World Journal of Pharmaceutical and Life Sciences
WJPLS
www.wjpls.org
SJIF Impact Factor: 5.088

DIVERSITY OF PLANT SPECIES ALONG WITH INVASIVE ALIEN SPECIES OF SHOREA ROBUSTA GAERTN AND PINUS ROXBURGHII SARG (350-1900 M) FORESTS OF NAINITAL DISTRICT WEST HIMALAYA

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Article Received on 17/05/2018 **Article Revised on 07/06/2018** **Article Accepted on 28/06/2018**

ABSTRACT

Biological invasions are often thought to be one of the leading threats to global biodiversity. Plant invaders of natural ecosystems, also termed 'environmental weeds', have been shown to inhibit the recruitment of resident native species by preventing seedling establishment and growth, and modifying plant pollinator interactions displace resident species through direct below and above ground competition for resources, such as space , water, nutrients, and light and modify or 'engineer' ecosystem processes and the physical resources of the recipient community, such sedimentation, nutrient cycling and disturbance regimes. In the present study the list and documentation of total associated plants species were prepared and total 247 species were found which includes 39 tree species, 65 species of shrub, 132 species of herb (grasses and climber). All these species belongs to 75 families and under 176 generas. Among all the families the most dominated family were Poaceae 27 species followed by Fabaceae 26 species, followed by Asteraceae 21 species, Lamiaceae 18 species and Malvaceae 10 species were recorded.

KEYWORDS: Biological invasions, Associated plants species, *Eupatorium adenophora* Spreng, *Lantana camara*. L, *Shorea robusta* Gaertn., *Pinus roxburghii* Sarg.

1. INTRODUCTION

The Indian Himalayan Region supports about 8000 species (47.06 % of the total flowering plants of India) of which 30% are endemics, 10.2% trees, 8.44% wild edibles and over 15 % medicinal (Samant, 1998). The dependence of humans and livestock on this rich plant diversity is well known phenomenon since time immemorial (Samant and Dhar, 1997). It is well known fact that the Himalayan region is reservoir of plant resources. The flora of Uttarakhand has been explored and worked out by several workers (Duthie, 1906 and 1903-1929; Osmaston, 1927; Kanjilal, 1928; Gupta, 1968; Rau, 1975; Raizada 1976; Raizada and Saxena, 1978; Naithani, 1984 & 1985; Pant, 1986; Pangtey et al., 1991;Gaur, 1999; Singh and Pakash, 2002; Rana et al., 2003 and Uniyal et al., 2007; Tewari et al.,2010; Arya et al., 2018., and Joshi et al., 2018). Due to the altitudinal variation, wide array of climatic zones are available, which favours the luxuriant growth of diversified and rich vegetation. Invasive plant species alternative community composition depletes species diversity, affect ecosystem process and thus cause huge economic and ecological imbalance. These plants possess a set of remarkable traits that allow them to colonize huge areas upon invasion. According to the World Conservation Union, invasive species are generally considered to be the second greatest threat to biodiversity after habitat destruction. The present study was carried out in Nainital district, a part of Kumaun Himalaya, India lies between N 29^0 22' 58·6": E 79^0 27' 34·0", height 2009 m. Extensive field survey were done and 24 intensive sites comprised the Sal forest, Chir pine community forets were selected. To investigate the invasion of this exotic species, two specific sites were identified from the chosen area, a logged site (invaded) 12 sites in Sal and pine forest (Both highly dominated by *Eupatorium adenophora* and *Lantana camara*) and a comparatively 12 less invaded adjacent sites (Both Least dominated by Eupatorium and Lantana) where per hectare density of *Eupatorium adenophora* and *Lantana camara* was less. Fifteen plots were laid in all the study sites and the associated species with the concerned two invasive species were listed.

The present work conclude that out of 24 sites studied from Nainital district 6 sites were highly dominated with *Eupatorium* in both Sal and Pine forest named Ghatgarh, Mangoli, Nalini, Pines, Bhumihadhr, Jokhiya and the 6

adjacent sites nearby area with least dominated. Likewise 6 sites were highly dominated with Lantana in the respective sites HMT, Ranibag, Bhujiyaghat, Kanchi, Ratighat, Shyamkhet and the 6 adjacent sites nearby area with least dominated. The associated plant species with these two alien invasive species were taken in consideration and their list was prepared.

