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Research Article

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Study of Invasive Plant Species Distribution in Warangal City, Telangana, India

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Abstract: The invasive plant species are non-native organisms which invade natural habitats and destroy the indigenous flora. The invasion of alien plant species into various places is recognized as a major cause of loss of biodiversity, after habitat destruction. The aim of the present investigation is to study invasive flora of city of Warangal, Telangana with detailed study about their nativity, family, habit and distribution. A total of 97 species belonging to 72 genera of 30 families have been recorded as alien species. Among them about 63% are native to tropical America. Fabaceae is the dominant family with 13 species, followed by Asteraceae with 12 species, Convolvulaceae with 8 species, Amaranthaceae, Malvaceae, Solanaceae, Euphorbiaceae with 6 species each. Remaining families are represented by species less than 6. Habit wise analysis of invasive plant species showed that 75% species belongs to herbs, 9% belongs to shrubs, 3% trees, and 2% climbers. *Mesosphaerum suaveolens, Parthenium hysterophorous, Alternanthera ficoidea, Senna uniflora, Prosopis juliflora* are dominant terrestrial species. *Typha domingensis, Eichhornia crassipes* are dominant aquatic species observed throughout the study area. *Chromolaena odorata, Lanata camara* are fast spreading in the city and if they are neglected they can become aggressive in future. Most of these alien species are problematic and causing damage to the ecosystem of the city. Neverthless some of the plants have medicinal value, some as fodder and few are used as fuel plants. *Eichhornia crassipes* can be used for preparation of environmental friendly products like paper, fabrics. Hence this study helps for early recognition, monitoring and management of invasive plant species in the study area.

Keywords: Warangal city, Urban ecosystem, Alien species, Aggressive Colonization, Herbs.

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1. INTRODUCTION

Invasive plant species are also known as exotic, non-native, non-indigenous, foreign, alien or introduced plant species. Invasive plants have the potential to cause damage to the environment and economy.[1]Once the alien plants are established in the natural habitats, they adversely destroy the indigenous flora by competing with them for habitat and nutrients. Most of the invasive species spread rapidly and utilizes available resources and have much ecological flexibility than native species.[2] The invasion of alien species into various places is recognized as a major cause of loss of biodiversity, after habitat destruction.[3] These invasive plants are introduced from one region to another region by human beings intentionally for the purpose of ornamental, agricultural or business. Half of them are naturalized. Some plant species introduced unintentionally during the transportation of goods and articles to various places.[4] Whatever it may be, most of them are unsuccessful, but once they establish in natural habitats, they become invasive alien species. Despite negative impact, they do sometimes beneficial role in ecological restoration, soil conservation, and generating new socio- economic prospects. Many of invasive plant species are uses in many ways, for instance *Argemone mexicana, Calotropis procera, C.giantia, Celosia argentia, Eclipta prostata, Senna occidentalis, Cleome viscosa, Martynia annua* are used as medicinal plants[5]*Prosopis juliflora, Leucaena leucocephala* using as fuel wood. *Antigonon leptopus, Mirabilus jalapa*, *Stachytarpheta jamaicensis, Turnera subulata,T.umlifolia* are grown as ornamental plants.[6]All the invasive species do not spread to the entire country, Most of them inhabit harvested agricultural fields, vacant places, along road sides, along railway tracks and in open forest areas and also in water bodies. Most of the invasive species are unnoticed for many years. Some may spread in small areas, but some have the capacity to colonize in large areas, and become aggressive colonizers.[7]Environmental information system centre for floral diversity described total 173 species, belonging to 117 genera under 44 families in India.[8] Environmental information system centre for Tamilnadu listed out 275 invasive plants in Tamilnadu.[9] Most of the alien plant species belonging to 10 families Asteraceae, Fabaceae, Convolvulaceae, Caesalpiniaceae, Solanaceae, Amaranthaceae, Poaceae, Euphorbiaceae, Mimosaceae and Tiliaceae (about 63.6% species).[10] The success in faster distribution of terrestrial invasive plant species lies in their habitat, faster growth, reproduction and production of tiny numerous seeds, and vegetative reproduction for aquatic invasive plant species. Which enable them faster distribution in degraded and barren lands.[11] Control of these invasive plant species require integrated management for complete eradication along with mechanical, chemical, and biological methods of control.[12]Early detection and rapid eradication are the two methods to prevent the establishment of invasive plants in an area.[13]Urban environments possess a wide range of habitat that enable colonization of different plant species, many of them are of alien origin. For future urban planning and expansion of the green areas within the city, study of the spatial distribution of invasive alien species is of great importance.[14]While reviewing literature most of the previous research studies enlisted invasive plant species in forest ranges, in protected areas to conserve biodiversity, in tribal hamlets to know the ethno botanical aspects. Only few studies are available for urban environments. 21 plant species are reported from Andhra University campus, Visakapatnam.[15]165 invasive species are listed out from the Rurkela steel city, Sundargarh, Odisha. It could be helpful to involve local people to detect and report for invasive species in an area.[6] No studies reported for Warangal city to enlist invasive plant species and their possible uses and adverse affects. Hence, this study is useful for early recognition of alien plant species and of monitor and control such species without disturbing the local flora; and our study is also useful to document the ethno botanical uses of invasive plants.

