



## STATUS OF INVASIVE ALIEN PLANT SPECIES (IAPs) IN ARUNACHAL PRADESH, INDIA: A REVIEW

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### ABSTRACT:

Globalization has paved way to invasion in eastern Himalaya region of Arunachal Pradesh, slowly threatening native flora and ecosystem. As the neutralisation of bio geographical barriers, IAPs are moving upwards in higher elevation and existence of native species are looming in great danger in the state. In order to curb out this looming danger, we provide an overview on the status of IAPs in Arunachal Pradesh. Based on an extensive literature review, we identified 63 IAPs belonging to 28 families reported to occur in Arunachal Pradesh. Majority of these species are herb (50), followed by shrub (7), climber (2), grass (2) and single species of trees and undershrub. Tropical America (57%) and South America (9%) contribute maximum proportion to the IAPs of Arunachal Pradesh. Habit wise analysis shows 54% annuals and 46% perennials, respectively. The highest diversity is reported from Asteraceae family. Present study will help in further understanding of IAPs (early detection, seasonal inventories, developing strategic management and control protocol) and provide a baseline data for the future research.

**Keywords:** Arunachal Pradesh; Habit; Himalaya; Invasion; Native.

### INTRODUCTION:

In the context of invasion biology, the terminology are very confusing both “invasive” and “alien” having political overtones (Brunel et al., 2013) as the word; invasive / invasion has the notion of aggression, assault, attack, incursion, raid, etc., (Richardson et al., 2000) whereas alien means exotic, non-native or/foreign species; which has been introduced intentionally or accidentally into an area with the assistance of humans. The plants that spread outside its natural area, with the influence of human participation either deliberately or unintentionally are called as “Invasive Alien Plant Species” (IAPs). According to Weber and Li (2008), the increasing pace of globalisation has a high chance of invasion in developing countries as their economic

situation intends to climb. To date, there was no general agreement on invasion mechanism and prediction models (Alpert et al., 2000; Milbau et al., 2003). Though Article 8(h), CBD states that “Each contracting Party shall, as far as possible and as appropriate, prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species”.

The hole in the bio-geographic barriers of the continents on the Earth's biota has led to spread of the invasive plants around the world (Davis, 2003; Khuroo et al., 2007), altering the Earth's biodiversity (Vitousek et al., 1996). Invasive plants are considered the second most threat after anthropogenic activities (CBD, 2002) and impacts caused by them are

recognised worldwide (Mooney and Hobbs, 2000). However, the chronicle of biological invasion started from the book “The Ecology of Animal and Plant Invasion” by Charles Elton (1958) and later known as “Invasion Ecology” (Rajmanek et al., 2005a). Most of the invasive plants were either introduced unintentionally or intentionally as horticulture or nursery trade (Turbelin et al., 2017) and due to lack of basic information (Meyer, 2000), they were found outside their normal distribution; adversely affecting the ecological system (Master and Norggrove, 2010). Yet, there has been no report of extinction related to plant invasion (Downey and Richardson, 2016) though to safeguard future, implementation on people’s perception of invasion study has become one of the important factors that need to be awakened (Shackleton et al., 2019). The majority of the species invading are reported from Tropical America and Tropical Africa (Reddy, 2008) and introduced during the colonization period of European power from the 15<sup>th</sup> to 19<sup>th</sup> centuries (PEC, 2013).

India, the botanical garden of the world (Dubey et al., 2004) and 12<sup>th</sup> mega biodiversity region of the world (Agarwal, 1999) account a total plant diversity of more than 45,000 plant species, out of which 173 plant species are reported as Invasive Alien Plant Species (Reddy, 2008). The reported species are also declared as invasive by the Botanical Survey of India (BSI). In India, these invasive plants are governed by the colonial government policies of British rule (Kannan et al., 2013). According to Richardson and Pysek (2006), many of the invasion ecologies are related to human-mediated works. For example, in India, many species were introduced as fuelwood alternative and ornamental plants such as *Prosopis juliflora*, *Lantana camara*, *Parthenium*

*hysterophorus*, *Ageratum conyzoides*, etc. by the British (Hooker, 1882; Kohli and Rani, 1994; PEC, 2013).