2. MATERIAL AND METHODS

2.1 Vegetation analysis and phytosociological analysis

Vegetation analysis and extensive field survey was conducted during vegetation period from 2014-2016 covering both *Pinus roxburghii* (chir-pine) and *Shorea robusta* forest and listing of total associated species both in and outside the infested areas with *Lantana* and *Eupatorium* were made. The study was performed in Nainital district, Uttarakhand a part of Kumaun Himalaya. Uttarakhand is a amountainous and terai region consisting of thirteen districts of predominantly hill areas and lies between latitude 28◦45’ to 31◦30’ N and longitude 77◦30’ to 81◦5’ E with an altitudinal variation ranging from 200 to 7,800 m above mean sea level. The state is very unque in its geographical boundaries it goes with Tibet in the north, Himachal Pradesh in the west and the north-west, Gangetic plains of Uttar Pradesh in the south and Nepal in the east. District Nainital is situated in the Lower Himalayan range of Uttarakhand state. It is formed due to the tectonic activities and the upliftment of sediments between the Tibetan plane and the Indo-Gangetic plane and is located at 29◦23’N and 79◦27’E with an average elevation of 2,084 m. Sedimentary rocks are the main characteristic of rock type while Quartzite is the dominating rock type in the region. 24 sites were selected on the basis of physiognomy, exposure, and altitude representing vegetation variation. The total 480 quadrate of 10×10 m (100 m^2) for trees species and quadrats of 5×5 m laid for shrubs in each sites and 1×1 m for herb species were placed and list of total associated plant species were recorded. The identified plant specimen were dried and mount on herbarium sheet deposited in the departmental herbarium room for further documentation. The identification was done with the help of the available literature and Herbarium. Authors tried to collect the samples/Plant specimens that must have at least flower or fruits or both in case of possibility. In case of grasses, sedges and other herb whole plants including the underground part were collected (Rao and Jain 1976). The collected plants will be identified with the help of available literature (Collett, 1902; Duthie, 1906; Osmaston, 1927; Champion and Seth, 1968; Singh and Singh, 1992; Gaur 1999; and Joshi et al., 2018) and specified and accepted keys.

Table 1: Characteristic feature of studies sites.

site	Location	Forest type and invasion	Latitude N	Longitude E	Altitude M
1	HMT 1&2	1.Sal, *Lantana* heavily infested site. 2. Least infested site	29.21' N	79.51' E	350- 443 m
2	Ranibag 1&2	1.Sal, *Lantana* heavily infested site. 2. Least infested site	29.23' N	79.53' E	443- 500 m
3	Bhujiyaghat 1&2	1.Sal, *Lantana* heavily infested site. 2. Least infested site	29.21' N	79.51' E	443-700 m
4	Mangoli 1&2	1.Sal, *Eupatorium* heavily infested site. 2. Least infested site	29.35' N	79.40' E	520 m
5	Nalini1&2	1.Sal, *Eupatorium* heavily infested site. 2. Least infested site	29.35' N	79.40' E	520-450 m
6	Ghatgarh1&2	1.Sal, *Eupatorium* heavily infested site. 2. Least infested site	29.28' N	79.34' E	300-400 m
7	Pines1&2	1.Pine, *Eupatorium* heavily infested site. 2. Least infested site	29.23' N	79.22' E	1800-1746 m
8	Jokhiya1&2	1.Pine, *Eupatorium* heavily infested site. 2. Least infested site	29.38' N	79.46' E	1880-1845 m
9	Bhumiadhar1&2	1.Pine, *Eupatorium* heavily infested site. 2. Least infested site	29.38' N	79.46' E	1540-1750 m
10	Kanchi1&2	1.Pine, *Lantana* heavily infested site. 2. Least infested site	29.42' N	79.51' E	443-1609 m
11	Ratighat1&2	1.Pine, *Lantana* heavily infested site. 2. Least infested site	29.38' N	79.47' E	1116 m
12	Shyamkhet1&2	1.Pine, *Lantana* heavily infested site. 2. Least infested site	29.38' N	79.53' E	1700-1860 m

3. RESULTS

A total list of 247 plant species were found associated with these alien-invasive species within the selected forest communities i.e heavily or least invaded by these two species (*Lantana camara* & *Eupatorium adenophora*). Total 75 families were recorded. Among these total species 39 species of trees, 65 species of shrub

and 132 species of herb along with climbers and grasses were recorded that belongs to total 176 genera (Fig. 1). Out of the total families recorded poaceae was the dominant family consist of total 27 species followed by fabaceae 26 species, followed by asteraceae 21 species; lamiaceae 18 species; malvaceae 10 species; Apocynaceae & Rosaceae 7 species; Rubiaceae 6 species; Acanthaceae, Solanaceae, Urticaceae 5 species; Cyperaceae, Fagaceae, Menispermaceae, Rutaceae consist of 4 species; and Amaranthaceae, Berberidaceae, Combretaceae, Convolvulaceae, Euphorbiaceae, Meliaceae, Moraceae, Phyllanthaceae, Polygonaceae, Rhamnaceae consist of 3 species each and the remaining families having the least number of species (Fig. 2). The tree species belongs to 31 genera and 26 families (Fig. 3) likewise the shrub species belongs to 50 genera and 32 families (Fig. 4) and total herb species belongs to 98 genera and 41 families (Fig. 5).

