



## Diversity and distribution of exotic and alien plant species in Angul district of Odisha, India

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### ABSTRACT

An exhaustive floristic survey was carried out during 2013-2015 in the Angul district of Odisha state to assess the diversity and distribution of exotic and alien plant species. The study revealed the occurrence a total of 124 species of flowering plants belonging to 92 genera under 42 families. Of these, trees, shrubs, climbers and herbs are represented by 2, 14, 3 and 105 species respectively. Asteraceae was the most speciose family with 20 species followed by Amaranthaceae (9 spp.), Convolvulaceae (7 spp.), Euphorbiaceae (7 spp.), Caesalpinaceae (7 spp.) and Fabaceae (7 spp.). *Chromolaena odorata*, *Hyptis suaveolens*, *Parthenium hysterophorus*, *Alternanthera philoxeroides*, *Eichhornia crassipes* and *Lantana camara* were found to be the most dominant and aggressive alien weeds of the district. Most of the exotics and alien weeds reported from the district were found to be native of Tropical America, and Tropical Africa and only few from the Asiatic region.

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### 1. Introduction

Invasive alien plant species are the species whose introduction or spread threatens the environment, the economy of society, human health and biodiversity of a region. Biological invasions by alien species are widely recognized as a significant component of human caused global environmental change which results a significant loss in the economic value, biological diversity and change in the functioning of invaded ecosystem beyond its home range that establishes, naturalizes and spreads (Williamson, 1996). Introduction of these species may occur accidentally or through their being imported for a limited purpose and subsequently escaping or deliberately on a large scale (Levine, 1989). Many people introduce exotic species into new habitats for economic reasons (McNealy, 2001) and most cases of invasiveness can be linked to the intended or unintended consequences of economic activities. In many continental areas 20% or more of the plant species are now non-indigenous. On many islands the proportion of non-

indigenous plant species is 50% or more (Randall and Marinelli, 1997). Invasive alien plants are a problem of global significance, causing impacts running into billions of dollars annually. In South Africa, at least 161 species cause serious problems in natural and semi-natural systems (Henderson, 1995); these plants may spread and come to dominate large areas in just a few years. The loss due to invasive species in United States estimated to be ~\$125-150 billion each year and 25% of U.S agriculture gross national product is lost due to foreign pests and weeds (McNeely et al., 2001). Exotic plants can spread rapidly because of our mobile society and the intentional transportation of ornamental and forage plants (Randall and Marinelli, 1997).

India is a biodiversity rich country with different climate, soil, topography and vegetation which encourages different alien plants to proliferate extensively. Inventory of exotics and invasive alien plants of India has been done by several workers in different parts of the country (Reddy, 2008; Wagh & Jain, 2015; Chandrasekhar, 2012; Singh and

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Mahammed, 2015). In Odisha, 131 species of alien plant species have been identified in Dhenkanal district of Odisha (Nayak and Satapathy, 2015) and 80 from Utkal University campus, Bhubaneswar (Satapathy *et al.*, 2016). In the present study, an account of 124 species of alien plant species of Angul district of Odisha belonging to 92 genera and under 42 families has been provided.

## 2. Materials and methods

### 2.1 Study area

Angul, a centrally located district in the state of Odisha, covers a geographical area of 6232 sq. km and lies between 20° 31' N and 20° 40' N Latitude and 84° 15' E and 85° 23' E Longitude. The climate of the Angul district is hot and dry sub-humid type with an average annual rainfall of 1696 mm. The average minimum and maximum temperatures are 19.6°C and 33.3°C respectively. The relative humidity generally varies from 31 to 88%. The forest coverage of the district is 3336.63 sq. km. (<http://angul.nic.in/>)

### 2.2 Methods

The present study was conducted in Angul district during 2013-15 to document the diversity and distribution of exotic and alien plant species including invasive ones. Interaction with local inhabitants was made to collect information regarding the uses of these Invasive Alien plant Species (IAPS) by them. Plant samples were collected and photographed from their natural habitats including agricultural lands, wetlands, roadside and forest areas of the district and identified in consultation with “The Flora of Orissa” (Saxena and Brahmam, 1994-1996) and other available literature. Collected plant specimens were preserved as herbarium specimens following standard field and herbarium methods in the Herbarium of the Post Graduate Department of Botany, Utkal University, Bhubaneswar.

