) Hiern	Brassicaceae	Asia	Herb	February - August	[29]
85	<i>Scoparia dulcis</i> L.	Plantaginaceae	South America	Herb	March-May	[4]
86	<i>Senna alata</i> (L.) Roxb.	Fabaceae	South America	Shrub	March-June	[4]
87	<i>Senna occidentalis</i> (L.) Link	Fabaceae	South America	Shrub	August-October	[4]
88	<i>Senna tora</i> (L.) Roxb.	Fabaceae	South America	Shrub	July - November	[12]
89	<i>Sesbania bispinosa</i> (Jacq.) W. Wight	Fabaceae	Tropical America	Shrub	November - December	[12]
90	<i>Sida acuta</i> Burm. f.	Malvaceae	South America	Shrub	August - November	[29]
91	<i>Solanum americanum</i> Mill.	Solanaceae	North America South America	Herb	December - April	[4]
92	<i>Solanum nigrum</i> L.	Solanaceae	South America	Herb	Throughout the year	[27]
93	<i>Solanum pseudocapsicum</i> L.	Solanaceae	Tropical America	Herb	October - November	[12]
94	<i>Solanum viarum</i> Dunal	Solanaceae	South America	Herb	October - December	[4]
95	<i>Sonchus asper</i> (L.) Hill	Asteraceae	Mediterranean	Herb	February - April	[12]
96	<i>Sonchus oleraceus</i> L.	Asteraceae	Mediterranean	Herb	February - April	[12]
97	<i>Torenia fournieri</i> Linden ex E. Fourn.	Linderniaceae	Asia temperate	Herb	July-October	[4]
98	<i>Triadica sebifera</i> (L.) Small	Euphorbiaceae	Asia temperate	Tree	May - December	[4]
99	<i>Tribulus terrestris</i> L.	Zygophyllaceae	Tropical America	Herb	May - June	[5]
100	<i>Tridax procumbens</i> (L.) L.	Asteraceae	North America	Herb	Throughout the year	[4]
101	<i>Triumfetta rhomboidea</i> Jacq.	Malvaceae	South America	Shrub	May - August	[4]
102	<i>Urena lobata</i> L.	Malvaceae	Tropical Africa	Shrub	June - September	[12]
103	<i>Vachellia farnesiana</i>	Fabaceae	South America	Tree	November-March	[4]

	(L.)Wight& Am.					
104	<i>Xanthium strumarium</i> L.	Asteraceae	Tropical America	Shrub	July-December	[4]
105	<i>Youngia japonica</i> (L.) DC	Asteraceae	South America	Herb	March-June	[4]

39 of the species are found to have flowering and fruiting season of up to 6 months and more which facilitates regular seed production resulting in high proliferation of the species in the habitat. It is also found that maximum number of species flower during the month of February – April which make them early germinating species and potential for early germination has been considered as an important trait for invasiveness [20]. Early germinating species benefit early access to the resources like space and have lesser competition in terms of establishment which leads to substantial increase in their size before other species [21]. Pre-emption of resources by early germinating species significantly affect establishment of other late germinating species by exercising founder control over later germinating species [22].

4. CONCLUSION

The current study revealed the presence of 105 species of IADS under 79 genera belonging to 30 families. Asteraceae was found to be the dominant family of IADS from the region. 16 of the families of IADS were represented by single species. Herbs were found to be the dominant life form. Since their life cycle is short, they have better and easier proliferation which might contribute to the dominance of herbs [17]. In the study, species of South American nativity dominated the invasive alien dicot flora of the region. Since Pantnagar is a hot and humid habitat resembling the climatic conditions of South American region, therefore the alien species of South American nativity have proliferated the area abundantly [17]. At global level invasive alien species constitute about 3.9% of global vascular flora [23] and at national level, invasive alien dicot species constitute about 1.23 % of total flora of India [24, 25], but in Pantnagar area their share is too high being above 23% showing the poor state of native dicot angiosperm flora. Although invasive plant species are abused for massive local impacts by reducing native plant diversity, changing fire regimes and nutrient cycling [26], their longer-

term impacts on regional and global plant diversity are still elusive. In Pantnagar these 105 species are considered as a threat to native flora although there are hardly any evidences of plant extinction by invasive alien species in the world [27]. At present these species are contributing to the greenery of the campus.