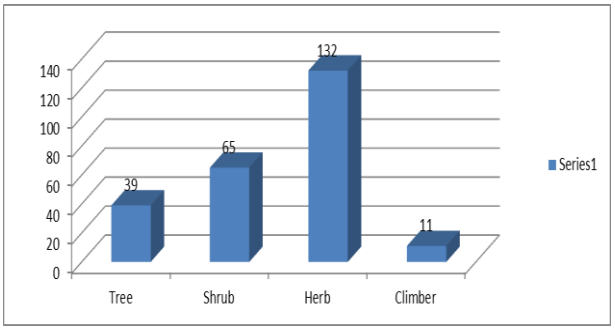

Fig. 1: Representation of total species, Trees, Shrubs, and Herbs.

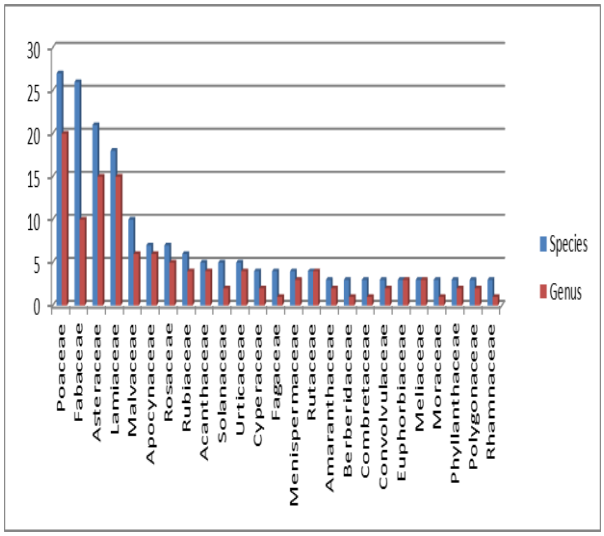

Fig. 2: Representation of dominated families.

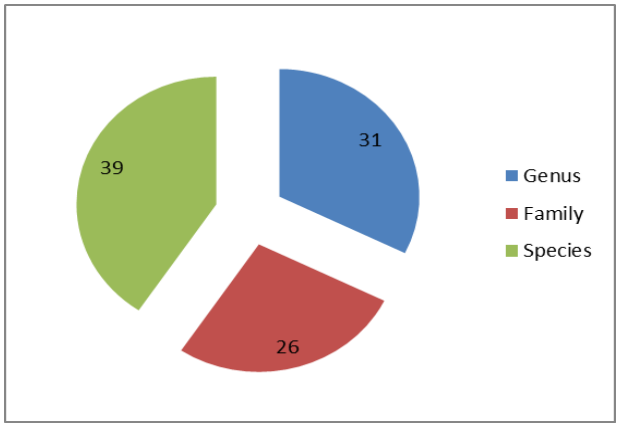

Fig. 3: Representation of Tree species belonging under genus and families.

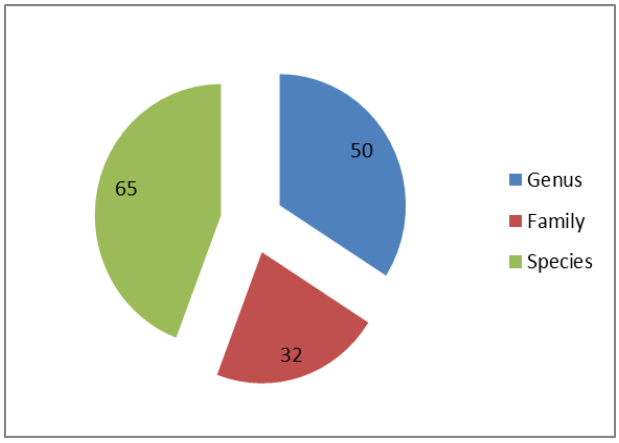

Fig. 4: Representation of Shrub species belonging under genus and families.

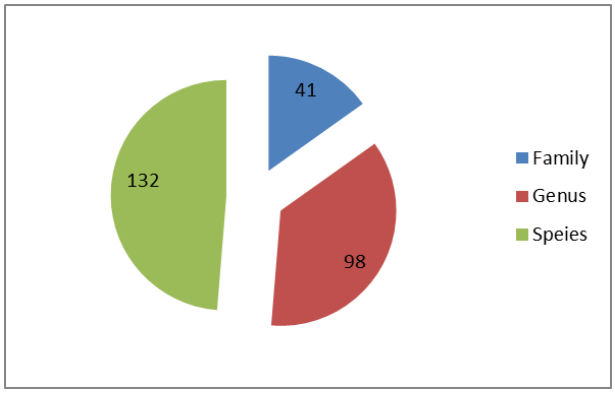

Fig. 5: Representation of Herb species belonging under genus and families.

Table 1: List of total associated plant species.