2. MATERIALSAND METHODS

This study was entirely based on the field survey and carried out during August 2018 to February 2020. Extensive floristic studies were undertaken in different areas of the city of Warangal, Telangana. This includes mainly along main roads, road sides in developing colonies, open grounds in parks, lake bunds, water bodies and sewage canals. Each corner of the city was covered in different seasons to collect the plants and for correct authentication of plants. The information regarding their uses and harmful effects are also collected from local inhabitants. The collected plants were identified with the help of floras.[16-19]and their nativity recognized by literature of invasive flora.[20,21]Plants were collected in different seasons, dried, pressed and mounted on the herbarium sheets. Plant Specimens were preserved in Kakatiya University Herbarium (KUW) along with collection numbers (Table-1). Later, the invasive plant species were categorized according to their habit into herbs, shrubs, climbers and trees.

2.1 *Study Area*

Warangal is the 2nd biggest city after Hyderabad in Telangana state (Figure-1a). It is located at a distance of 135k.m. from the state capital of Telangana. Warangal was the capital of the Kakatiya Dynasty. Warangal urban district located GPS coordinates of latitude 17°58'8.04"N and a longitude of 79°35'38.6"E. The average annual rainfall of the district is 800 mm, with maximum rainfall recorded in the months of July, August and September every year. Warangal has both black soil and red soil. The Warangal corporation area is with 110 Sq.k.m with 58 divisions and the population is 11 lakhs. Warangal municipal corporation area consists of three main cities i.e. Warangal, Hanamkonda and Kazipet situated side by side (Figure-1b). These have a number of developing colonies on the outskirts and numbers of villages are merged into Warangal Corporation to become Greater Warangal Municipal Corporation (GWMC).Many agricultural fields in the adjacent villages are converted to construction business, resulting in barren fields for many years. These vacant fields, open grounds, and open plots in the city have paved way for the invasion of alien plant species into these areas and now, some become very aggressive colonizers. So, there is a need to study these invasive plant species in this area and take measures to protect the local flora.

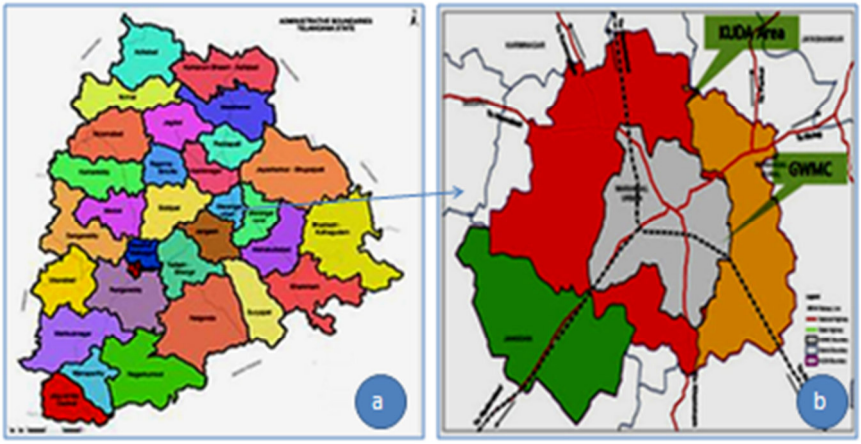

Fig1. Study Area a. Telangana State; b. Warangal city

3. RESULTS AND DISCUSSION

Total 97 species belongs to 72 genera under30 families are identified as alien species in of Warangal city, Telangana (Table.1). The number of dicotyledonous species identified in this area are 87, belongs to 62 genera under 24 families. The number of monocotyledonous species identified in this area are 10, belongs to 10 genera under 6 families.

