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Research Article

Occurrence of Invasive Plant in three phytogeographical region of Bilaspur district of Chhattisgarh

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Abstract: The present study deals with comprehensive list of invasive species in the flora of Bilaspur district of Chhattisgarh, India with background information of family, nativity, mode of introduction, flowering and fruiting. 83 species of plant belong to 26 families were documented as invasive plant in all three phytogeographical regions (agricultural land, urban land and protected land). Both native and invasive plants were found in the same region, but the occurrence of invasive species were found high in the urban land (34.58%) in comparison with protected land (29.16%) and agriculture land (25%). Habit wise analysis of invasive species showed 84.52% herbs, followed by 13.09% shrubs and 2.38% climbers. Maximum proportion of invasive plant are native to Tropical America and belongs to family Asteraceae (16), followed by Malvaceae (9), Euphorbiaceae (8), Fabaceae (6), Solanaceae (5), Convolvulaceae (4) and Lamiaceae (4).

Keywords: Occurrence, Nativity, Invasive species, Mode of Introduction.

Introduction

International Union for Conservation of Nature and Natural Resources (IUCN) defines invasive species as an alien species which established in natural or semi-natural ecosystems or habitat and threatens to native biological diversity. A large number of invasive species worldwide were introduced accidentally through transportation or intentionally for commercial purposes, value to human health and economic purposes (Ewel *et al.,* 1999). Biological invasion of invading species cause species extinction (D'Antonio and Vitousek, 1992), and long-lasting change on habitats, which makes the restoration of native plants impossible, even when the invasive plants have been detached. Invasive plants affect the ecosystem functions, ecosystem processes, primary productivity, hydrology, geomorphology and biogeochemical cycle of an area (Vitousek *et al.,* 1997; Gordon, 1998; Mack *et al.,* 2000; Ehrenfeld, 2003; Liao *et al.,* 2007). These species do not separate native plant diversity but compete with the local community for the limited natural resources and alter the rule of existence for all species (Vitousek *et al.,* 1997). Litter of these invasive plants decomposed very slowly than those of the native plant community (Allison and Vitousek, 2004; Rothstein *et al.,* 2004).

Mantri *et al.,* (2002) gave 10 laws for examining the potential of invasive species. Aforesaid 10 laws are as follows (1) High input of viable propagules (2) High rate of aerial biomass production (3) Seeds or other reproductive unit with extensive period of dormancy (4) Adaptative features for long distance dispersal (5) Allelopathic effect on native plant community (6) Successful colonizer in disturbed land (7) Short time to overcome the reproductive maturity (8) Dense foliage canopy (9) Alternative mode of reproduction that facilitate to grow on adverse conditions (10) Wide distribution of species in different ecotypes (Figure-1). Long distance dispersal of seed results due to their adhesive properties (Cousens and Mortimer, 1995). Many plant seeds modified into special structure like awned, hooked, sticky, or barbed appendages for dispersal. These seeds stick to animal fur, insects and human clothes for dispersal (Sorensen, 1986). Davies and Sheley, (2007) gave a conceptual framework for dispersal of invasive plants seeds through wind, water, and vehicle.

GISD (Global Invasive Species Database) reported 100 worst invasive species throughout the world (Lowe *et al.,* 2000). Numerous works regarding the distribution of invasive plants done all over the world (Daehler and Carino, 2000; Zhu *et al.,* 2007). Similarly, various studies have been done in different states of India such as Himanchal Pradesh (Dogra *et al.,* 2009), North West Himalaya (Negi and Hajra, 2007), Rajasthan (Pandey and Parmar, 1994), Himalayan region (Sekar, 2012) and special work on India (Raghubanshi *et al.,* 2005; Reddy, 2008; Dogra *et al.,* 2009; Nayar, 1977). Phytochemical screening of several invasive species has been analyzed by Baral, (2011); Rashmi and Rajkumar, (2011). Harmful effects of invasive plants such as habitat destruction, environmental damage, soil erosion etc. have been reported by Towns *et al.,* 2006; and Jordon *et al.,* 2008. Dixit and Chourasia, (2015) studied the ethnomedicinal importance of weeds of GGU campus, Bilaspur, CG. In

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Chhattisgarh state the knowledge of invasive plant is very poorly documented. So, the present paper focuses on the comprehensive list of invasive plant biodiversity in three phytogeographical region of Bilaspur District of Chhattisgarh.