Review of literature on invasive and alien plant species throughout the world (Mooney and Drake, 1987; Heywood, 1989; Cox, 1999; D’Antonio and Vitousek, 1992; Drake *et al.*, 1989; Huxel, 1999; Mooney, 1999; Almeilla and Freitas, 2001; Cowie, 2001; McNeely *et al.*, 2001; Reddy *et al.*, 2008) was helpful to throw light on the history of invasion, spread and harmful effects of alien weeds especially those occurring in Angul district of Odisha. The country of origin of the species were determined based on the work of Vavilov (1951), Matthew (1969), Maheswari and Paul (1975), Nayar (1977), Hajra and Das (1982), Sharma (1984), Saxena (1984), Reddy and Raju (2002) and Reddy, and Reddy (2004).

## 3. Results and Discussion

The exhaustive floristic survey of Angul district revealed the occurrence of 124 invasive alien plant species belonging to 92 genera and under 42 families. Habit-wise analysis revealed that the herbs were represented by 105 species (84.6%) followed by shrubs (14), climbers (03) and trees (02) (Table 2 & Figure-1). Among the 42 families, Asteraceae was the dominant family with 20 (47.6%) species followed by Amaranthaceae (09), Convolvulaceae (07), Euphorbiaceae (07), Caesalpinaceae (07), Fabaceae (07), Poaceae (05), Solanaceae (05), Cleomaceae (04), Mimosaceae (03), Asclepiadaceae (03), Cyperaceae (03), Lamiaceae (03), Malvaceae (03), Tiliaceae (02) etc. These top fifteen families contributed 90 species which is 72.58% of the total species listed. The genus *Cassia* has the maximum number of species (7) followed by *Ipomoea* (6 species), *Alternanthera* (4 species), *Cleome* (4 species), and *Ludwigia* (3 species) (Table-1). The most invasive and troublesome species recorded from the district were *Chromolaena odorata*, *Hyptis suaveolens*, *Parthenium hysterophorus*, *Alternanthera philoxeroides*, *Eichhornia crassipes* and *Lantana camara*. The Invasive Alien Plant Species (IAPS) of Angul district were found growing in all kinds of ecosystems like forests, agricultural fields, waste and fallow lands, gardens and road-sides. It was also noted that more than half of alien plant species are growing luxuriantly, spreading rapidly and getting naturalized to newer areas and habitats.

Out of the 124 species now listed, 27 were identified as invasive weeds of wetland habitats including *Aeschynomene americana*, *Alternanthera paronychioides*, *Alternanthera philoxeroides*, *Cassia alata*, *Cyperus difformis*, *Cyperus iria*, *Echinochloa colona*, *Echinochloa crusgalli.*, *Eclipta prostrata.*, *Eichhornia crassipes*, *Gnaphalium polycaulon*, *Grangea maderaspatana*, *Ipomoea carnea*, *Ludwigia adscendes*, *Ludwigia octovlavis*, *Ludwigia perennis*, *Monochoria vaginalis*, *Pistia stratiotes*, *Salvinia molesta* *Sesbania bispinosa* and *Typha angustata* (Table-1). Similarly, aliens like *Lantana camara*, *Chromolaena odorata*, *Parthenium hysterophorus*, *Alternanthera* species etc. have invaded the forest floors and wastelands badly affecting the growth of indigenous species. It was observed that fast growing exotic trees like *Acacia auriculiformis*, *Cassia siamea*, *Acacia mangium*, *Grevillea pteridifolia* etc. have been introduced in the locality to meet the increasing demand of firewood or as avenue plants.