For example, in India, introduction of *Lantana* has a wide history with records stating that it was used as ornamental hedge in Calcutta in 1809 (Kohli et al., 2006). *Parthenium hysterophorus*, presence in India as early as 1810 was reported (Bennett et al., 1978), a noxious weed that are rapidly replacing the native vegetation in India and causes health problems such as, skin allergy and eye irritation. *Prosopis juliflora*, another invasive species from Latin America was first introduced into India in 1857 as a substitute for slow-growing *Prosopis cineraria* (Tewari et al., 2011) and quickly adapted into a new environment of arid and semi-arid areas of India. With time, it spread all over India and started invading the crop fields and competing with other plants for water and nutrients. *Hyptis suaveolens*, a potent invader that restrict the growth of other species by increasing livestock pressure because of its unpalatable nature have become an emerging invader in Doon and Shivalik ranges of India (Padalia et al., 2013).

There are still many regions in the world where basic information on plant invasion is completely lacking, Arunachal Pradesh also comes under this region. In Arunachal Pradesh, comprehensive studies on invasive alien plant species are still missing. Till now, there is no report on status/listing of invasive alien plant species in this Himalayan state. Because of these, we attempt to compile and present the first list of invasive alien plant species in order to reduce the study gap and provide an adequate data for the future researchers and by providing a platform to

understand these plants and research design toward future strategic management.

#### **MATERIALS AND METHODS:**

In the Himalayan region, Arunachal Pradesh lies in a rich biodiversity hotspot that falls in the realm of Oriental and Indo- Malayan region (Myers, 1988; Myers et al., 2000). The state has rich biodiversity due to its geographical variation in altitude. It spread over 87,743 km<sup>2</sup> in total area, out of which 51,540 km<sup>2</sup> is covered with forest area (Singh, 2003; Srivastava and Adi, 2009). The state endowed with unique and rich floral diversity with 4503 species (Rana and Rawat, 2017) and the highest number of flowering plants among the seven sister states of North East (Hedge, 2000). Known for rich flora and fauna, Arunachal Pradesh is a home of 28 different tribes and 110 sub-groups (Tag et al., 2005), inhabiting in the 25 districts with a total population of about 13.84 lakh (Census, 2011). These tribes have their own culture, tradition, languages and have recognised more than 500 plants that have medicinal values (Hedge, 2000; Anon., 2003).

A comprehensive literature search was conducted using Web of Science/knowledge, Google Scholar (<https://scholar.google.com>), PubMed (<https://pubmed.ncbi.nlm.nih.gov>), CABI (<https://www.cabi.org>), Elsevier Science Direct (<https://www.sciencedirect.com>), Springer Online Journals (<https://link.springer.com>) and Research Gate (<https://www.researchgate.net>). The focus was on the peer-reviewed articles and reports including of the Convention on Biological Diversity (CBD) and Centre for Agriculture and Bioscience International (CABI). Concerned literatures are searched on databases

comprising information on invasive alien plant species were browsed using the following main search terms:

1. “India” and “eastern Himalaya” and “invasive alien plant” OR “invasive plant species” OR “non- native plant” OR “exotic plant”
2. “Arunachal Pradesh” and “eastern Himalaya” and “invasive alien plant” OR “invasive plant species” OR “non- native plant” OR “exotic plant”
3. “India” and “biological invasion” OR “plant invasion”
4. “Arunachal Pradesh” and “biological invasion” OR “plant invasion”

Initially a total of 240 publications were identified. A further review of the abstracts, titles and keywords led to elimination of about 200 articles due to lack of relevance. Finally, 9 articles were included for this review research (Table 1). These publications share the focus on the status of invasive alien plant species of Arunachal Pradesh