Materials and Methods

To record the maximum number of plants random samplings were done during 2014 - 2016 in margins of study sites *i.e.* wastelands, forest cover area, river bank, agricultural field, bare lands, gardens etc. in district of Bilaspur C.G. These collected plants were categorized in life forms (herb, shrub and climber). All invasive plants were enumerated in alphabetic order followed with family, criteria of invasive species, nativity, flowering, fruiting and mode of introduction. Nativity of plants were checked through various literatures (Matthew, 1969; Maheswari and Paul, 1975; Saxena, 1991). Criteria of invasive plant was studied through periodic observations of SC (Successful colonizer) SLC (Small Life Cycle), DFC (Dense Foliage Canopy), DSE (Distribution of Species in different Ecosystem), AF (Adaptive Features) and AMR (Alternative Mode of Reproduction). Plants have been collected in flowering and fruiting conditions and compressed for herbarium preparation. Collected plant samples were identified with the help of flora of Bilaspur District, M.P. (Murti and Panigrahi, 1999).

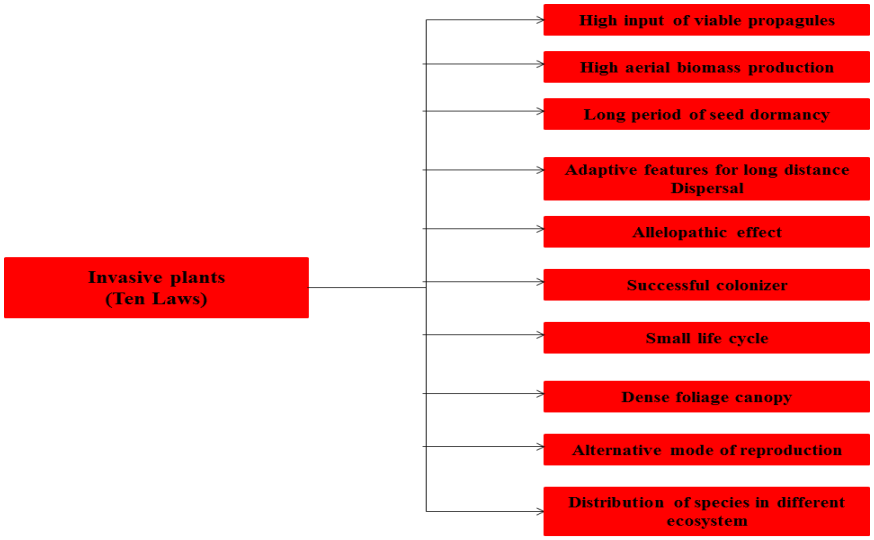

Figure 1. Ten laws criteria of invasive species. (Mantri *et al.,* 2002)

Figure 2. A map of study areas (red dots) in the position of Bilaspur district, Chhattisgarh, India; Site A - Achanakmar Biosphere reserve (protected land); Site B – Turkadiah (Agriculture land); Site C - Bilaspur City (Urban area).

Study Site

Bilaspur district lies between 21°47' and 23°8' north latitudes and 81°14' and 83°15' east latitudes and is situated in the eastern part of Chhattisgarh state with geographical area of 6377 km². It is divided into three phytogeographic regions; Protected land (Achanakmar Biosphere reserve), Agricultural land (Turkadiah) and Urban land (Bilaspur City). Climate of the region is typically tropical, subtropical and sub humid and dividable into three distinct seasons *i.e.* rainy (July to October) winter (November to Feb), and summer (March to June).

Results

Initially 240 plant species were observed and checked, out of which 84 plant species were found to be invasive. These plants were found along the

roadside area, exposed slopes, roadways, gullies, besides track lines, crop fields and river banks throughout the study sites. (Table-1) A total of 84 invasive species belonging to 26 families were recorded from Bilaspur district of Chhattisgarh, out of which 84.52% species of herbs, 13.09% species of shrubs and 2.38% species of climbers (figure – 2).