S. No.	Plant	Family	Altitude (m)	Habit
1	*Abrus precatorius* L.	Fabaceae	Up to 1000	H
2	*Abrus pulchella* Wall.	Fabaceae	Up to 1200	H
3	*Acacia gageana* Craib.	Fabaceae	Up to 800	H
4	*Acacia nilotica* (L.) Willd. ex Delile	Fabaceae	Up to 800	T
5	*Acacia pennata* (L.) Willd.	Fabaceae	Up to 800	T
6	*Achyranthes aspera* L.	Amaranthaceae	Up to 2200	H
7	*Aegle marmelos* (L.) Correa	Rutaceae	Up to 1200	T
8	*Ageratum conyzoides* L.	Asteraceae	1700-2000	H
9	*Agrimonia pilosa* Ledeb.	Rosaceae	Up to 2500	H
10	*Agrostis stolonifera* L.	Poaceae	Up to 2500	H
11	*Albizia mollis* Boiv.	Fabaceae	1400-1700	T
12	*Albizia procera* (Roxb.) Benth.	Fabaceae	1400-1700	T
13	*Alnus nepalensis* D. Don	Betulaceae	1000-2500	T
14	*Anaphalis busua* (Buch.-Ham. ex D. Don)	Asteraceae	2200-3400	H
15	*Anaphalis contorta* Hook. f.	Asteraceae	2200-3400	H
16	*Anaphalis margaritacea* (L.) Benth.	Asteraceae	1700-3000	H
17	*Apluda mutica* L.	Poaceae	Up to 2000	H
18	*Arachne cordifolia* (Decne.)	Phyllanthaceae	600-2400	H
19	*Ardisia solanacea* Roxb.	Myrsinaceae	Up to 800	S
20	*Argemone mexicana* L.	Papavaraceae	200-1500	H
21	*Arisaema jacquemontii* Blume	Araceae	1500-3200	H
22	*Artemisia nilagirica* (C.B.Clarke) Pamp.	Asteraceae	Up to 1500	S
23	*Artemisia vestita* Wall. Ex Besser	Asteraceae	Up to 1500	S
24	*Arthraxon lancifolius* (Trin.) Hochst	Poaceae	1400-2000	H
25	*Arthraxon prionodes* Steud.	Poaceae	Up to 2500	H
26	*Arundinella benghalensis* (Spreng.) Druce	Poaceae	Up to 2000	H
27	*Arundinella nepalensis* Trin.	Poaceae	1400-2000	H
28	*Arundinella pumila* (Hochst.) Steud	Poaceae	1400-20001	H
29	*Arundo donax* L.	Poaceae	Up to 2500	H
30	*Asparagus adscendens* Roxb.	Asparagaceae	Up to 1800	S
31	*Asparagus racemosus* Willd.	Asparagaceae	1300-2300	S
32	*Aster thomsonii* C.B.Clarke	Asteraceae	2500-3400	H
33	*Avena barbata* Pott.	Poaceae	350-1900	H
34	*Azadirachta indica* A. juss.	Meliaceae	Up to 1000	T
35	*Bambusa bambos* L.	Poaceae	350-1000	H
36	*Barberis aristata* DC.	Barberidaceae	1700-3200	S
37	*Bauhinia vahlii* Wight & Arn.	Fabaceae	Up to 1300	Cl
38	*Begonia picta* J.E. Smith	Begoniaceae	600-3000	H
39	*Berberis asiatica* Roxb.	Berberidaceae	1700-2400	S
40	*Berberis chitria* Ham.ex Ker.	Berberidaceae	2100-3000	S
41	*Bergenia ciliata* (Haw.) Sternb.	Saxifragaceae	Up to 3000	H
42	*Bidens biternata* (Lour.) Sherff.	Asteraceae	1300-2500	H
43	*Bidens pilosa* L.	Asteraceae	1300-2600	H
44	*Boehmeria rugulosa* Wedd.	Urticaceae	Up to 2000	T
45	*Boenninghausenia albiflora* (Hk.f.)	Rutaceae	1500-2800	H
46	*Boerhaavia diffusa* L.	Nyctaginaceae	Up to 1200	H
47	*Bombex ceiba* L.	Malvaceae	Up to 1600	T
48	*Bulbophyllum careyanum* (Hook.) Spreng	Orchidaceae	800-2000	H
49	*Butea monosperma* (Lamk.) Taubert	Fabaceae	Up to 1200	T
50	*Calamus tenuis* Roxb.	Arecaceae	Up to 1500	Cl
51	*Calotropis gigantea* (L.) R. Br.	Apocynaceae	Up to 1200	S
52	*Calotropis procera* (Ait.) R. Br.	Apocynaceae	Up to 600	S
53	*Cannabis sativa* L.	Cannabaceae	1300-3200	H
54	*Carissa spinarum* L.	Apocynaceae	Up to 1200	S
55	*Caryopteris foetida* (D. Don)	Lamiaceae	1600-2700	S