#### **RESULTS AND DISCUSSION:**

From the available literature, a total of 63 species belonging to 28 families are reported as invasive alien in the flora of Arunachal Pradesh (Table 2). A total of 13 different geographical regions in terms of nativity are recorded in this review. The majority of invasive species in Arunachal Pradesh are from Tropical America (57%) followed by South America (9%), North America (6%), Tropical Africa (4%) and Europe, Mediterranean, Mexico (2% each). Among these regions, Tropical America, South America and North America nearly contributed 71% of total invasion. The invasive alien flora of Arunachal Pradesh comprises 54% and 46% annuals and

perennials, respectively (Fig. 2). The herbs constitutes 79% (50 Species), 7 shrubs, two climbers (*Mikania micrantha* and *Macroptilium atropurpureum*) and two grasses (*Imperata cylindrica* and *Saccharum spontaneum*) while undershrub and trees are represented by only one species viz., *Senna occidentalis* and *Acacia mearnsii*, respectively (Fig. 1). The genera with highest number of invasive alien species in Arunachal Pradesh are *Solanum* and *Senna* (3 species each.); *Cleome*, *Crotolaria*, *Echinochloa*, *Galingosa*, *Ipomea*, *Sonchus* and *Stachytarpheta* (2 species each). Nine genera contributed 28% taxa of invasive alien flora of Arunachal Pradesh. Moreover, Asteraceae (15 species) has the highest count of invasive alien species followed by Fabaceae (6 species), Poaceae (5 species), Mimosaceae, Solanaceae, Verbanaceae and Caesalpiniaceae (3 species each), Cleomaceae, Convolvulaceae, Malvaceae, Scrophulariaceae, and Lamiaceae (2 species each) and contributed 76% of the total species. The 16 families i.e. Amaranthaceae, Araceae, Brassicaceae, Cyperaceae, Euphorbiaceae, Lythraceae, Melastomataceae, Oxalidaceae, Papaveraceae, Pontederaceae, Pedaliaceae, Piperaceae, Portulacaceae, Sterculiaceae and Tiliaceae are represented by single species.

#### CONCLUSION:

According to the available information, 63 invasive alien plant species (IAPs) of 28 families are found in the Arunachal Pradesh. Herb species are more vastly spreading than shrub, climber, grass and tree in this beautiful state. Clearly indicate IAPs are moving upwards in higher elevations than their natural habitat. In order to monitor this biological invasion, seasonal species inventories, ground based methods as well as better planning for early detection and link

communication between staffs and researcher are very much needed. This review study concludes that Arunachal Pradesh is having rich and unique biodiversity hotspot but faced severe threats of IAPs due to least investigation.

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#### Author Contributions:

HBS and AK conceptualized the topic, HBS collected and wrote the manuscript, HBS, AK, and BSA checked and edited the manuscript. All the authors read and approved the manuscript.

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#### REFERENCES:

- Brunel S, Fernandez- Galiano E, Genovesi P, Heywood VH, Kueffer C, Richardson DM. 2013 Invasive alien species: a growing but neglected threat? In: Late lessons from early warn. Science, precaution, innovation. Lessons preventing harm. European Environmental Agency EEA, Copenhagen, pp 518–540.
- Richardson DM, Pyšek P, Rejmanek M, Barbour MG, Dane-Panetta F, West CJ. 2000. Naturalization and invasion of alien plants: concepts and definitions. Diversity and Distributions 6, 93–107.
- Weber E and Li, B. (2008). Plant Invasions in China: What Is to Be Expected in the Wake of Economic Development? BioScience, 58(5), 437–444.