The most dominant families were Asteraceae (16), Malvaceae (9), Euphorbiaceae (8), Fabaceae (6), Solanaceae (5) Convolvulaceae (4), Lamiaceae (4), Acanthaceae (3), Amaranthaceae (3), Boraginaceae (3), Cleomaceae (3), Commelinaceae (2), Plantaginaceae (2), Poaceae (2) and Polygonaceae (2) (Figure-3). Eleven families of flowering plant represent one species each, *i.e.* Apocynaceae, Balsaminaceae, Gentianaceae, Martyniaceae, Molluginaceae, Papaveraceae, Phyllanthaceae, Pontederiaceae, Rubiaceae, Verbenaceae and Vitaceae (Table -1).

Out of 84 invasive species, 34.58% were recorded in the urban land, 29.16% in the Agricultural land and 25% in the protected land (figure-4). In total of 84 invasive species, 80 species were introduced unintentionally, 2 ornamentally and 2 Agroforestry (table -1). Most of the invasive species were native to Tropical America (42), Tropical Africa (10), Asia (9), South America (5) Europe (3) and North America (Table-1). Very few species *i.e. Merremia emarginata*, *Cayratia trifolia and Leucas cephalotes* were native to Australia, Mediterranean and South Africa.

Table 1. List of invasive species of Bilaspur, Chhattisgarh, India.

