



Original Research Article

doi: <http://dx.doi.org/10.20546/ijcrbp.2016.303.012>

Diversity of Invasive Alien Plants in Soor Sarovar Bird Sanctuary (SSBS), Keetham, Agra, India

Vijay V. Wagh*

Plant Diversity Systematics and Herbarium Division, CSIR- National Botanical Research Institute, Lucknow- 226 001, Uttar Pradesh, India

*Corresponding author.

Abstract

Present study provides the comprehensive list of invasive alien plants of Soor Sarovar Bird Sanctuary, Keetham, Agra. In study area total of 76 species under 67 genera and 35 families have been found as invasive alien plant. Of total only 09 species have been found introduced intentionally, while the other species introduced unintentionally. In terms of nativity the majority of invasive plants reported from American continent (61%). The life form category shows that 56 species are herbs, 11 species of shrubs, 4 species of climbers, 4 species of trees and only one liana species. The invasive alien species possess serious threat to local biodiversity, effects crop production and human health. Therefore systematic study about the invasive plant species is required.

Article Info

Accepted: 04 March 2016

Available Online: 06 March 2016

Keywords

Biodiversity
Invasive plants
Soor Sarovar Bird Sanctuary
Threat

Introduction

Alien species are non-native or exotic organisms that occur outside their natural adapted ranges and dispersal potential (McGeoch et al., 2010). These invasive species are widely distributed in all kinds of ecosystems throughout the world and include all categories of living organisms. Nevertheless, plants, mammals, and insects comprise the most common types of invasive alien species in terrestrial environments (Raghubanshi et al., 2005). An important requirement for successful colonization of invaders is open habitat with reduced competition. Generally, the microsites created by grazing may be occupied by invader species (Singh, 1976; Sinha, 1976; Sawarker, 1984).

Invasive alien plant caused an impact worldwide (Mooney and Hobbs, 2000), there are still many regions such as Asia and Neighbouring region in the world where basic information on naturalized plant taxa and plant invasions is lacking (Corlett, 1988; Enmoto, 1999;

Meyer, 2000). Database establishment of naturalized species is the first step in the development of invasion biology, and will also serve as a stepping stone for further detailed studies on the biology and impact of individual species (Wu et al., 2004). Naturalization has been recognized as the first phase of biological invasions. A naturalized species is the species that can consistently reproduce and sustain populations over many generations without direct intervention by humans (Richardson et al., 2000; Pyšek et al., 2002). Many invasive plant species cause economic and/or environmental damage, and referred to as alien pests or weeds (Richardson et al., 2000).

In India Invasive alien plants became a issue of great concern that affects the local biodiversity of the country. These species were introduced in India accidentally or deliberately mostly for fodder and ornamental purpose. Due to its growing concern and harmful effects on the biodiversity several studies has been carried out in different regions of India out of that some important are,

impact of *Lantana camara* on the biodiversity of Melghat Tiger Reserve, Maharashtra by Sawarker (1984), Pandey and Parmar (1994) worked on the exotic flora of Rajasthan. Kshirsagar (2005) made a very interesting study on the origin, present status and distribution of exotic plants of South Gujarat, Alien flora of Doon valley has been done by Negi and Hajra (2007), Sekar (2012) made a comprehensive study on the invasive alien plants of Indian Himalayan region, Das and Durah (2013) worked on invasive alien plant of Jharkhand, Assam, Srivastava et al. (2014) and Wagh and Jain (2015) made study on the North Eastern Uttar Pradesh and Western Madhya Pradesh of India respectively.

From thorough literature survey it was found that the only study on floristic diversity and ethnomedicinal uses of plant of Soor Sarovar Bird Sanctuary was done by Rani et al. (2009). So far no comprehensive study on the diversity of invasive alien plants is conducted on this region. The present study would be helpful for the academicians, botanists and ecologists as basic information for future research towards conservation and management of the invasive alien plants of this region.