Table1. List of invasive plant species in Warangal city

S.No	Name of the Plant species	Collection number	Family	Habit	Nativity
1	*Acacia farnesiana* (L)Willd.	4169	Fabaceae	Tree	South.America
2	*Acanthospermum hispidum* DC.	4198	Asteraceae	Herb	Trop.America
3	*Ageratum conyzoides* (L.) L.	4136	Asteraceae	Herb	Trop.America
4	*Alternanthera ficoidea* (L.) Sm.	4091	Amaranthaceae	Herb	Trop.America
5	*Alternanthera philoxeroides* (Mart) Griseb	4138	Amaranthaceae	Herb	Trop.America
6	*Alternanthera pungens* Kunth	4170	Amaranthaceae	Herb	Trop.America
7	*Antigonon leptopus* Hook.&Arn	4093	Polygonaceae	Climber	Trop.America
8	*Argemone Mexicana* L.	4121	Papaveraceae	Herb	Trop.S.America
9	*Asclepias curassavica* L.	4140	Apocyanaceae	Herb	Trop.America
10	*Blumea lacera* (Burm.f.) DC.	4095	Asteraceae	Herb	Trop.America
11	*Blumea oblique* (L.) Druce	4097	Asteraceae	Herb	Trop.America
12	*Borassus flabellifer* L.	4215	Arecaceae	Tree	Trop.Africa
13	*Calotropis gigantean* (L.) R.Br.	4051	Apocyanaceae	Shrub	Trop.America
14	*Calotropis procera* (Ait.)R.Br	4053	Apocyanaceae	Shrub	Trop.America
15	*Celosia argentea* L.	4173	Amaranthaceae	Herb	Trop.America
16	*Chamaecrista absus*(L). H.S. Irwin &Brneby	4172	Fabaceae	Herb	Trop.America
17	*Chloris barbata* Sw.	4218	Poaceae	Herb	Trop.America
18	*Chromolaena odorata* (L.) R.M King &H.Rob	4226	Asteraceae	Shrub	Trop.America
19	*Chrozophora rottleri* (Geis.) Sprl	4222	Euphorbiaceae	Herb	Trop.America
20	*Cleome gynandra* L.	4126	Cleomaceae	Herb	Trop.America
21	*Cleome viscosa* L.	4128	Cleomaceae	Herb	Trop.America
22	*Corchorus estuvans* L.	4143	Malvaceae	Herb	Trop.America
23	*Corchorus trilocularis* L.	4145	Malvaceae	Herb	Trop.Africa
24	*Croton bonplandianus* Baill.	4200	Euphorbiaceae	Herb	Temp.America
25	*Cryptostegia grandiflora Roxb. ex* R.Br.	4147	Apocynaceae	Herb	Madagascar
26	*Cuscuta reflexa* Roxb.	4148	Convolvulaceae	Herb	Meditararian
27	*Cyperus iria* L.	4225	Cyperaceae	Herb	Trop.America
28	*Datura innoxia* Mill.	4175	Solanaceae	Shrub	Trop.America
29	*Datura metel* L.	4176	Solanaceae	Shrub	Trop.America
30	*Dicliptera paniculata* (Forssk.) Brummitt	4210	Acanthaceae	Herb	Trop.America
31	*Digera muricata* (L.) Mart.	4055	Amaranthaceae	Herb	South west asia
32	*Dinebra retroflexa* (Vahl) Panz	4058	Poaceae	Herb	Trop.America
33	*Echhicornia crassipes* (Mart) Solms-Loub	4229	Pontederiaceae	Herb	Trop.America
34	*Echinochloa colona* (L.) Link.	4061	Poaceae	Herb	Trop.S.America
35	*Echinops echinatus* Roxb.	4063	Asteraceae	Herb	Afghanistan
36	*Eclipta prostrata* (L.) L..	4177	Asteraceae	Herb	Trop.America
37	*Euphorbia cyathophora* Murray	4149	Euphorbiaceae	Herb	Trop.America