Analysis of relevant literature on country of origin and distribution of alien plant species of Angul district, it is observed that that maximum number of species were from tropical America and tropical Africa (Table-2). These alien

Table 1

List of invasive alien plants of Angul district, Odisha

| S.N. | Species  | Family         | Habit   | Nativity                      |
|------|--|----------------|---------|-------------------------------|
| 1.   | <i>Acanthospermum hispidum</i> DC.                   | Asteraceae     | Herb    | Brazil                        |
| 2.   | <i>Aerva javanica</i> (Burm.f.) Juss. ex Schult.     | Amaranthaceae  | Herb    | Trop. America                 |
| 3.   | <i>Aeschynomene americana</i> L.                     | Fabaceae       | Herb    | Trop. America                 |
| 4.   | <i>Ageratum conyzoides</i> L.                        | Asteraceae     | Herb    | Trop. America                 |
| 5.   | <i>Alternanthera paronychioides</i> St. Hill         | Amaranthaceae  | Herb    | Trop. America                 |
| 6.   | <i>Alternanthera philoxeroides</i> (Mart.) Griseb.   | Amaranthaceae  | Herb    | Trop. America                 |
| 7.   | <i>Alternanthera pungens</i> Kunth                   | Amaranthaceae  | Herb    | Trop. America                 |
| 8.   | <i>Alternanthera sessilis</i> (L.) DC.               | Amaranthaceae  | Herb    | Trop. America                 |
| 9.   | <i>Amaranthus spinosus</i> L.                        | Amaranthaceae  | Herb    | Trop. America                 |
| 10.  | <i>Antigonon leptopus</i> Hook. & Arn.               | Polygonaceae   | Climber | Trop. America                 |
| 11.  | <i>Argemone mexicana</i> L.                          | Papaveraceae   | Herb    | Trop. Central & South America |
| 12.  | <i>Bidens pilosa</i> L.                              | Asteraceae     | Herb    | Trop. America                 |
| 13.  | <i>Blainvillea acmella</i> (L.) Philipson            | Asteraceae     | Herb    | Trop. America                 |
| 14.  | <i>Blumea lacera</i> (Burm. f.) DC.                  | Asteraceae     | Herb    | Trop. America                 |
| 15.  | <i>Blumea obliqua</i> (L.) Druce                     | Asteraceae     | Herb    | Trop. America                 |
| 16.  | <i>Borassus flabellifer</i> L.                       | Arecaceae      | Tree    | Trop. Africa                  |
| 17.  | <i>Calotropis gigantea</i> R. Br.                    | Asclepiadaceae | Shrub   | Trop. Africa                  |
| 18.  | <i>Calotropis procera</i> (Ait.) R. Br.              | Asclepiadaceae | Shrub   | Trop. Africa                  |
| 19.  | <i>Cannabis sativa</i> L.                            | Cannabaceae    | Herb    | Central Asia                  |
| 20.  | <i>Cardiospermum halicacabum</i> L.                  | Sapindaceae    | Climber | Trop. America                 |
| 21.  | <i>Cassia absus</i> L.                               | Caesalpiaceae  | Herb    | Trop. America                 |
| 22.  | <i>Cassia alata</i> L.                               | Caesalpiaceae  | Shrub   | West Indies                   |
| 23.  | <i>Cassia hirsuta</i> L.                             | Caesalpiaceae  | Herb    | Trop. America                 |
| 24.  | <i>Cassia obtusifolia</i> L.                         | Caesalpiaceae  | Herb    | Trop. America                 |
| 25.  | <i>Cassia pumila</i> Lam.                            | Caesalpiaceae  | Herb    | Trop. America                 |
| 27.  | <i>Cassia tora</i> L.                                | Caesalpiaceae  | Herb    | Trop. South America           |
| 28.  | <i>Catharanthus pusillus</i> (Murr.) G. Don          | Apocynaceae    | Herb    | Trop. America                 |
| 29.  | <i>Celosia argentea</i> L.                           | Amaranthaceae  | Herb    | Trop. Africa                  |
| 30.  | <i>Chenopodium album</i> L.                          | Chenopodiaceae | Herb    | Europe                        |
| 31.  | <i>Chloris barbata</i> Sw.                           | Poaceae        | Herb    | Trop. America                 |
| 32.  | <i>Chromolaena odorata</i> (L.) King & Robins.       | Asteraceae     | Herb    | Trop. America                 |
| 33.  | <i>Chrozophora rotterli</i> (Geis.) Juss. ex Spreng. | Euphorbiaceae  | Herb    | Trop. Africa                  |
| 34.  | <i>Cleome gynandra</i> L.                            | Cleomaceae     | Herb    | Trop. America                 |
| 35.  | <i>Cleome monophylla</i> L.                          | Cleomaceae     | Herb    | Trop. Africa                  |
| 36.  | <i>Cleome rutidosperma</i> DC.                       | Cleomaceae     | Herb    | Trop. America                 |
| 37.  | <i>Cleome viscosa</i> L.                             | Cleomaceae     | Herb    | Trop. America                 |
| 38.  | <i>Conyza bipinnatifida</i> Wall.                    | Asteraceae     | Herb    | Trop. America                 |
| 39.  | <i>Corchorus aestuans</i> L.                         | Tiliaceae      | Herb    | Trop. America                 |
| 40.  | <i>Crotalaria pallida</i> Ait.                       | Fabaceae       | Herb    | Trop. America                 |