- Alpert P, Bone E and Holzapfel C. 2000. Invasiveness, invasibility, and the role of environmental stress in preventing the spread of non-native plants. *Perspectives in Plant Ecology, Evolution and Systematics* 3: 52–66.
- Milbau A, Nijs I, van Peer L, Reheul D and de Cauwer B. 2003. Disentangling invasiveness and invasibility during invasion in synthesized grassland communities. *New Phytologist* 159.
- Davis MA. 2003. Biotic Globalization: Does Competition from Introduced Species Threaten Biodiversity? *Bio-Science*, 53(2), 131–140.
- Khuroo AA, Rashid I, Reshi Z, Dar GH, and Wafai, BA. 2007. The alien flora of Kashmir Himalaya. *Biological Invasions*, 9(3), 269–292.
- Vitousek PM, D'Antonia CM, Loope LL and Westbrooks R. 1996. Biological invasions as global environmental change. *American Scientist*, 218–229.
- CBD. 2002. Sixth Conference of the Parties, The Hague, the Netherlands, 7-19 April 2002: Decision VI/23: Alien species that threaten ecosystems, habitats or species to which is annexed Guiding principles for the prevention, introduction and mitigation of impacts of alien species that threaten ecosystems, habitats or species (available at [www.biodiv.org](http://www.biodiv.org))
- Mooney HA and Hobbs RJ. 2000. *Invasive Species in a Changing World*. Island Press, Washington D.C.
- Elton CS. 1958: *The ecology of invasions by animals and plants*. Chicago: University of Chicago Press.
- Rejmánek M, Richardson DM, Higgins SI, Pitcairn MJ and Grotkopp E. 2005a: Ecology of invasive plants: state of the art. In Mooney, H.A., Mack, R.M., McNeely, J.A., Neville, L., Schei, P. and Waage, J., editors, *Invasive alien species: searching for solutions*, Washington, DC: Island Press, 104–61.
- Turbelin AJ, Malamud, BD and Francis RA. 2017. Mapping the global state of invasive alien species: patterns of invasion and policy responses. *Global Ecology and Biogeography*, 26(1), 78–92.
- Meyer JY. 2000. Preliminary review of the invasive plants in the Pacific islands. In: Sherley G (Eds.). *Invasive Species in the Pacific: A Technical Review and Draft Regional Strategy*. South Pacific Regional Environmental Programme, Samoa; 85 – 114.
- Masters G and Norgrove L. 2010. *Climate Change and Invasive Alien Species*. CABI Working Paper 1, (November), 30.
- Downey PO and Richardson DM. 2016. Alien Plant Invasions and Native Plant Extinctions: A Six-Threshold Framework. *AoB Plants*, 8.
- Shackleton, Ross T., David M. Richardson, Charlie M. Shackleton, Brett Bennett, Sarah L. Crowley, Katharina Dehnen-Schmutz, Rodrigo A. Estévez, Anke Fischer, Christoph Kueffer, Christian A. Kull, Elizabete Marchante, Ana Novoa, Luke J. Potgieter, Jetske Vaas, Ana S. Vaz, and Brendon M. H. Larson. 2019. “Explaining People’s Perceptions of Invasive Alien Species: A Conceptual Framework.” *Journal of Environmental Management* 229:10–26.