56	*Cassia angustifolia* Mill.	Fabaceae	500-2300	H
57	*Cassia fistula* L.	Fabaceae	Up to 1400	T
58	*Cassia floribunda* Cav.	Fabaceae	1200	S
59	*Cassia mimosoides* L.	Fabaceae	1600	H
60	*Cassia occidentalis* L.	Fabaceae	Up to 1500	H
61	*Cedrus deodara* (Roxb. ex D.Don)G.Don	Pinaceae	1500-2000	T
62	*Centella asiatica* (L.) urban	Apiaceae	2500	H
63	*Cerastium glomeratum* Thuill.	Caryophyllaceae	Up to 2700	H
64	*Chenopodium album* L.	Amaranthaceae	1300-2600	H
65	*Chenopodium ambrosioides* L.	Amaranthaceae	1300-2500	H
66	*Chrysopogon assimila*	Poaceae		H
67	*Chrysopogon serrulatus* (L.) Trin	Poaceae	1300-2600	H
68	*Cirsium verutum* (D.Don) Spreng.	Asteraceae	600-700	H
69	*Cissus repanda* Vahl.	Vitaceae	1300-1800	Cl
70	*Clematis buchaniana* DC.	Ranunculaceae	1300-3200	Cl
71	*Clematis gouriana* Roxb.	Ranunculaceae	800-1300	Cl
72	*Clerodendron trichotomum* var.	Lamiaceae	300-1200	S
73	*Clerodendron viscosum* Vent.	Lamiaceae	Up to 900	S
74	*Cocculus laurifolius* DC.	Menispermaceae	300-1500	S
75	*Colebrookea oppositifolia* Sm.	Lamiaceae	Up to 1800	S
76	*Commelina benghalensis* Linn.	Commelinaceae	Up to 2000	H
77	*Conyza japonica* (Thunb.)Less. ex DC.	Asteraceae	1200-2200	H
78	*Conyza stricta* Willd.	Asteraceae	Up to 2100	H
79	*Coriaria nepalensis* Wall.	Coriariaceae	1300-2800	S
80	*Cryptolepis buchanani* Roem. & Schult.	Apocynaceae	1200	Cl
81	*Cupressus torulosa* D.Don	Cupressaceae	1300-2800	T
82	*Curculigo orchioides* Gaetrn.	Hypoxidaceae	Up to 2000	H
83	*Cuscuta reflexa* Roxb.	Convolvulaceae	Up to 2500	Cl
84	*Cynodon dactylon* (L.) Pers.	Poaceae	Up to 1800	H
85	*Cynoglossum lanceolatum* Forssk.	Boraginaceae	1300-2200	H
86	*Cynoglossum zeylanium* (Vahl ex Hornem.) Thunb. ex Lehm.	Boraginaceae	Up to 3200	H
87	*Cyperus flavidus* Retz.	Cyperaceae	Up to 1500	H
88	*Cyperus niveus* Retz.	Cyperaceae	Up to 1600	H
89	*Cyperus rotundus* Linn.	Cyperaceae	Up to 1800	H
90	*Daphne cannabina* Wall.	Thymelaeaceae	1500-2600	S
91	*Dautra stamonium* L.	Solanaceae	1300-2600	H
92	*Dendrocalamus strictus* (Roxb.)	Poaceae	Up to 1800	H
93	*Desmodium elegans* DC.	Fabaceae	1000-2300	S
94	*Desmodium gangeticum* (L.) DC.	Fabaceae	1000	S
95	*Desmodium parviflorum* (Willd.) DC.	Fabaceae	2000	S
96	*Dicliptera bupleuroides* Nees.	Acanthaceae	2000	H
97	*Dioscorea bulbifera* L.	Dioscoriaceae	Up to 2500	H
98	*Dioscoria belophylla* Voizt.	Dioscoriaceae	1500	H
99	*Diospyros exsulpta* Buch.-Ham.	Ebenaceae	Up to 800	T
100	*Dipsacus inermis* Wall.	Caprifoliaceae	2000-3300	H
101	*Drymaria diandra* Blume	Caryophyllaceae	700-2000	H
102	*Eclipta prostata* L.	Asteraceae	Up to 1600	H
103	*Eragrostis pilosa* (L.) P. Beauv.	Poaceae	1600	H
104	*Erigeron bonariensis* L.	Asteraceae	Up to 1800	H
105	*Erigeron karvinskianus* DC.	Asteraceae	1500-2600m	H
106	*Erigeron vernus* (L.)	Asteraceae	300-2300	H
107	*Eriophorum comosum* Wall. ex Nees	Cyperaceae	2500	H
108	*Eupatorium adenophorum* Spreng.	Asteraceae	1300-2200	H
109	*Euphorbia hirta* L.	Euphorbiaceae	1300-2500	H
110	*Eurya acuminata* DC.	Pentaphylacaceae	1300-2400	S
111	*Evolvulus alsinoides* (L.) L.	Convolvulaceae	1600-2300	H
112	*Evolvulus nummularius* (L.) L.	Convolvulaceae	Up to 1500	H
113	*Ficus auriculata* Lour.	Moraceae	Up to 1800	T