|     |  |                |       |                         |
|-----|--|----------------|-------|-------------------------|
| 41. | <i>Crotalaria retusa</i> L.                | Fabaceae       | Herb  | Trop. America           |
| 42. | <i>Croton bonplandianum</i> Baill.         | Euphorbiaceae  | Herb  | Temperate South America |
| 43. | <i>Cryptostegia grandiflora</i> R.Br.      | Asclepiadaceae | Herb  | Madagascar              |
| 44. | <i>Cuscuta chinensis</i> Lam.              | Cuscutaceae    | Herb  | Mediterranean           |
| 45. | <i>Cuscuta reflexa</i> Roxb.               | Cuscutaceae    | Herb  | Mediterranean           |
| 46. | <i>Cynodon dactylon</i> (L.) Pers.         | Poaceae        | Herb  | Trop. Africa            |
| 47. | <i>Cyperus difformis</i> L.                | Cyperaceae     | Herb  | Trop. America           |
| 48. | <i>Cyperus iria</i> L.                     | Cyperaceae     | Herb  | Trop. America           |
| 49. | <i>Datura innoxia</i> Mill.                | Solanaceae     | Shrub | Trop. America           |
| 50. | <i>Datura metel</i> L.                     | Solanaceae     | Shrub | Trop. America           |
| 51. | <i>Digera muricata</i> (L.) Mart.          | Amaranthaceae  | Herb  | SW Asia                 |
| 52. | <i>Echinochloa colona</i> (L.) Link        | Poaceae        | Herb  | Trop. South America     |
| 53. | <i>Echinochloa crusgalli</i> (L.) Beauv.   | Poaceae        | Herb  | Trop. South America     |
| 54. | <i>Eclipta prostrata</i> (L.) Mant.        | Asteraceae     | Herb  | Trop. America           |
| 55. | <i>Eichhornia crassipes</i> (Mart.) Solms  | Pontederiaceae | Herb  | Trop. America           |
| 56. | <i>Emilia sonchifolia</i> (L.) DC.         | Asteraceae     | Herb  | Trop. America           |
| 57. | <i>Euphorbia heterophylla</i> L.           | Euphorbiaceae  | Herb  | Trop. America           |
| 58. | <i>Euphorbia hirta</i> L.                  | Euphorbiaceae  | Herb  | Trop. America           |
| 59. | <i>Evolvulus nummularius</i> (L.) L.       | Convolvulaceae | Herb  | Trop. America           |
| 60. | <i>Fuirena ciliaris</i> (L.) Roxb.         | Cyperaceae     | Herb  | Trop. America           |
| 61. | <i>Galinosoga parviflora</i> Cav.          | Asteraceae     | Herb  | Trop. America           |
| 62. | <i>Gnaphalium pensylvanicum</i> Willd.     | Asteraceae     | Herb  | Trop. America           |
| 63. | <i>Gnaphalium polycaulon</i> Pers.         | Asteraceae     | Herb  | Trop. America           |
| 64. | <i>Gomphrena serrata</i> L.                | Amaranthaceae  | Herb  | Trop. America           |
| 65. | <i>Grangea maderaspatana</i> (L.) Poir.    | Asteraceae     | Herb  | Trop. South America     |
| 66. | <i>Hyptis suaveolens</i> (L.) Poit.        | Lamiaceae      | Herb  | Trop. America           |
| 67. | <i>Impatiens balsamina</i> L.              | Balsaminaceae  | Herb  | Trop. America           |
| 68. | <i>Indigofera astragalina</i> DC.          | Fabaceae       | Herb  | Trop. America           |
| 69. | <i>Indigofera linnaei</i> Ali              | Fabaceae       | Herb  | Trop. Africa            |
| 70. | <i>Ipomoea carnea</i> Jacq.                | Convolvulaceae | Shrub | Trop. America           |
| 71. | <i>Ipomoea eriocarpa</i> R.Br.             | Convolvulaceae | Herb  | Trop. Africa            |
| 72. | <i>Ipomoea hederifolia</i> L.              | Convolvulaceae | Herb  | Trop. America           |
| 73. | <i>Ipomoea obscura</i> (L.) Ker-Gawl.      | Convolvulaceae | Herb  | Trop. America           |
| 74. | <i>Ipomoea pes-tigridis</i> L.             | Convolvulaceae | Herb  | Trop. East Africa       |
| 75. | <i>Ipomoea quamoclit</i> L.                | Convolvulaceae | Herb  | Trop. America           |
| 76. | <i>Jatropha curcas</i> L.                  | Euphorbiaceae  | Shrub | Trop. America           |
| 77. | <i>Jatropha gossypifolia</i> L.            | Euphorbiaceae  | Shrub | Brazil                  |
| 78. | <i>Lantana camara</i> L.                   | Verbenaceae    | Herb  | Trop. America           |
| 79. | <i>Leonotis nepetiifolia</i> (L.) R. Br.   | Lamiaceae      | Herb  | Trop. Africa            |
| 80. | <i>Leucaena leucocephala</i> (Lam.) de Wit | Mimosaceae     | Tree  | Trop. America           |
| 81. | <i>Ludwigia adscendes</i> (L.) Hara        | Onagraceae     | Herb  | Trop. America           |
| 82. | <i>Ludwigia octovlavis</i> (Jacq.) Raven   | Onagraceae     | Herb  | Trop. Africa            |