38	*Euphorbia heterophylla* L.	4151	Euphorbiaceae	Herb	Trop.America
39	*Euphorbia hirta* L.	4153	Euphorbiaceae	Herb	Trop.America
40	*Euphorbia indica* Lam	4103	Euphorbiaceae	Herb	Trop.S.America
41	*Evolvulus nummularius* (L.) L.	4105	Convolvulaceae	Herb	Trop.America
42	*Galinsoga parviflora* Cav.	4201	Asteraceae	Herb	Trop.America
43	*Gomphrena serrata* L.	4154	Amaranthaceae	Herb	Trop.America
44	*Impatiens balsamina* L.	4065	Balsaminaceae	Herb	Trop.America
45	*Imperata cylindrica* (L.) Raeusch.	4156	Poaceae	Herb	Trop.America
46	*Indigoera linnaei* Ali	4068	Fabaceae	Herb	Trop.America
47	*Indigofera linifolia* (L.f.) Retz	4107	Fabaceae	Herb	Trop.America
48	*Indigofera trita* L.f.	4180	Fabaceae	Herb	Trop.Africa
49	*Ipomea fistulosa* Mart ex ChiocyJacq.	4109	Convolvulaceae	Shrub	Trop.America
50	*Ipomea hederifolia* L.	4181	Convolvulaceae	Herb	Trop.America
51	*Ipomea obscura* L..	4183	Convolvulaceae	Herb	Trop.Africa
52	*Ipomea pestigridis* L.	4186	Convolvulaceae	Herb	Trop..Africa
53	*Ipomea quamoclit* L.	4159	Convolvulaceae	Herb	Trop.Africa
54	*Lantana camara* L.	4110	Verbenaceae	Shrub	Trop.America
55	*Legascea mollis* Cav	4213	Asteraceae	Herb	Trop.America
56	*Leonotis nepetifolia* (L.)R.Br	4187	Lamiaceae	Herb	Trop.Africa
57	*Leucaena leucocephala* (Lam.)de Wit	4230	Fabaceae	Tree	Trop.America
58	*Ludwigia adsendens* (L.)H. Hara	4112	Onagraceae	Herb	Trop.America
59	*Ludwigia perennis* L.	4160	Onagraceae	Herb	Trop.Africa
60	*Malachra capitata* (L.) L.	4161	Malvaceae	Herb	Trop.America
61	*Malvastrum coromandelianum* (L.) Garcke	4163	Malvaceae	Herb	Trop.America
62	*Martynia annua* L.	4130	Pedaliaceae	Herb	Trop.America
63	*Mecardonia procumbens* (Mill.)Small	4203	Plantaginaceae	Herb	Trop.N.America
64	*Merremia aegyptia* (L.) Urban	4207	Convolvulaceae	Herb	Trop.America
65	*Mesosphaerum suaveolens* (L.)Kuntze.	4179	Lamiaceae	Herb	Trop.America
66	*Mimosa pudica* L.	4071	Fabaceae	Herb	Brazil
67	*Mirabilis jalapa* L.	4131	Nyctaginaceae	Herb	Peru
68	*Ocimum americanum* L.	4164	Lamiaceae	Herb	Trop.America
69	*Oxalis corniculata* L.	4189	Oxalidaceae	Herb	Europe
70	*Parthenium hysterophorus* L.	4079	Asteraceae	Herb	Trop.America
71	*Passiflora foetida* L.	4081	Passifloraceae	Climber	South.America
72	*Pennisetum purpureum* Schum.	4208	Poaceae	Herb	Trop.America
73	*Physalis angulata* L.	4090	Solanaceae	Herb	Trop.America
74	*Physalis pruinosa* L.	4165	Solanaceae	Herb	Trop.America
75	*Pistia stratiotes* L.	4133	Araceae	Herb	Trop.America
76	*Portulaca oleracea* L.	4233	Portulacaceae	Herb	Trop.America
77	*Portulaca quadrifida* L.	4192	Portulacaceae	Herb	Trop.America
78	*Prosopis juliflora* (Sw.)DC.	4113	Fabaceae	Tree	Mexico
79	*Ruellia tuberosa* L.	4115	Acanthaceae	Herb	Trop.America
80	*Scoparia dulcis* L.	4117	Plantaginaceae	Herb	Trop.America
81	*Senna alata* (L).Roxb.	4124	Fabaceae	Shrub	West indies
82	*Senna hirsuta* (L). H.S. Irwin &Brneby	4099	Fabaceae	Herb	Trop.America
83	*Senna occidentalis* (L).Link.	4101	Fabaceae	Herb	Trop.S.America
84	*Senna* tora (L.) Roxb.	4123	Fabaceae	Herb	Trop.S.America
85	*Senna uniflora* (Mill). H.S. Irwin &Brneby	*4141*	Fabaceae	Herb	Trop.S.America
86	*Sida acuta* Burm.f.	4083	Malvaceae	Herb	Trop.America
87	*Solanum americanum* Mill.	4085	Solanaceae	Herb	Meditararian
88	*Solanum torvum* Sw.	4193	Solanaceae	Herb	Meditararian
89	*Spermacoce hispida* L.	4196	Rubiaceae	Herb	Trop.America
90	*Stachytarpheta jamaicensis* (L.)Vahl	4134	Verbenaceae	Herb	Trop.America
91	*Tribulus terrestris*L.	4211	Zygophyllaceae	Herb	Trop.America
92	*Tridax procumbens* L.	4087	Asteraceae	Herb	Trop.America
93	*Turnera subulata* J.E.Smith.	4088	Passifloraceae	Herb	Trop.America
94	*Turnera ulmifolia* L.	4090	Passifloraceae	Herb	Trop.America
95	*Typha domingensis*.Pers.	4168	Typhaceae	Herb	Trop.America
96	*Urena lobata* L.	4118	Malvaceae	Shrub	Trop.Africa
97	*Xanthium strumarium* L.	4120	Asteraceae	Herb	Trop.America