- Reddy CS. 2008. Catalogue of invasive alien flora of India. Life Science Journal 5(2):84-8.
- Kannan R, Shackleton CM, and Uma Shaanker R. 2013. Reconstructing the history of introduction and spread of the invasive species, Lantana, at three spatial scales in India. Biological Invasions, 15(6), 1287–1302.
- Richardson DM and Pysek P. 2006. Plant Invasions: Merging the concepts of species invasiveness and community invisibility. Progress in physical geography, 30(3), 252-258.
- Hooker J. 1882. The Flora of British India Vol III. The Authority of the Secretary Of State for India In Council. London: Reeve and Co., 6 Henrietta Street, Covent Garden.
- Kohli RK and Rani D. 1994. *Parthenium hysterophorus*– a review. Research Bulletin (Science), Panjab University 44, 105-149.
- PEC. 2013. Invasive Alien Plant Species in Punjab, 11(4), 7–10.
- Dubey NK, Kumar R and Tripathi P. 2004. Global promotion of herbal medicine: India's opportunity. Current Science 86, 37–41.
- Agarwal KC, Biodiversity. Bikaner: Agrobotanica (1999).
- Kohli RK, Batish DR, Singh HP and Dogra KS, 2006. Status, invasiveness and environmental threats of three tropical American invasive weeds (*Parthenium hysterophorus* L., *Ageratum conyzoides* L., *Lantana camara* L.) in India. Biol. Invasion, 8, 1501–1510.
- Bennet SSR, Naithani HP and Raizada MB, 1978. *Parthenium* L. in India: a review and history. Indian Journal of Forestry 1: 128–131.
- Tewari JC, Ratha Krishnan P and Harsha SL, Bohra HC, 2011 (Eds.). *Prosopis juliflora*: Past, Present and Future. Desert Environmental Conservation Association (DECO), Jodhpur and Central Arid Zone Research Institute (CAZRI), Jodhpur, II5.
- Padalia H, Kudrat M and Sharma KP, 2013. Mapping sub-pixel occurrence of an alien invasive *Hyptis suaveolens* (L.) Poit. using spectral unmixing technique, International Journal of Remote Sensing Vol. 34, No. 1, 10 January, 325–340.
- Myers N. 1988. Threatened Biotas: Hotspots in Tropical Forests. The Environmentalist, 8: 187-208.
- Myers N, Russell A, Mittermeier, CG. Mittermeier, GA, da Fonseca B and Kent J. 2000. Biodiversity hotspots for conservation priorities. *Nature* volume 403, pages853–858
- Singh DN. 2003. Conservation of Tropical Rain Forest in Arunachal Pradesh. Conservation of Rain Forest in India. Envis (Wildlife and Protected Area) 4 (1): 279 – 285.
- Srivastava RC and Adi Community. 2009. Traditional knowledge of Adi tribe of Arunachal Pradesh on plants. Indian Journal of Traditional Knowledge Vol. 8(2), April 2009, pp. 146-153.
- Rana S and Rawat GS. 2017. Database of Himalayan Plants based on Published Floras during a Century. Data 2, 36.
- Hegde SN. 2000. Conservation of North East Flora. Arunachal Forest News, v. 18, no. 1/2, p. 5-26.

Tag H, Das AK and Kalita P. 2005. Plants used by the Hill Miri of Arunachal Pradesh in ethno fisheries. Indian J. Traditional Knowledge. 4(1): 57-64.  
<https://www.census2011.co.in/census/state/arunachal+pradesh.html>.

Anonymous, State Forest Research Institute, Information Bulletin No. 16. SFRI, Itanagar, Arunachal Pradesh, (2003).

Kosaka Y, Saikia B, Mingki T, Tag H, Riba T and Ando K. 2010. Roadside Distribution Patterns of Invasive Alien Plants along an Altitudinal Gradient in Arunachal Himalaya, India. Mountain Research and Development, 30(3), 252-258.

Jeyaprakash K and Rathinavel S. 2016. Floristic investigations on D' Ering memorial wildlife sanctuary, Arunachal International Journal of Research in Plant Science ISSN 2249-9717 Original Article Floristic investigations on D' Ering memorial wildlife sanctuary, Arunachal Pradesh, (March).

Dhaundiyal N, Agarwal P, Kumaiyan M and Sah P. 2009. Species Richness in an Oak Uttarakhand Himalaya, Proc. Natl. Acad. Sci., India, Sect. B Biol. Sci. (July-September 2012) 82(3):375-383 DOI 10.1007/s40011-012-0040-2

Sastry TCS and Kavathekar KY. 1990. Plants for reclamation of wastelands. New Delhi, India; Publications and Information Directorate, Council of Scientific and Industrial Research, xii + 684 pp.

Naithani HB and Bennet SSR. 1990. Note on the occurrence of *Cuphea carthagensis* from India. Indian Forester, 116(5):423-424.

Randall RP. 2012. A Global Compendium of Weeds. Perth, Australia: Department of Agriculture and Food Western Australia, 1124pp.

Shukla U. 1996. The Grasses of North-Eastern India. Jodhpur, India: Scientific Publishers, 325 pp.

Gopal B. 1987. Biocontrol with arthropods. Water hyacinth. 208-230.