|      |   |                  |         |                       |
|------|---|------------------|---------|-----------------------|
| 83.  | <i>Ludwigia perennis</i> L.                   | Onagraceae       | Herb    | Trop. Africa          |
| 84.  | <i>Malachra capitata</i> (L.) L.              | Malvaceae        | Herb    | Trop. America         |
| 85.  | <i>Martynia annua</i> L.                      | Martyniaceae     | Herb    | Trop. America         |
| 86.  | <i>Mecardonia procumbens</i> (Mill.) Small    | Scrophulariaceae | Herb    | Trop. North America   |
| 87.  | <i>Melilotus alba</i> Desv.                   | Fabaceae         | Herb    | Europe                |
| 88.  | <i>Melochia corchorifolia</i> L.              | Sterculiaceae    | Herb    | Trop. America         |
| 89.  | <i>Mikania micrantha</i> Kunth                | Asteraceae       | Climber | Trop. America         |
| 90.  | <i>Mimosa pigra</i> L.                        | Mimosaceae       | Shrub   | Trop. North America   |
| 91.  | <i>Mimosa pudica</i> L.                       | Mimosaceae       | Herb    | Brazil                |
| 92.  | <i>Mirabilis jalapa</i> L.                    | Nyctaginaceae    | Herb    | Peru                  |
| 93.  | <i>Monochoria vaginalis</i> (Burm. f.) Presl. | Pontederiaceae   | Herb    | Trop. America         |
| 94.  | <i>Nicotiana plumbaginifolia</i> Viv.         | Solanaceae       | Herb    | Trop. America         |
| 95.  | <i>Ocimum canum</i> Sims                      | Lamiaceae        | Herb    | Trop. America         |
| 96.  | <i>Opuntia stricta</i> (Haw.) Haw.            | Cactaceae        | Herb    | Trop. America         |
| 97.  | <i>Oxalis corniculata</i> L.                  | Oxalidaceae      | Herb    | Europe                |
| 98.  | <i>Parthenium hysterophorus</i> L.            | Asteraceae       | Herb    | Trop. North America   |
| 99.  | <i>Passiflora foetida</i> L.                  | Passifloraceae   | Herb    | Trop. South America   |
| 100. | <i>Pedaliium murex</i> L.                     | Pedaliaceae      | Herb    | Trop. America         |
| 101. | <i>Peperomia pellucida</i> (L.) Kunth         | Piperaceae       | Herb    | Trop. South America   |
| 102. | <i>Pistia stratiotes</i> L.                   | Araceae          | Herb    | Trop. America         |
| 103. | <i>Portulaca oleracea</i> L.                  | Portulacaceae    | Herb    | Trop. South America   |
| 104. | <i>Portulaca quadrifida</i> L.                | Portulacaceae    | Herb    | Trop. America         |
| 105. | <i>Prosopis juliflora</i> (Sw.) DC.           | Mimosaceae       | Shrub   | Mexico                |
| 106. | <i>Ruellia tuberosa</i> L.                    | Acanthaceae      | Herb    | Trop. America         |
| 107. | <i>Saccharum spontaneum</i> L.                | Poaceae          | Herb    | Trop. West Asia       |
| 108. | <i>Salvinia molesta</i> D. S. Mitch.          | Salviniaceae     | Herb    | Brazil                |
| 109. | <i>Scoparia dulcis</i> L.                     | Scrophulariaceae | Herb    | Trop. America         |
| 110. | <i>Sesbania bispinosa</i> (Jacq.) Wight       | Fabaceae         | Shrub   | Trop. America         |
| 111. | <i>Sida acuta</i> Burm.f.                     | Malvaceae        | Herb    | Trop. America         |
| 112. | <i>Solanum torvum</i> Sw.                     | Solanaceae       | Shrub   | West Indies           |
| 113. | <i>Solanum viarum</i> Dunal                   | Solanaceae       | Herb    | Trop. America         |
| 114. | <i>Sonchus asper</i> Hill                     | Asteraceae       | Herb    | Mediterranean         |
| 115. | <i>Spermacoce hispida</i> L.                  | Rubiaceae        | Herb    | Trop. America         |
| 116. | <i>Stachytarpheta jamaicensis</i> (L.) Vahl   | Verbenaceae      | Herb    | Trop. America         |
| 117. | <i>Synadenium grantii</i> Hook. f.            | Euphorbiaceae    | Shrub   | Trop. America         |
| 118. | <i>Synedrella nodiflora</i> (L.) Gaertn.      | Asteraceae       | Herb    | West Indies           |
| 119. | <i>Tribulus terrestris</i> L.                 | Zygophyllaceae   | Herb    | Trop. America         |
| 120. | <i>Tridax procumbens</i> L.                   | Asteraceae       | Herb    | Trop. Central America |
| 121. | <i>Triumfetta rhomboidea</i> Jacq.            | Tiliaceae        | Herb    | Trop. America         |
| 122. | <i>Typha angustata</i> Bory. & Choub.         | Typhaceae        | Herb    | Trop. America         |
| 123. | <i>Urena lobata</i> L.                        | Malvaceae        | Shrub   | Trop. Africa          |
| 124. | <i>Xanthium indicum</i> L.                    | Asteraceae       | Herb    | Trop. America         |