3.1 Habit wise analysis

Habit wise analysis of invasive plant species in Warangal city shows that 75% species belong to herbs, 9% species belongs to shrubs, 3% species trees, and 2% species climbers (Figure-2). Habit wise analysis clearly indicates that herbaceous members are aggressive invasive plant species of city. Habit wise analysis showed predominance of herbaceous nature of invasive plants contributing about 151 species of invasive alien species in India.[21]

3.2 *Family-wise analysis*

Among the identified invasive plant species Fabaceae was the dominant family representing with maximum number of species13, followed by Asteraceae with 12 species, Convolvulaceae with 8 species, Malvaceae, Solanaceae, Euphorbiaceae with 6 each, Poaceae with 5, Apocyanaceae with 4, Lamiaceae, Passifloraceae with 3 each, Portulacaceae, Acanthaceae, Cleomaceae, Onagraceae, Verbinaceae and Plantaginaceae with 2 each species each and remaining all families are with only one species each (Table.2) Only 7 families are contributing about 55% of total identified invasive plant species. Results are correlated with invasive plant assessment in urban ecosystem of Visakhapatnam, where Fabaceae was the dominant family.[15] Suthari et *al* [22]reported 74 invasive alien flora of Asteraceae in Telangana and residual Andhra Pradesh. Asteraceae was the dominant family with 33 plants species of invasive alien species in India,[21]with 15 plant species in Jhabua district, Madhya Pradesh, India,[23]and Boluvampatti forest Range, Southern Western Ghats, India.[24]

3.3 *Nativity analysis*

The contribution of different nativity of invasive plant species is shown in Table-3. Total 14 geographical areas are recorded. Most of them are from tropical American in origin (70%) and followed by tropical Africa (9.27%), Trop.S.America (5.82%) and remaining regions contributing 3% and below. Results are correlated with the results of invasive alien species in India.[21]and Invasive alien species of terrestrial vegetation of North-Eastern Uttar Pradesh.[25]