S.No.	Botanical name	Family	Habit	Criteria of IP species	Mode of Introduction	Nativity	Flowering & Fruiting
1.	*Abutilon hirtum* (Lam.) Sweet	Malvaceae	S	SC, SLC, DFC, DSE	Ui	Madagascar	March-Sep
2.	*Acalypha indica* L.	Euphorbiaceae	H	SC, SLC, DFC, DSE	Ui	Asia	July- Oct
3.	*Aerva lanata* (L) Juss. Ex. Schult	Amaranthaceae	H	SC, SLC, DFC, DSE	Ui	Madagascar	Aug –Nov
4.	*Aeschynomene indica* Sensee auct, pp.	Fabaceae	H	SC, SLC, DFC, DSE	Ui	Trop. America	Aug – Jan
5.	*Ageratum conyzoides* L.	Asteraceae	H	SC, SLC, DFC, DSE, AF	O	Trop. America	July – Jan
6.	*Alternanthera sessilis* (L) R.Br. *ex* DC.	Amaranthaceae	H	SC, SLC, DFC, DSE	Ui	Trop. America	July – Jan
7.	*Antigonon leptopus* Hook & Arn	Polygonaceae	C	SC, SLC, DFC, DSE	Ui	Trop. America	March – Dec
8.	*Argemone mexicana* L.	Papaveraceae	H	SC, SLC, DFC, DSE	Ui	South America	Sep – Jan
9.	*Bidens bipinnata* L.	Asteraceae	H	SC, SLC, DFC, DSE, AF	Ui	Trop. America	Aug – Oct
10.	*Bidens pilosa* L.	Asteraceae	H	SC, SLC, DFC, DSE, AF	Ui	Trop. America	July – Dec
11.	*Blumea fistulosa* (Roxb.) Kuntze	Asteraceae	H	SC, SLC, DFC, DSE, AF	Ui	Madagascar	Oct – March
12.	*Blumea lacera* (Burm.f.) DC.	Asteraceae	H	SC, SLC, DFC, DSE, AF	Ui	Trop. America	Aug – Feb
13.	*Calotropis gigantea* (L.) W.T. Aiton	Apocynaceae	S	SC, SLC, DFC, DSE, AF	Ui	Trop. Africa	Throughout the year
14.	*Cassia alata* L.	Fabaceae	S	SC, SLC, DFC, DSE	O	West Indies	May – Dec
15.	*Cassia occidentalis* L.	Fabaceae	H	SC, SLC, DFC, DSE	Ui	South America	July – Dec
16.	*Cassia tora* L.	Fabaceae	H	SC, SLC, DFC, DSE	Ui	South America	Aug – Dec
17.	*Cayratia trifolia* (L.) Domin	Vitaceae	C	SC, SLC, DFC, DSE	Ui	Mediterranean	June – Sep
18.	*Celosia argentea* L.	Amaranthaceae	H	SC, SLC, DFC, DSE	Fd	Trop. Africa	Sep – Dec
19.	*Cenchrus ciliaris* L.	Poaceae	H	SC, SLC, DFC, DSE	Fo	Trop. Africa	Sep – March
20.	*Chromolaena odorata* (L.) R. M. King & H. Rob.	Asteraceae	S	SC, SLC, DFC, DSE, AF	Ui	Trop. America	Dec-may
21.	*Chrozophora rottleri* (Geiseler) A. Juss. Ex Spreng.	Euphorbiaceae	H	SC, SLC, DFC, DSE	Ui	Trop. Africa	Sep- Feb
22.	*Cleome gynandra* L.	Cleomaceae	H	SC, SLC, DFC, DSE	Ui	Trop. Africa	Sep – Dec
23.	*Cleome rutidosperma* DC.	Cleomaceae	H	SC, SLC, DFC, DSE	Ui	Trop. America	Aug – Dec
24.	*Cleome viscosa* L.	Cleomaceae	H	SC, SLC, DFC, DSE	Ui	Trop. America	Aug – Dec
25.	*Coldenia procumbens* L.	Boraginaceae	H	SC, SLC, DFC, DSE	Ui	Asia	Oct –March
26.	*Commelina benghalensis* L.	Commelinaceae	H	SC, SLC, DFC, DSE	Ui	Asia	June – Dec
27.	*Convolvulus nummularius* L.	Convolvulaceae	H	SC, SLC, DFC, DSE	Ui	Trop. America	October – Feb
28.	*Corchorus fascicularis* Lam.	Malvaceae	H	SC, SLC, DFC, DSE	Ui	Trop. America	July – Dec
29.	*Crassocephalum crepidioides* (Benth.) S. Moore	Asteraceae	H	SC, SLC, DFC, DSE, AF	Ui	Trop. America	July – Dec
30.	*Croton bonplandianum* Baill	Euphorbiaceae	H	SC, SLC, DFC, DSE, AF	Ui	South America	Aug – Dec
31.	*Cynoglossum lanceolatum* forsskal	Boraginaceae	H	SC, SLC, DFC, DSE, AF	Ui	Europe	July –Nov
32.	*Datura alba* Nees.	Solanaceae	H	SC, SLC, DFC, DSE	Ui	Trop. America	July – Feb
33.	*Datura metel* L.	Solanaceae	H	SC, SLC, DFC, DSE	Ui	Trop. America	Aug – Feb
34.	*Eclipta prostrata* (L.)	Asteraceae	H	SC, SLC, DFC, DSE, AF	Ui	Trop. America	June – March
35.	*Eichhornia crassipes* (C. Martius) Solms-Loub.	Pontederiácea	H	SC, SLC, DFC, DSE, AMR	O	Trop. America	Aug – Dec
36.	*Elephantopus scaber* L.	Asteraceae	H	SC, SLC, DFC, DSE, AF	Ui	Asia	Aug- Dec
37.	*Emilia Sonchifolia* (L.) Dc. Ex. Wight	Asteraceae	H	SC, SLC, DFC, DSE, AF	Ui	Trop. America	Aug -March
38.	*Euphorbia heterophylla* L.	Euphorbiaceae	H	SC, SLC, DFC, DSE	Ui	Trop. America	Aug – Dec
39.	*Euphorbia hirta* L.	Euphorbiaceae	H	SC, SLC, DFC, DSE	Ui	Trop. America	Aug – Dec
40.	*Euphorbia thymifolia* L.	Euphorbiaceae	H	SC, SLC, DFC, DSE	Ui	Trop. America	June – Oct
41.	*Exacum pedunculatum* L.	Gentianaceae	H	SC, SLC, DFC, DSE	Ui	Mexico	Feb- April
42.	*Grangea maderaspatana* (L.) Poir.	Asteraceae	H	SC, SLC, DFC, DSE, AF	Ui	South America	Aug – Dec
43.	*Heliotropium indicum* L.	Boraginaceae	H	SC, SLC, DFC, DSE	Ui	Asia	Feb – June
44.	*Hygrophila auriculata* (Schumach.) Heine	Acanthaceae	H	SC, SLC, DFC, DSE	Ui	Asia	June- Dec
45.	*Hyptis suaveolens* (L.) Poit	Lamiaceae	H	SC, SLC, DFC, DSE	Ui	Trop. America	Aug – March
46.	*Impatiens balsamina* L.	Balsaminaceae	H	SC, SLC, DFC, DSE	O	Trop. America	July – Jan
47.	*Indigofera linnaei* Ali.	Fabaceae	H	SC, SLC, DFC, DSE	Ui	Trop. Africa	Aug – Jan
48.	*Ipomoea carnea* Jace.	Convolvulaceae	H	SC, SLC, DFC, DSE, AF, AMR	Ui	Trop. America	Throughout the year
49.	*Ipomoea hederifolia* L.	Convolvulaceae	H	SC, SLC, DFC, DSE	Ui	Trop. America	Aug – Dec
50.	*Jatropha curcas* L.	Euphorbiaceae	S	SC, SLC, DFC, DSE	Af	Trop. America	June – Oct
51.	*Jatropha gossypifolia* L.	Euphorbiaceae	S	SC, SLC, DFC, DSE	Af	Mexico	July- Nov
52.	*Lagascea mollis* Cav.	Asteraceae	H	SC, SLC, DFC, DSE	Ui	Central America	Aug – Feb