Table 2

Regions of nativity of invasive alien plant species of Angul district

| Sl. No. | Region of Nativity             | No. of Species |
|---------|--------------------------------|----------------|
| 1.      | Tropical America               | 76             |
| 2.      | Tropical Africa                | 13             |
| 3.      | Tropical South America         | 08             |
| 4.      | Brazil                         | 04             |
| 5.      | Europe                         | 03             |
| 6.      | Tropical North America         | 03             |
| 7.      | West Indies                    | 03             |
| 8.      | Mediterranean                  | 03             |
| 9.      | Central America                | 01             |
| 10.     | Tropical Central South America | 01             |
| 11.     | Tropical East Africa           | 01             |
| 12.     | Peru                           | 01             |
| 13.     | Mexico                         | 01             |
| 14.     | Temperate South America        | 01             |
| 15.     | Madagascar                     | 01             |
| 16.     | West Asia                      | 01             |
| 17.     | South West Asia                | 01             |
| 18.     | Tropical West Asia             | 01             |
| 19.     | Central Asia                   | 01             |

Table 3

Habit-wise distribution of invasive alien plant species in Angul district of Odisha

| Sl. No. | Habit   | No. of Species |
|---------|---------|----------------|
| 1       | Herb    | 105            |
| 2       | Shrub   | 14             |
| 3       | Climber | 3              |
| 4       | Tree    | 2              |

species were mostly from Tropical America (76 spp.), Tropical Africa (13 spp.), Tropical South America (8 spp.), Brazil (4 spp.), Europe (3 spp.), Tropical north America (3 spp.), West Indies (3 spp.) and Mediterranean region (3 spp.). However, one species each was native to Tropical Central America, Mexico, Tropical Central South America, Tropical East Africa, Peru, Temperate South America, Madagascar, West Asia, South West Asia, Central Asia and Tropical West Asia. (Table-2)