114	*Ficus benghalensis* L.	Moraceae	Up to 1400	T
115	*Ficus foveolata* Wall. ex Miq.	Moraceae	600-2000	Cl
116	*Flemingia bracteata* (Roxb.) Wight	Fabaceae	Up to 1800	S
117	*Flemingia procumbens* Roxb.	Fabaceae	2000-2900	H
118	*Flemingia semialata* Roxb.	Fabaceae	Up to 1800	H
119	*Flemingia strobilifera* (L.) R. Br.	Fabaceae	1500	H
120	*Floscopa scandens* Lour.	Commelinaceae	1000	H
121	*Galium aparine* L.	Rubiaceae	1000-2800	H
122	*Garuga pinnata* Roxb.	Burseraceae	Up to 600	S
123	*Geranium lucidum* Linn.	Geraniaceae	2200-3400	H
124	*Gerardinia heterophylla* (Vahl) Decne.	Urticaceae	Up to 2500	H
125	*Grewia optiva* J. R. Drumm. Ex Burret.	Malvaceae	Up to 1600	T
126	*Grewia sapida* Roxb.	Malvaceae	Up to 600	S
127	*Haldina cordifolia* (Roxb.)	Rubiaceae	Up to 1000	T
128	*Hedychium spicatum* Sm.	Zingiberaceae	1500-3000	H
129	*Hypericum oblongifolium* Choisy	Hypericaceae	2000-2800	S
130	*Hypericum perforatum* L.	Hypericaceae	1300-2400	H
131	*Indigofera dosua* Buch.-Ham. ex D. Don	Fabaceae	1200-2700	S
132	*Indigofera hamiltonii* Graham ex Duthie & Prain	Fabaceae	Up to 2000	H
133	*Indigofera linifolia* (L. f.)Retz.	Fabaceae	Up to 1500	H
`134	*Indigofera pulchela* Roxb.	Fabaceae	2000	S
135	*Inula cappa* (Buch.-Ham. ex D.Don) DC.	Asteraceae	2500	S
136	*Iris germanica* L.	Iridaceae	Up to 2500	H
137	*Iris hookeriana* R. C. Fost.	Iridaceae	2000-2600	H
138	*Justica procumbens* L.	Acanthaceae	Up to 2000	H
139	*Lantana camera* L.	Verbenaceae	300-2000	S
140	*Leucas lanata* (Roth) Spreng.	Lamiaceae	1300-3000	H
141	*Lindenbergia grandiflora* (Buch.-Ham.) Benth.	Orobanchaceae	1600	H
142	*Lyonia ovalifolia* (Wall.) Drude.	Ericaeceae	1000-3000	T
143	*Machilus duthiei* King ex Hook. f.	Lauraceae	Up to 2200	T
144	*Maesa indica* (Roxb.) DC.	Primulaceae	700-2000	S
145	*Mallotus philippinensis* (Lam.) Muell.-Arg.	Euphorbiaceae	Upto 1600	T
146	*Melia azedarach* L.	Meliaceae	200-1200	T
147	*Mangifera indica* L.	Anacardiaceae	Up to 1200	T
148	*Micromerria biflora* (Buch.-Ham.)	Lamiaceae	1400-3400	H
149	*Murrraya koenigii* (L.) Spreng.	Rutaceae	400-1500	S
150	*Myrica esculenta* Buch.-Ham. ex D. Don	Myricaceae	1500-2200	T
151	*Myrsine africana* L.	Primulaceae	600-2000	S
152	*Nerium indicum* Mill.	Apocynaceae	Up to 2000	S
153	*Nyctanthes arbour-tristis* L.	Oleaceae	Up to 1400	S
154	*Ocimum sanctum* L.	Lamiaceae	400-1500	H
155	*Ophiopogon intermedius* D. Don	Asparagaceae	1500-3000	H
156	*Oplismenus burmannii* (Retz.) P.Beauv.	Poaceae	Up to 2000	H
157	*Oplismenus compositus* (L.)	Poaceae	Up to 2000	H
158	*Origanum majorana* L.	Lamiaceae		S
159	*Origanum vulgare* L.	Lamiaceae	1000-2000	H
160	*Oxalis corniculata* L.	Oxalidaceae	1800	H
161	*Pandanus nepalensis* H. St. John.	Pandanaceae	Up to 1000	S
162	*Peristrophe bicalyculata* (Retz.) Nees	Acanthaceae	1300-1700	H
163	*Phoenix humilis* Royle	Areaceae	500-1300	S
164	*Phragmites karka* (Retz.) Trin. ex Steud	Poaceae	1300-2000	H
165	*Phyllanthus emblica* L.	Phyllanthaceae	Up to 1500	T
166	*Phyllanthus parvifolius* Ham.	Phyllanthaceae	1200-2200	S
167	*Pinus roxburghii* Sarg.	Pinaceae	1500-2000	T
168	*Plectranthus japonicus* (Brum. f.) Koidz.	Lamiaceae	2500	H
169	*Plectranthus mollis* (Aiton.) Spreng.	Lamiaceae	2800	H
170	*Poa alpina* L.	Poaceae	1000-2000	H
171	*Poa annua* L.	Poaceae	1600-3300	H