53.	*Lantana camara* L.	Verbenaceae	S	SC, SLC, DFC, DSE	O	Trop. America	Throughout the year
54.	*Leonotis nepetifolia* (L.) R. Br.	Lamiaceae	H	SC, SLC, DFC, DSE	Ui	Trop. Africa	Aug – Dec
55.	*Leucas cephalotes* (Roth) Spreng	Lamiaceae	H	SC, SLC, DFC, DSE	Ui	South Africa	Aug – Dec
56.	*Malachra capitata* (L.) L.	Malvaceae	H	SC, SLC, DFC, DSE	Ui	Trop. America	June-Jan
57.	*Malvastrum coromandelianum* (L.) Garcke	Malvaceae	H	SC, SLC, DFC, DSE	Ui	Trop. America	Aug – Jan
58.	*Martynia annua* L.	Martyniaceae	S	SC, SLC, DFC, DSE, AF	Ui	Trop. America	Aug – Dec
59.	*Mecardonia procumbens* (Mill.) Small	Plantaginaceae	H	SC, SLC, DFC, DSE	Ui	Asia	Aug – Jan
60.	*Melochia corchorifolia* L.	Malvaceae	H	SC, SLC, DFC, DSE	Ui	Trop. America	Aug – Dec
61.	*Merremia emarginata* (Burm. fil.) Hall. fil.	Convolvulaceae	H	SC, SLC, DFC, DSE	Ui	Australia	Nov – Feb
62.	*Mollugo pentaphylla* L.	Molluginaceae	H	SC, SLC, DFC, DSE	Ui	Trop. Africa	June –Sep
63.	*Murdannia nudiflora* (L.) Brenn	Commelinaceae	H	SC, SLC, DFC, DSE	Ui	Trop. Africa	June –Aug
64.	*Parthenium hysterophorus* L.	Asteraceae	H	SC, SLC, DFC, DSE, AF	Ui	North America	July-Feb
65.	*Peristrophe paniculata* (Forssk.) R.K. Brummitt	Acanthaceae	H	SC, SLC, DFC, DSE	Ui	Trop. America	Aug – Jan
66.	*Phyllanthus virgatus* G. Forst	Phyllanthaceae	H	SC, SLC, DFC, DSE	Ui	Europe	Sep – Dec
67.	*Physalis minima* L.	Solanaceae	H	SC, SLC, DFC, DSE	Af	Trop. America	July – Jan
68.	*Plectranthus mollis* (W.T.) Aiton) Spreng	Lamiaceae	H	SC, SLC, DFC, DSE	Ui	Trop. America	Aug – Dec
69.	*Ruellia tuberosa* L.	Acanthaceae	H	SC, SLC, DFC, DSE	O	Trop. America	Aug – Dec
70.	*Rumex crispus* L.	Polygonaceae	H	SC, SLC, DFC, DSE	Ui	Europe	Oct - Feb
71.	*Scoparia dulcis* L.	Plantaginaceae	H	SC, SLC, DFC, DSE	Ui	Trop. America	July – Dec
72.	*Setaria viridis* (L.) P. Beauv.	Poaceae	H	SC, SLC, DFC, DSE, AF	Af	Trop. America	June – Sep
73.	*Sida acuta* Burm.f.	Malvaceae	H	SC, SLC, DFC, DSE, AF	Ui	Trop. America	July – Dec
74.	*Sida cordata* (Burm.f.) Borss. Waalk	Malvaceae	H	SC, SLC, DFC, DSE	Ui	Asia	Aug- Dec
75.	*Solanum sisymbriifolium* Lam.	Solanaceae	S	SC, SLC, DFC, DSE	Ui	Trop. America	Aug – Feb
76.	*Solanum torvum* Sw.	Solanaceae	S	SC, SLC, DFC, DSE	Ui	West Indies	Oct – March
77.	*Spermooce hispida* L.	Rubiaceae	H	SC, SLC, DFC, DSE	Ui	Trop. America	June – Oct
78.	*Spilanthes acmella* (L.) L.	Asteraceae	H	SC, SLC, DFC, DSE	Ui	North America	Oct – March
79.	*Tephrosia purpurea* (L.) Pers.	Fabaceae	H	SC, SLC, DFC, DSE	Ui	Asia	June - Oct
80.	*Tridax procumbens* L.	Asteraceae	H	SC, SLC, DFC, DSE, AF	Ui	Central America	Throughout the year
81.	*Triumfetta rhomboidea* jacq.	Malvaceae	H	SC, SLC, DFC, DSE, AF	Ui	Trop. America	June – Dec
82.	*Urena lobata* L.	Malvaceae	H	SC, SLC, DFC, DSE, AF	Ui	Trop. Africa	July – Dec
83.	*Xanthium strumarium* L.	Asteraceae	H	SC, SLC, DFC, DSE, AF	Ui	Trop. America	Aug – March