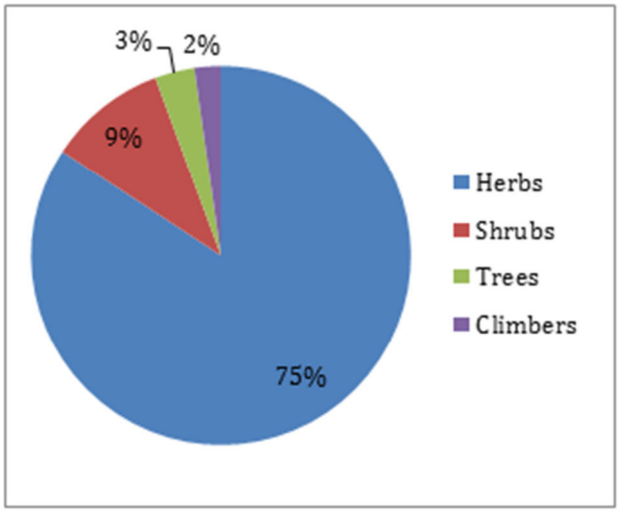

Fig.2 Graphical representation of habit wise distribution of invasive plant species in Warangal city

Table 2. Family wise distribution of invasive plant species in Tricities of Warangal urban

S.No	Family	No. of species
01	Fabaceae	13
02	Asteraceae	12
03	Convolvulaceae	08
04	Amaranthaceae, Euphorbiaceae Solanaceae,Malvaceae	06
05	Poaceae	05
06	Apocyanaceae,	04
07	Passifloraceae, Lamiaceae	03
08	Acanthaceae,Onagraceae, Portulacaceae, Verbenaceae,Cleomaceae, Plantaginaceae	02
09	All other families	01

Table 3. Nativity of invasive plant species found in Warangal city

S.No.	Native region	Number of species
01	Trop.America	68
02	Trop.Africa	09
03	Trop.S.America	06
04	South America	02
05	Trop.N.America	01

06	Peru	01
07	Brazil	01
08	Madagascar	01
09	Meditararian	03
10	Afghanistan	01
11	Europe	01
12	West indies	01
13	Mexico	01
14	South west Asia	01

In the present study, the distribution of most of the invasive plant species are noticed all over in Warangal city. Aggressive colonization of exotic plants such as *Senna uniflora, Mesosphaerum suaveolens, Alternanthera ficoidea*, *Prosopi sjuliflora, Parthenium hysterophorus, Turnera subulata* (Figure-3) are mainly noticed in open plot areas, along roadsides in colonies, along main roads, along lake bunds of city. *Typha domingensis, Eichhornia crassipes* (Figure-3) are aggressive in main water bodies, open marshy areas and in sewage canals. This aggressive distribution of invasive species was due to accelerated growth of native soil pathogens by invasive plant species, thus inhibits the growth of native flora as reported by Mangla *et al.*[26] *Sida acuta, Ludwigia perennis, Chromolaena odorata, Lantana camara* are showing less distribution. Suthari *et al*[27] recorded intrusion of *Chromolaena odorata* in Eturunagaram (Warangal dist), and Kinnerasani wildlife sanctuaries(Khammam dist) and now spreading of this plant species is noticed in the study area. They may become aggressive in future in study area. Mack [28] opined that invasive plant list of an area should prepare for prediction of future aggressive colonizers.