172	*Pogostemon benghalensis* (Burm.f.) Kuntze	Lamiaceae	Up to 2000	S
173	*Polygonum capitatum* Buch.-Ham. ex D. Don	Polygonaceae	600-2000	H
174	*Polygonum plebejum* R. Br.	Polygonaceae	1300	H
175	*Polypogon monspeliensis* (L.) Desf.	Poaceae	2500	H
176	*Potentilla fulgens* Wall.	Rosaceae	1500-3000	H
177	*Pouzolzia hirta* (BI.) Hassk.	Urticaceae	1000-1800	H
178	*Pyracantha crenulata* (D. Don) M. Reom.	Rosaceae	2600	S
179	*Pyrus pashia* Buch.-Ham. ex D. Don	Rosaceae	1500-2300	T
180	*Quercus leucotricophora* A.Camus	Fagaceae	1200-2500	T
181	*Quercus floribunda* Rehder	Fagaceae	1500-2000	T
182	*Quercus glauca* Thunb.	Fagaceae	1500-2000	T
183	*Quercus semecarpifolia* Sm.	Fagaceae	Up to 3500	T
184	*Randia dumetorum* (Retz.) Poir.	Rubiaceae	200-1200	S
185	*Randia tetrasperma* (Roxb.) Benth. & Hook.f.	Rubiaceae	Up to 2000	S
186	*Randia uliqinosa* (Retz.) Poir.	Rubiaceae	Up to 800	S
187	*Reinwardtia indica* Dumort.	Linaceae	Up to 2400	S
188	*Ricinus communis* Linn.	Euphorbiaceae	1400	S
189	*Rubia cordifolia* L.	Rubiaceae	Up to 2500	S
190	*Rubus ellipticus* Smith	Rosaceae	Up to 2200	S
191	*Rubus foliosus* D. Don	Rosaceae	1600-3200	S
192	*Rubus niveus Thunb.*	Rosaceae	Up to 2500	S
193	*Rumex hastatus D. Don*	Polygonaceae	Up to 2000	H
194	*Saccharum bengalense* Retz.	Poaceae	600-1500	H
195	*Salvia lanata* Roxb.	Lamiaceae	Up to 2500	H
196	*Sarcococca saligna* (D. Don) Muell.-Arg.	Buxaceaceae	Up to 2700	S
197	*Scrophularia calycina* Benth.	Scrophulariaceae	Up to 3000	S
198	*Scutellaria angulosa* Benth.	Lamiaceae	1000-2500	H
199	*Setaria glauca* (L.) P. Beauv.	Poaceae	1300-2000	H
200	*Setaria Verticillata* (L.) P.Beauv.	Poaceae	600-2000	H
201	*Shorea robusta* Gaertn.	Dipterocarpaceae	500-1000	T
202	*Sida acuta* Burm. f.	Malvaceae	Up to 1000	H
203	*Sida cordifolia* L.	Malvaceae	Up to 800	H
204	*Sida rhombifolia* L.	Malvaceae	Up to 800	H
205	*Siegesbeckia orientalis* L.	Asteraceae	Up to 2000	H
206	*Simlax macrophylla* Roxb.	Smilacaceae	Up to 2000	S
207	*Smilax aspera* Linn.	Smilacaceae	Up to 2000	S
208	*Solanum erianthum* D. Don.	Solanaceae	Up to 2400	H
209	*Solanum nigrum* L.	Solanaceae	800-2400	H
210	*Solanum surrattense* Burm. f.	Solanaceae	Up to 1500	H
211	*Solanum verbascifolium* L.	Solanaceae	Up to 1400	H
212	*Stachys melissaefolia* Benth.	Lamiaceae	1500-2300	H
213	*Stephania elegans Hook.*	Menispermaceae	Above 1500	Cl
214	*Stephania gracilenta* Miers.	Menispermaceae	Up to 2500	Cl
215	*Strobilanthes angustifrons* C.B.	Acanthaceae	800-2500	H
216	*Strobillanthes tomentosa* (Wall. ex Nees)	Acanthaceae	Up to 1400	S
217	*Syzygium cumunii* (L.) Skeels	Myrtaceae	600-2000	T
218	*Tectona grandis* L.	Lamiaceae	Up to 700	T
219	*Terminalia alata* Heyne	Combretaceae	Up to 1200	T
220	*Terminalia bellirica* (Gaertn) Roxb.	Combretaceae	Up to 1200	T
221	*Terminalia chebula* Retz.	Combretaceae	Up to 1400	T
222	*Teucrium quadrifarium* Buch.-Ham.ex D.Don	Lamiaceae	1000-2500	H
223	*Themeda arundinaceae* (Roxb.) Ridley	Poaceae	350-2200	H
224	*Thespesia lampas* (Cav.)	Malvaceae	Up to 1300	H
225	*Tinospora cordifolia* Miers	Menispermaceae	Up to 1500	Cl
226	*Toona ciliata M. Roem.*	Meliaceae	1000-1600	T
227	*Tridax procumbens* L.	Asteraceae	1300	H
228	*Triumfetta pilosa* Roth.	Malvaceae	Up to 2000	H
229	*Triunfetta annua* L.	Malvaceae	Up to 1200	H