Materials and methods

Study site

A Keetham lake also known as Soor Sarovar National Bird Sanctuary which has been declared in 1991 Soor Sarovar Bird Sanctuary potential as a natural wonder has been recognised by the Uttar Pradesh forest department. Recently has been declared as National wetland in November 2007 by central forest and Ministry of environment (Gautam and Gautam, 2008). Keetham lake a place that ignited by passions of lord Krishna and Radha and inspired the famous poet Surdas to compose the Bhakti Kavya.

Soor Sarovar lake is located at a distance of 20 km from Agra city in Uttar Pradesh and a distance 180 Km from Delhi (Fig. 1). Keetham initially covering an area of 4.03 sq. kms has been expanded to an impressive area of 7.83 sq. kms. This pentagonal shaped lake's depth varies from 5m to 8m. Soor Sarovar "Keetham Lake" from the riverine belt of the Yamuna River. Keetham also has wild life conservation in form of bear rescue facility and python point as well. Further this lake is surrounded by different kinds of wild vegetations. During the field survey it was observed that the natural wild

vegetation is depleting day by day and in place *Prosopis juliflora* and *Lantana camara* are growing gregariously that posing a severe threat to the natural vegetation of Soor Sarovar Bird Sanctuary.

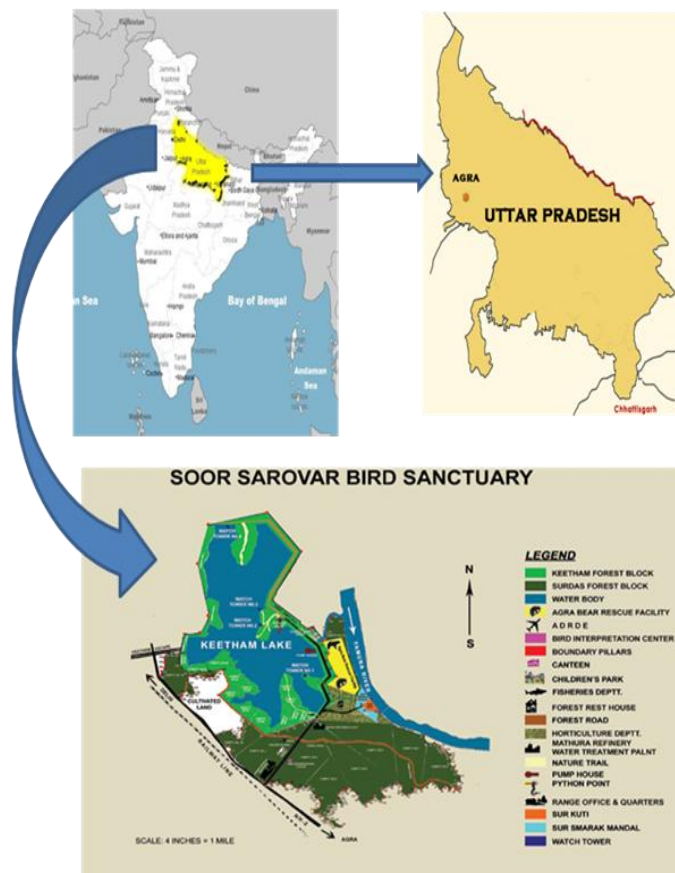


Fig. 1: Map of Soor Sarovar Bird Sanctuary.

Field survey and data collection

Extensive and intensive survey was undertaken for the collection of invasive alien plants in Soor Sarovar Bird Sanctuary during 2015. The collected specimens were processed for herbarium preparation by standard methods (Lawrence, 1951) and identified with the help of local floras and published literature (Hooker, 1822 - 1883; Cooke, 1901-1908; Duthie, 1903-1929; Gamble and Fisher, 1915-1936; Maheshwari, 1963; Verma et al., 1993; Khanna and Kumar, 2000; Khanna et al., 2001). The herbarium specimen was deposited in the herbarium of CSIR- National Botanical Research Institute, Lucknow. Information regarding nativity was collected from (Raghubanshi et al., 2005; Sujay et al., 2010; Singh, 1976; Sinha, 1976). The species are enumerated family wise alphabetically followed by botanical name, common name, life form, habitat, nativity, mode of introduction and categories.