#### 4. Conclusion

The invasive alien plant species of Angul district of Odisha pose great threat to the indigenous flora of the region. Due to their competitive advantage over native species in terms of seed dispersal and plant establishment, colonization in new and hostile habitats, ecological adaptability to a range of ecosystems and micro-climates, they have rapidly invaded

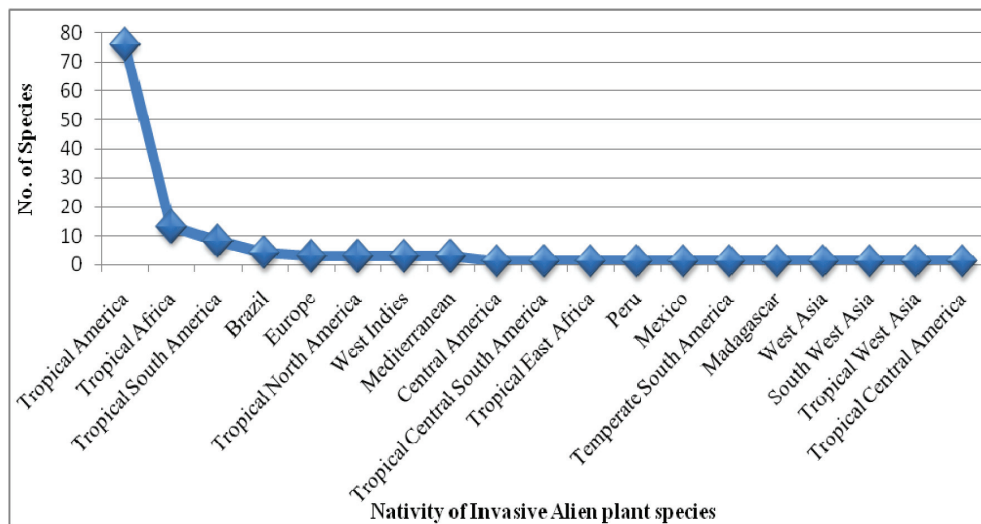


Fig. 1: Origin of invasive alien plants in Angul district of Odisha

the wastelands, crop fields, forest floors, village thickets, road sides and eliminated the native elements at several habitats. Weed invasion in agricultural fields is a matter of concern leading to considerable loss to the farmers in terms of requirement of additional manpower for weed control and reduction in crop productivity. However, many of the

alien species are economically important as source of food, feed, medicine and could be used as valuable resources. Importantly, the ecological impact of exotics and alien weeds on local biodiversity and human health need to be assessed at regional and national level.