**Table 1:** Number of IAPs analysed in the paper

Year	Year and publication	No. of IAPs studied
1987	Gopal, 1987	1
1990	Naithani & Benett, 1990	1
	Sastry & kavathekar, 1990	1
1996	Shukla, 1996	1
2009	Dhaundhiyal et al., 2009	1
2010	Kosaka et al., 2010	17
2012	Randall, 2012	1
	Sekar, 2012	19
2016	Jeyaprakash & Rathinavel, 2016	34

Table 2: Invasive alien plant of Arunachal Pradesh

Species	Habit	Life form	Nativity	References
<b>Asteraceae</b>				
<i>Ageratum conyzoides</i> L.	Annual	Herb	Trop. America	Kosaka et al.,2010; Jeyaprakash & Rathinavel, 2016
<i>Ambrosia artemisiifolia</i> L.	Annual	Herb	N. America	Kosaka et al., 2010
<i>Ageratina Adenophora</i> (Spreng)	Perennial	Herb	Mexico	Kosaka et al., 2011
<i>Bidens pilosa</i> L	Annual	Herb	Trop. America	Kosaka et al.,2010; Jeyaprakash & Rathinavel, 2016
<i>Chromolaena odorata</i> (L.) King & Robinson	Perennial	Herb	Trop. America	Kosaka et a.l,2010
<i>Crassocephalum crepidioides</i> (Benth.) S. Moore	Annual	Herb	Trop. America	Jeyaprakash & Rathinavel, 2016
<i>Eclipta prostrata</i> (L.) Mant.	Annual	Herb	Trop. America	Jeyaprakash & Rathinavel, 2016
<i>Erigeron karvinskianus</i> DC.	Perennial	Herb	Mexico & Trop. America	Dhaundhiyal et a.l, 2009
<i>Galinsoga quadriradiata</i> Ruiz & Pavon	Annual	Herb	Mexico	Kosaka et al., 2010
<i>Galinsoga parviflora</i> Cav.	Annual	Herb	Trop. America	Sekar, 2012
<i>Parthenium hysterophorus</i> L	Annual	Herb	N. America	Kosaka et al., 2010; Jayeprakash & Rathinavel, 2016
<i>Mikania micrantha</i> Kunth	Perennial	Climber	Trop. America	Kosaka et al., 2010; Jayeprakash & Rathinavel, 2016
<i>Sonchus asper</i> (L.) Hill	Annual	Herb	Mediterranean	Sekar, 2012
<i>Sonchus oleraceus</i> L.	Annual	Herb	Mediterranean	Sekar, 2012
<i>Taraxacum officinale</i> (L.) Weber ex F.H. Wigg	Perennial	Herb	Europe, Asia	Kosaka et al., 2010
<b>Amaranthaceae</b>				
<i>Alternanthera sessilis</i> (L.) DC.	Perennial	Herb	Trop. America	Sekar, 2012.
<b>Araceae</b>				
<i>Pistia stratiotes</i> L.	Perennial	Herb	Trop. America	Jeyaprakash & Rathinavel, 2016
<b>Asclepiadaceae</b>				
<i>Calotropis procera</i> (Ait.) R. Br.	Perennial	Shrub	Trop. Africa	Sastry & kavathekar,1990
<b>Brassicaceae</b>				
<i>Cardamine hirsuta</i> L.	Perennial	Herb	Trop. America	Jeyaprakash & Rathinavel, 2016
<b>Cleomaceae</b>				
<i>Cleome rutidosperma</i> DC.	Annual	Herb	Trop. America	Sekar, 2012.
<i>Cleome viscosa</i> L.	Annual	Herb	Trop. America	Sekar, 2012
<b>Convulvulaceae</b>				
<i>Ipomoea carnea</i> Jacq. subsp. fistulosa (Mart. ex Choisy) Austin	Annual	Shrub	Trop. America	Sekar, 2012; Kosaka et al., 2010
<i>Ipomoea purpurea</i> (L.) Roth	Annual	Herb	South America	Sekar, 2012
<b>Cyperaceae</b>				
<i>Cyperus difformis</i> L	Annual	Herb	Trop. America	Sekar, 2012
<b>Caesalpinacea</b>				
<i>Senna alata</i> L.	Perennial	Shrub	South America	Jeyaprakash & Rathinavel, 2016
<i>Sennaecia dentalis</i> (L.) Link, 1829	Annual	Under shrub	Trop. America	Jeyaprakash & Rathinavel, 2016
<i>Senna tora</i> L.	Annual	herb	South America	Jeyaprakash & Rathinavel, 2016