Life form: H—Herb; C—Climber; S—Shrub; Criteria of invasive plants: SC (Successful colonizer) SLC (Small Life Cycle), DFC (Dense Foliage Canopy), DSE (Distribution of Species in different Ecosystem), AF (Adaptive Features), AMR (Alternative Mode of Reproduction); Mode of introduction: Ui – Unintentional, Fd- Fodder, O- Ornamental, Af –Agroforestry.

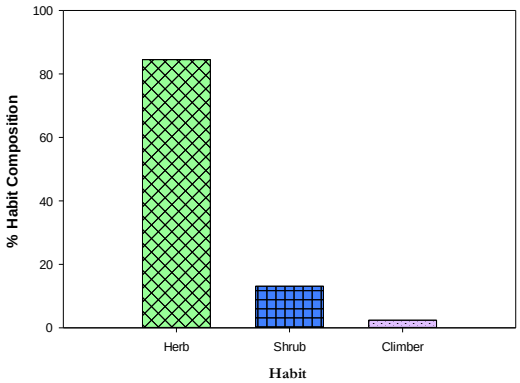

Figure 2. Percent composition of habit analysis of invasive plant.

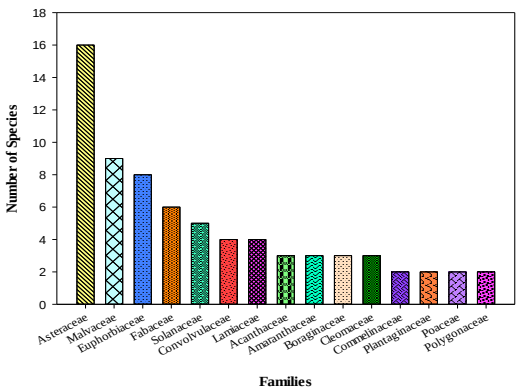

Figure 3. Dominant family graph of invasive plant.

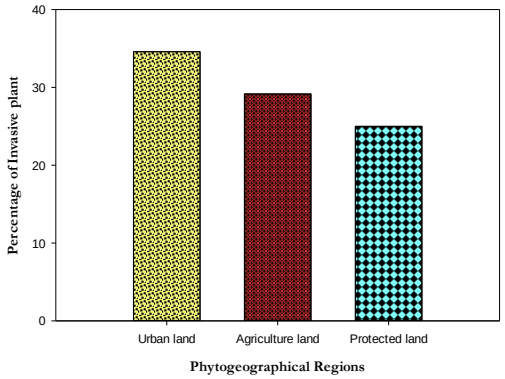

Figure 4. Percent wise occurrence of invasive plants in all three phytogeographical regions.