230	*Typha angustifolia* L.	Typhaceae	Up to 1000	H
231	*Urena lobata* L.	Malvaceae	Up to 1500	S
232	*Urochloa panicoides* P. Beauv.	Poaceae	400-2100	H
233	*Urtica dioca* L.	Urticaceae	1300-3400	H
234	*Urtica parviflora* Roxb.	Urticaceae	1300-3400	S
235	*Vertiveria Zizanioides* (Linn.)	Poaceae	500-2300	H
236	*Vigna vexilleta* (L.) Nash	Fabaceae	Up to 2400	H
237	*Viola canescens* Wall. ex Roxb.	Violaceae	1200-2000	H
238	*Vitex negundo* L.	Lamiaceae	Up to 2000	S
239	*Wattaka volubilis* (L. f.) Stapf.	Apocynaceae	700-2300	S
240	*Witstroemia canescus* Wall.ex Meisn.	Thymelaeaceae	Up to 3000	S
241	*Woodfordia fruticosa* (L.) Kurz.	Lythraceae	1500	S
242	*Wrightia tomentosa* (Roxb.)	Apocynaceae	Up to 1200	T
243	*Xanthium strumarium* L.	Asteraceae	Up to 1600	H
244	*Zanthoxylum armatum* DC.	Rutaceae	Up to 2000	S
245	*Ziziphus glaberrima* Santapau	Rhamnaceae	Up to 800	S
246	*Ziziphus mauritiana* Lamk.	Rhamnaceae	Up to 1200	S
247	*Ziziphus oenoplia* (L.) Mill.	Rhamnaceae	Up to 600	H

4. DISCUSSION

The mosaics of species distribution of plant species in any forest are governed by various environmental factors (Bajpai et al. 2012). Bliss (1963), Douglas & Bliss (1977) and Billings (1973) have reported that vegetation of any place is the outcome interaction of many factors like meso-topographic gradients, the elevation, soil, species composition and biotic interferences. According to the study or research it has been reported that the regional patterns of species richness are consequences and result of many interacting factors, such as plant productivity, competition (with exotic and other plant species), geographical area, historical or evolutionary development, regional species dynamics, regional species pool, environmental variables, human activity and other anthropogenic activities (Woodward 1988, Palmer 1991, Eriksson 1996, Zobel 1997, Criddle et al. 2003). The presence of these opportunistic species such as *Eupatorium adenophorum* and *Lantana camara* in forest are taking advantage of canopy opening on the one hand and changing environmental conditions from mesic to xeric on the other hand. In the present study total 247 species found associates with these two invasive alien species comprising tree, shrubs, and herb (climber and grasses) species. Out of the total families counted Poaceae was the dominant followed by Fabaceae, Asteraceae. Out of the total species found 39 were tree, 65 shrub, 139 species of herb.

5. CONCLUSION

The present study highlights the poor status of species richness especially due to the adverse impact of these invasive alien species inside the forests. Overall 39 tree, 65 shrub, 139 herb species were found and most of the families were having only one species. Out of the total families recorded Poacese was the dominant family with 27 species followed by Fabceae with 26 species followed by Asteraceae with 21 species. The distribution of the tree communities in these forest stands was governed mainly by the gradients of altitude, slope and canopy cover. These species and their communities must protected in whole of Kumaon Himalaya. All the plant communities as well as their associated biodiversity are, in general, threatened and in order to protect the whole range of biodiversity, these plant communities need to be conserved.

6. ACKNOWLEDGEMENTS

We are Thankful to the Head, department of botany, D.S.B. Campus, Kumaun University, Nainital for providing necessary facilities. Mamta Bharti also like to thank the UGC-BSR for providing the fellowship for the economic support.

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