<b>Euphorbiaceae</b>				
<i>Euphorbia hirta</i> L.	Annual	Herb	Trop. America	Jeyaprakash & Rathinavel, 2016
<b>Fabaceae</b>				
<i>Trifolium repens</i> L.	Perennial	Herb	Europe & Asia	Kosaka et al., 2010
<i>Crotalaria pallida</i> Ait.	Annual	Herb	Trop. America	Jeyaprakash & Rathinavel, 2016
<i>Crotalaria retusa</i> L.	Annual	Herb	Trop. America	Jeyaprakash & Rathinavel, 2016
<i>Cytisus coparius</i> (L.) Link	Annual	Herb	Europe	Sekar, 2012
<i>Indigo feratrita</i> L.f.	Perennial	Shrub	Trop. Africa	Sekar, 2012
<i>Macroptilium atropurpureum</i> (Mocino & Sesse et DC) Urb.	Perennial	Climber	Trop. America	Sekar, 2012
<b>Lamiaceae</b>				
<i>Ocimum americanum</i> L.	Annual	Herb	Trop. America	Jeyaprakash & Rathinavel, 2016
<i>Hyptis suaveolens</i> (L.) Poit.	Annual	Herb	Trop. America	Jeyaprakash & Rathinavel, 2016
<b>Lythraceae</b>				
<i>Cupuea carthagenesis</i> (Jacq.) J.F. Macbr	Annual	Herb	Mexico & Trop. America	Kosaka et al., 2010; Naithani & Benett, 1990
<b>Melastomataceae</b>				
<i>Clidemia hirta</i> (L.) D.Don.	Annual	Herb	Trop. America	Sekar, 2012
<b>Malvaceae</b>				
<i>Sida acuta</i> Burm. f.	Annual	Herb	Trop. America	Jeyaprakash & Rathinavel, 2016
<i>Urena lobata</i> L.	Perennial	Shrub	Trop. Africa	Sekar, 2012; Randall, 2012; Jayeprakash & Rathinavel, 2016
<b>Mimosaceae</b>				
<i>Acacia mearnsii</i> De Wild.	Perennial	Tree	Australia	Sekar, 2012
<i>Mimosa pudica</i> L.	Perennial	Shrub	Brazil	Kosaka et al., 2010; Jayeprakash & Rathinavel, 2016
<b>Oxalidaceae</b>				
<i>Oxalis corniculata</i> L.	Perennial	Herb	Europe	Jeyaprakash & Rathinavel, 2016
<b>Papaveraceae</b>				
<i>Argemone mexicana</i> L.	Annual	Herb	South America	Jeyaprakash & Rathinavel, 2016
<b>Poaceae</b>				
<i>Echinochloa colona</i> (L.) Link	Annual	Herb	Trop. America	Sekar, 2012
<i>Echinochloa crus-galli</i> (L.) P. Beauv.	Annual	Herb	Trop. America	Sekar, 2012; Shukla, 1996; Jeyaprakash & Rathinavel, 2016
<i>Imperata cylindrica</i> (L.) Raeusch.	Annual	Grass	Trop. America	Jeyaprakash & Rathinavel, 2016
<i>Pennisetum purpureum</i> Schum.	Annual	Herb	Trop. America	Sekar, 2012
<i>Saccharum spontaneum</i> L.	Perennial	Grass	Trop. West Asia	Jeyaprakash & Rathinavel, 2016
<b>Ponterderiaceae</b>				
<i>Eichhornia crassipes</i> (C. Martius) Solms	Perennial	Herb	Trop. America	Kosaka et al., 2010; Gopal, 1987
<b>Pedaliaceae</b>				
<i>Martynia annua</i> L.	Perennial	Herb	Trop. America	Sekar, 2012
<b>Piperaceae</b>				
<i>Peperomia pellucida</i> (L.) Kunth	Annual	Herb	South America	Jeyaprakash & Rathinavel, 2016
<b>Portulacaceae</b>				
<i>Portulaca oleracea</i> L.	Annual	Herb	South America	Jeyaprakash & Rathinavel, 2016
<b>Scrophulariaceae</b>				
<i>Scoparia dulcis</i> L.	Perennial	Herb	Trop. America	Jeyaprakash & Rathinavel, 2016
<i>Torenia fournieri</i> Linden ex E. Fourn	Perennial	Herb	Australia	Jeyaprakash & Rathinavel, 2016
<b>Sterculiaceae</b>				
<i>Melochia corchorifolia</i> L.	Perennial	Herb	Trop. America	Jeyaprakash & Rathinavel, 2016