Many of invasive plant species are being utilized by local people in many ways. The best example is *Borassus flabellifer*. The phloem sap (Toddy) of this plant consumed by local people as it possess nutritional values. Leaves of *Eclipta prostata, Digera muricata,* flowers of *Senna tora* using as food. Some invasive plants are used as medicinal plants. *Tridax procumbens* for wounds, skin diseases, *Tribulus terrestis* for stones in bladder, skin diseases, *Mimosa pudica* for fever, constipation, *Euphorbia hirta* for jaundice. *Prosopis juliflora, Leucena leucocephala* as fuel wood, *Ipomia fistulosa* stems for making baskets. *Eichhornia crassipes* is used for preparation of various products like paper and frabrics.[29]*Alternanthera philoxeroides* used for phytoremediation in areas polluted with heavy metals.[30] Recent researches indicated that most of the invasive plants are investigated for their potential uses. Nwinuka *et* al[31] reported nutritional and medicinal values of *Chromolena odorata* enable it to use in better way. Vaisak and Anima pandey[32] reviewed its uses in traditional medicine. Ngozi et al[33] reviewed phytochemistry and medicinal uses and pharmacognostic properties of *Mesosphaerum suaveolens,* to proving it use in many ways. *Lantana camara* is known for its allelopathy, toxicity, trigger forest fires, besides this negative impacts Negi *et al* [34] highlighted its uses in biomass production, soil and water conservation, substituent for use as bio-energy and for insect resistant property. Pitchaiya *et al*[35] extracted porous graphitic carbon material from the biochar of *Echhironia crassipes* to prepare Perovskite Photovoltaic devices at low cost. Pandey *et al*[36] by taking 4 invasive plant species i.e. *Saccharum spontaneum, Prosopis juliflora, Typha latifolia* and *Ipomoea carnea* screened for their physiological tolerances in harsh fly ash deposits. Their research provides information to successful use of invasive plant species for their effective management and phyto restoration of fly ash dumps. Many invasive plants yet to be investigated for their phyto chemical properties to utilize in proper way. It is observed that growth of some indigenous medicinal plants like *Leucas biflora, Andrographis paniculata,* declined as a result of extensive growth of *Senna uniflora, Mesosphaerum suaveolens, Parthenium hysterophorus* in lake bunds of Warangal city. Similar results were observed by singh *et al*[37] Locals inhabiting out skirts of city use for live stock. The availability of fodder grass was declined as most of the open areas, open fields invaded by invasive plant species. The most noxious weed *Parthenium hysterophorus* causing allergic respiratory problems, contact dermatitis in people and live stock. Its allelopathic nature restricting the growth of other plants. Kato-Noguchi[38] reported that phytotoxic, allopathic substances isolated from the extractions of *Tithonia diversifolia* inhibits the germination and growth of neighbouring plants. Aggressive growth of aquatic invasive plants especially *Eichhornia crassipes*, *Typha domingensis, Ipomea carnea* in fresh water bodies and canals, leading to interruption of water flow and soil accumulation, which leads to shallow of fresh water bodies thus reducing the water retention capacity which supply water to Warangal city.. Aggressive growth of aquatic invasive plants in main sewage canals interrupting the flow of sewage water, and also became breeding sites for mosquitoes. Krajšek*et al*[39] suggested drying, composting are the best methods for disposal and to prevent the spread of 8 ornamental invasive plant species in Slovenia, which are propagated by means of vegetative propagation. For better management of invasive plants Huang and Asner[40]enumerated the application and limitations of remote sensing in monitoring the invasive alien species. Reddy [10] opined that species inventory, mapping, and remote sensing are useful for monitoring invasive plant species. To overcome challenges in identifying understory invasive plant species through traditional remote sensing technique, Dai et al [41] successfully utilized Land sat imagery, Spectral mixture analysis(SMA),and a maximum entropy (Maxent) modelling framework to map the spatial extent of *Mikania micrantha* in Chitwan National Park, Nepal. Identification of invasion hotspots is helpful to control and monitor the invasive species of an area. Adhikari *et al*[42] identified 47 eco regions and 4 hotspots in India for species through Ecological Niche Modeling.

a. Senna uniflora; b. Parthenium hysterophorus; c..Alternanthera ficoidea; d .Prosopis juliflora; e.Turnera subulata; f. Mesosphaerum suaveolens; g.Typha domingensis; h. Eichhornia crassipes

Fig 3. Aggressive colonization of Invasive plant species in Warangal city

4. CONCLUSION

Invasive plant species adversely affects the urban ecosystem and aesthetics of the city, even though some invasive plants are being utilized by the local people for various purposes i.e. *prosopis juliflora* using as fuel and to prevent soil erosion near water bodies. *Tribulus terrestris, Cleome viscosa, C.gynandra*, *Argemone mexicana, Senna occidentalis* etc being used in indigenous medicine. *Eichhornia crassipes* can be used in preparation of various products like paper, fabrics and sanitary napkins. Some invasive plant species i.e. *Alternanthera philoxeroides* is also used in phytoremediation in industrially polluted areas in Warangal city. Thus conservation biologists, researchers, and Greater Warangal Municipal Corporation officials should urgently look into distribution of exotic plant species, to prevent the loss of phyto-diversity of this area, to minimize their adverse effects and also for proper management of invasive plant species.

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6. AUTHORS CONTRIBUTION STATEMENT

Saritha Kommidi formulates the present idea, planned and performed the present study. Thirupathi Koppula developed the theory and carried out computational work. Sravanthi Yatla supported Saritha and Thirupathi for writing the manuscript. Mustafa Mohammed motivated to investigate the present study and supervised the findings of the research work. All authors discussed the results and equivalently contributed to the final manuscript.

7. CONFLICT OF INTEREST

Conflict of interest declared none.

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