Discussion

This work shows that maximum number of invasive plants were found in urban land, some in agriculture land and least in protected land. Establishment of invasive plant species in urban lands depends on human disturbance (Pyšek et al, 1998 and Byers 2002). Dominant family of the species belongs to Asteraceae family whose seeds possess adaptive features for dispersals. In Spite of *Eichhornia crassipes* and *Ipomoea carnea* all other species were reproduced by seeds but the above aforesaid species are reproduced through seeds and propagative stem. 84.52 % of invasive plants were herb which have small life cycles and occur specifically in rainy and winter season, remaining 13.09 % species of shrub have long life cycles and present throughout the year.

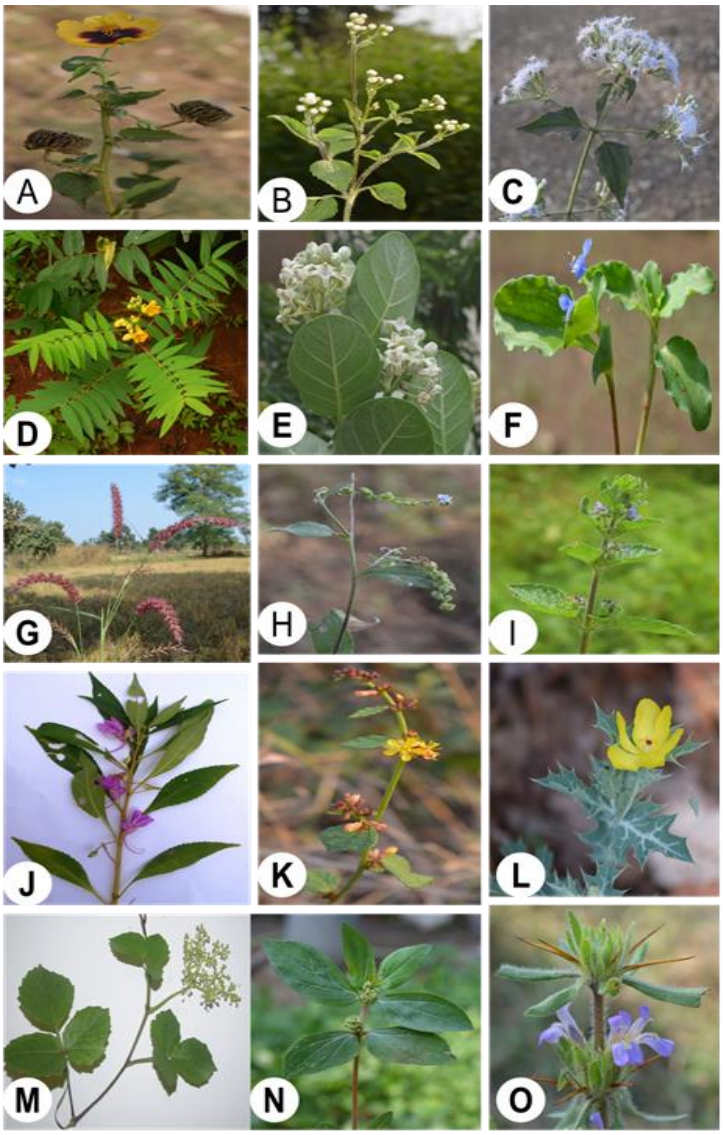

Plate 1: (A-O);

(A) *Abutilon hirtum* (B) *Ageratum conyzoides* (C) *Chromolaena odorata*
(D) *Cassia occidentalis* (E) *Calotropis gigantea* (F) *Commelina benghalensis*
(G) *Cenchrus ciliaris* (H) *Cynoglossum lanceolatum* (I) *Hyptis suaveolens*
(J) *Impatiens balsamina* (K) *Triumfetta rhomboidea* (L) *Argemone mexicana*
(M) *Cayratia trifolia* (N) *Euphorbia hirta* (O) *Hygrophila auriculata*

Conclusion

This work focuses heavily on presence of invasive species in all three phytogeographical areas of Bilaspur district in Chhattisgarh. It is a first attempt to prepare a checklist of invasive plant species which will help to understand the presence, distribution and reproduction of plant in Bilaspur district of Chhattisgarh. Present work will provide a better way to plan for early detection of invasion and establishment of routine monitoring of invasive plant by land managers, taxonomist, agriculturist, botanist and ecologist**.** One of the advantages of this work is prevention of certain diseases like asthma, allergy etc. caused by invasive plant and save loss of native species which have a great medical importance.

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