<b>Solanaceae</b>				
<i>Solanum carolinense</i> L.	Perennial	Herb	N. America	Kosaka et al., 2010
<i>Solanum torvum</i> Sw.	Perennial	Shrub	West Indies	Jeyaprakash & Rathinavel, 2016
<i>Solanum viarum</i> Dunal	Perennial	Herb	Trop. America	Jeyaprakash & Rathinavel, 2016; Sekar,2012
<b>Tiliaceae</b>				
<i>Triumfetta rhomboidea</i> Jacq.	Annual	Herb	Trop. America	Jeyaprakash & Rathinavel, 2016
<b>Verbenaceae</b>				
<i>Lantana camara</i> L.	Perennial	Herb	Trop. America	Kosaka et al,2010; Jeyaprakash & Rathinavel, 2016
<i>Stachytarpheta dichotoma</i> (Ruiz Lopez & Pavon) Vahl	Perennial	Herb	Trop. America	Kosaka et al., 2010
<i>Stachytarpheta jamaicensis</i> (L.) Vahl	Perennial	Herb	Trop. America	Jeyaprakash & Rathinavel, 2016

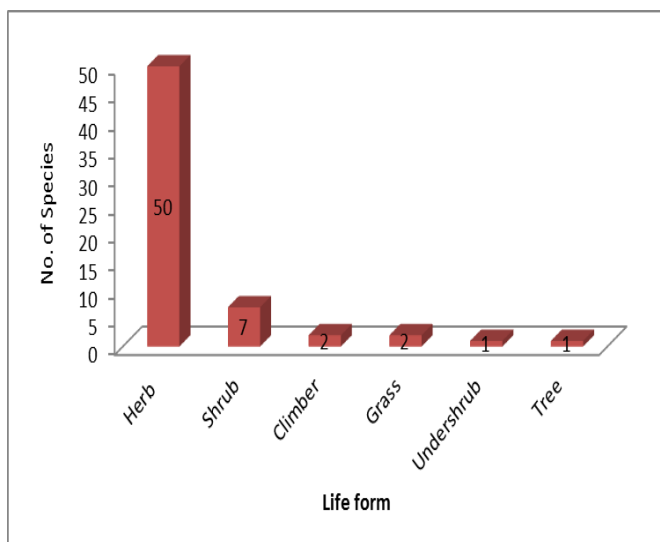


Fig 1: Number of IAPs in Life form.

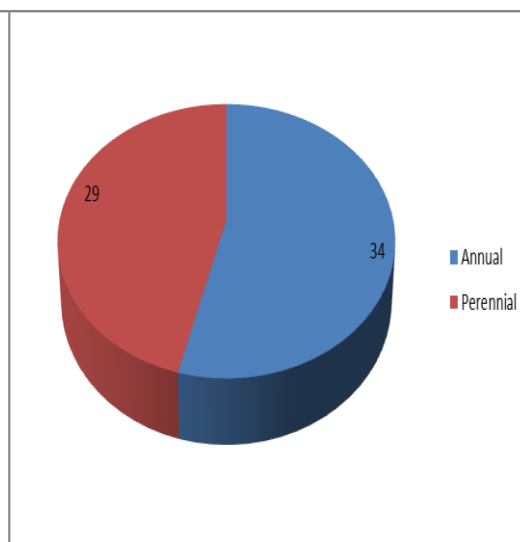


Fig 2: Showing the habitat of IAPs