UNDER PEER REVIEW

Plate 1. Some Invasive alien dicot plants of Pantnagar, Uttarakhand, India

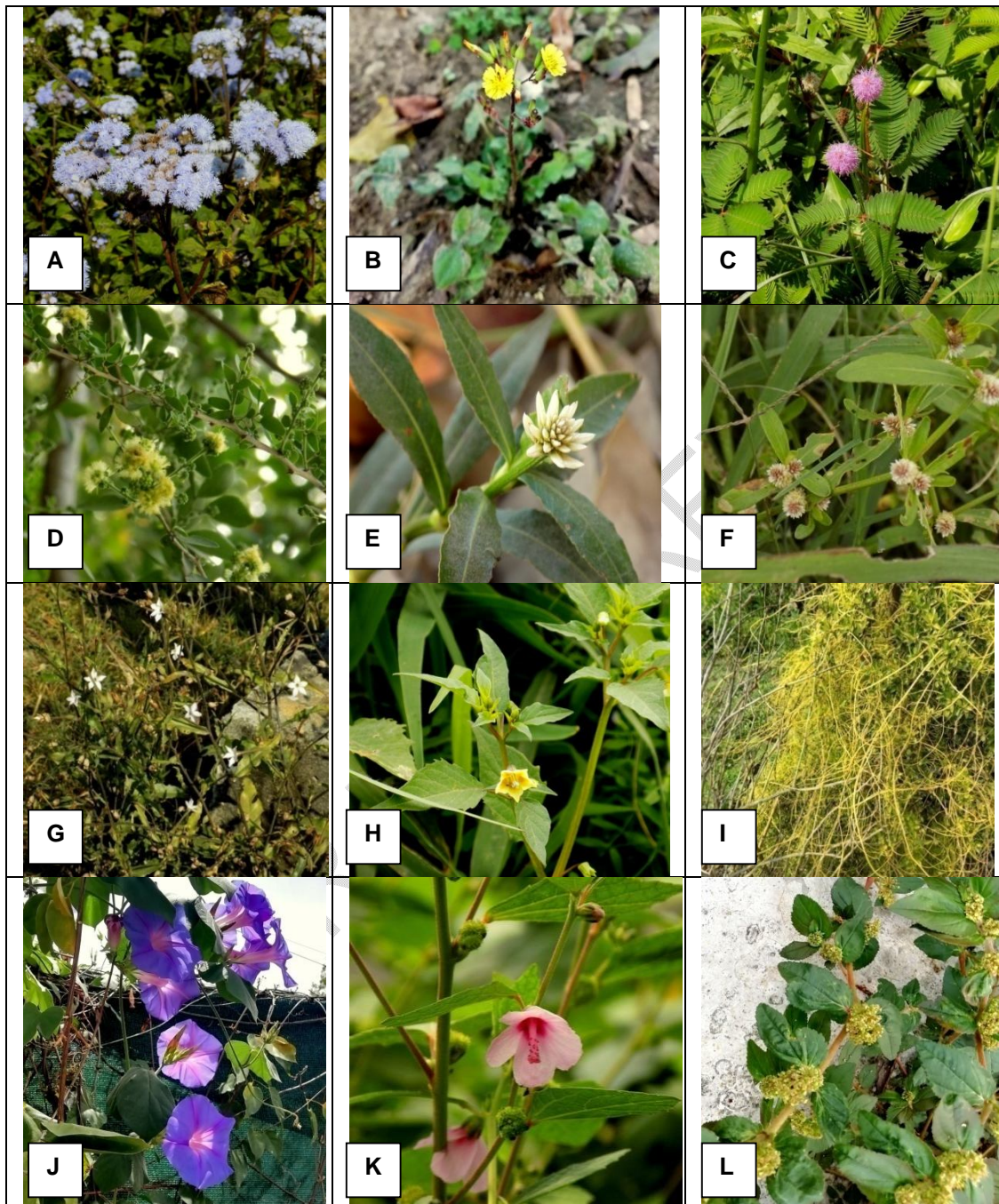


Plate :: A-*Ageratum conizoides* (Asteraceae); B- *Youngia japonica* (Asteraceae); C-*Mimosa pudica* (Fabaceae); D- *Pithecellobium dulce* (Fabaceae); E- *Alternanthera philoxeroides* (Amaranthaceae) ; F-*Alternanthera sesilis* (Amaranthaceae); G-*Nicotiana glauca* (Solanaceae); H- *Physalis angulata* (Solanaceae); I- *Cuscuta reflexa* (Convolvulaceae) ; J- *Ipomoea nil* (Convolvulaceae) ; K- *Urena lobata* (Malvaceae) ; L- *Euphorbia hirta* (Euphorbiaceae)

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