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### References

- Almeida, I. D. and Freitas, H. (2001). The exotic and invasive flora of Portugal. *Bot Complutensis* 25: 317- 327.
- Chandrasekar, K. (2012). Invasive alien plants of Indian Himalayan region: Diversity and implication. *Amer. Journ. Plant Sci.* 3: 177-184.
- Cowie, R. (2001). Does the public care about species loss? A glimpse into the public's flunking. *Conservation Biology in Practice* 2(3): 28 -29.
- Cox, G. W. (1999). *Alien Species in North America and Hawaii: Impacts on Natural Ecosystems*. Island Press, Washington, D.C.
- D'Antonio, C. M. and Vitousek, P. M. (1992). Biological invasions by exotic grasses: the grass/fire cycle and global change. *Annual Review of Ecology and Systematics* 23: 63 – 87.
- Drake, J. A., Mooney, H. A., di Castri, F. H., Groves, F., Kruger, J., Rejmanek, M. and Williamson M. (1989). *Biological Invasion: A global Prospective*. John Wiley, Chichester, UK.
- Hajra, P. K. and Das, B. K. (1982). Vegetation of Gangtok with special reference to alien plants. *India Forums* 107: 554-566.
- Heywood, V. (1989). Patterns, extents and modes of invasions by terrestrial plants. *In: Biological Invasions: A Global Perspective* (Drake, J. *et al.* Ed.), Wiley, NY. pp. 31-60.
- Huxel, G. R. (1999). Rapid displacement of native species by invasive species: effect of hybridization. *Biological Conservation* 89:143-152.
- Levine, S. A. (1989). Analysis of risk for invasions and control program. *In: Biological Invasion: A Global Perspective*, SCOPE 37 ((Drake, J. *et al.* Ed.), John Wiley, Chichester, UK, pp. 425-435.
- Maheswari, J. K. and Paul, S. R. (1975). The exotic flora of Ranchi. *J. Bombay Nat. Hist. Soc.* 72(1): 158 – 188.
- Matthew, K. M. (1969). Exotic flora of Kodaikanal and Palni hills. *Rec. Bot. Surv. India* 20(1): 1-241.
- McNeely, J. A. (2001). Invasive species: a costly catastrophe for native biodiversity. *Land Use Water Resour. Res.* 1: 1–10.
- McNeely, J. A., Mooney, H. A., Neville, L. E., Schei, P. and Waage, J. K. (2001). *A Global Strategy on Invasive Alien Species*. IUCN Gland, Switzerland, and Cambridge, U.K.
- Mooney, H. A. and Drake, J. A. (1987). The ecology of biological invasions. *Environment* 29(5): 12.
- Mooney, H. A. (1999). A global strategy for dealing with alien invasive species: Invasive species and biodiversity management (Sandlund, O. T., Schei, P. J. & Viken, A. Ed.). Kluwer Academic Publishers, London.
- Nayak, S. K. and Satapathy K. B. (2015). Diversity, uses and origin of invasive alien plants in Dhenkanal district of Odisha, India. *Int. Res. Journ. Biol. Sci.* 4(2): 21-27.
- Nayar, M. P. (1977). Changing patterns of the Indian flora. *Bull. Bot. Surv. India* 19 (1-4) : 145-155.
- Randall, J. M. and Marinelli, J. (1997). *Invasive Plants: Weeds of the Global Garden*. Brooklyn Botanic Garden, Brooklyn, New York.
- Reddy, C. S. (2008). Catalogue of invasive alien flora of India. *Life Sci. Journ.* 5 (2): 84-89.
- Reddy, C. S. and Raju, V. S. (2002). Additions to the weed flora of Andhra Pradesh, India. *J. Econ. Taxon. Bot.* 26: 195 – 198.
- Reddy, C. S. and Reddy, K. N. (2004). *Cassia rotundifolia* Pers. (Caesalpiniaceae): a new record for India. *J. Econ. Tax. Bot.* 28:73-74.
- Reddy, C. S., Bagyanarayana, G., Reddy, K. N, and Raju, V. S. (2008). *Invasive Alien Flora of India*. National Biological Information Infrastructure, USGS, USA.
- Satapathy, K. B., Nayak, S. K., Mishra, R, Mahatwal, S. and Chand, P. K. (2016). A greenery report on Utkal University Campus, Vani Vihar, Bhubaneswar. UGC-HRDC, Utkal University, Bhubaneswar pp.55-58.
- Saxena, H. O. and Brahmam, M. (1996). *The Flora of Orissa*, Vol. I-IV. Orissa Forest Development Corporation and RRL, Bhubaneswar.
- Saxena, K. G. (1991). Biological invasion in the Indian sub-continent: Review of invasion by plants. *In: Ecology of biological invasion in the tropics* (P. S. Ramakrishnan Ed.), International Scientific Publications, New Delhi, pp. 53-73.
- Sharma, B. D. (1984). Exotic flora of Allahabad, Botanical Survey of India, Dehra Dun.
- Singh, A and Mohammed, I. (2015). Diversity of invasive alien plant species in district Yamuna Nagar of Haryana, India. *Biological Forum* 7(2): 1051-1056.
- Vavilov, N. I. (1951). The origin, variation, immunity and breeding of cultivated plants. *Chron. Bot.* 13:1–36.
- Wagh, V. V and Jain, A. K, (2015). Invasive alien flora of Jhabua district, Madhya Pradesh, India. *Int. Journ. Biodiv. Conserv.* 7(4): 227-237.
- Williamson, M. (1996). *Biological Invasions*. Chapman & Hall, London.