Results and discussion

A total 76 species distributed in 67 genera and 35 families recorded as invasive alien in Soor Sarovar Bird Sanctuary, Keetham. The family Asteraceae is the most dominant family with 12 species followed by Euphorbiaceae (7 species) Convolvulaceae (6 species), Solanaceae (5 species), Amaranthaceae (4 species) and Malvaceae, Mimosaceae and Poaceae (3 species each) (Fig. 2). These dominant families contributed 41% of the alien invasive flora of the Soor Sarovar Bird Sanctuary, Keetham. The genera with the highest number of alien species are *Ipomoea* (4 species), *Alternanthera*, *Cassia*, *Chenopodium*, *Datura*, *Euphorbia* and *Jatropha* (2 species each) (Table 1). These top genera contributed 21% taxa of alien flora of SSBS. Life form category shows that 56 species of herbs, 11 species of shrubs, 4 species of climbers, 4 species of trees and only one species in liana category (Fig. 3).

A total 11 different geographic region in terms of nativity are recorded in the present study. Among these (89%) are contributed by the four major geographic region i.e., continent of America, Africa, Brazil and Europe. The American continent contributed majority (69%) while Africa (10%), Brazil and Europe (4% each). Of the total alien plant species in SSBS 45 species are judged as naturalized, 21 interfering and 10 noxious (Fig.4). The most alarming condition is the number of noxious species that are harmful to the natural species. Further some of these species are known to be highly allergic and causing diseases in human being (Saxena, 1991 and Tripathi, 1999). Only 9 species namely *Prosopis juliflora*, *Portulaca oleracea*, *Leucaena leucophloea*, *Lantana camara*, *Eichhornia crassipes*, *Duranta repens*, *Ageratum conyzoides*, *Chenopodium album* and *Celosia argentea* have been introduced deliberately and rest of them unintentionally through trade exchange including grain import.

Table 1. List of Invasive plant species found in Soor Sarovar Bird Sanctuary, Keetham, Agra, India.

Family	Botanical name	Common name	Collection number	Life form	Habitat	Nativity	Mode of introduction	Categories
Acanthaceae	<i>Peristrophe paniculata</i> (Forssk.) Brummitt	Panicled fold wing	258122	Herb	W	Tropical America	Ui	Interfering
	<i>Ruellia tuberosa</i> L.	Minnie root	258120	Herb	AR	Tropical America	Ui	Naturalized
Amaranthaceae	<i>Alternanthera sessilis</i> (L.) R.Br. ex DC.	Joy weed	258101	Herb	RB	Tropical America	Ui	Naturalized
	<i>Alternanthera philoxeroides</i> (Mart.) Griseb.	Alligator weed	258077	Herb	W	Tropical America	Ui	Naturalized
	<i>Celosia argentea</i> L.	Silver cock's comb	258104	Herb	CF	Tropical Africa	Fd	Naturalized
	<i>Gomphrena celosioides</i> Mart.	Bachelor's button	258125	Herb	CF	Tropical America	Ui	Naturalized
Apocynaceae	<i>Calotropis procera</i> (Aiton) R. Br.	Rubber bush	258092	Shrub	W	Tropical Africa	Ui	Interfering
Araceae	<i>Pistia stratiotes</i> L.	Water cabbage	258123	Herb		Tropical America	Ui	Naturalized
Arecaceae	<i>Borassus flabellifer</i> L.	Sugar palm	258130	Tree	W	Tropical Africa	Ui	Naturalized
Asclepiadaceae	<i>Cryptostegia grandiflora</i> R.Br.	Rubber vine	258134	Liana	CF	Madagascar	Ui	Interfering
Asteraceae	<i>Acanthospermum hispidum</i> DC.	Bristly starbur	258114	Herb	W	Brazil	Ui	Naturalized
	<i>Ageratum conyzoides</i> L.	Chick weed	258090	Herb	W	Tropical America	O	Noxious
	<i>Blumea obliqua</i> (L.) Druc	Clustered blumea	258118	Herb	W	Tropical America	Ui	Interfering
	<i>Echinops echinatus</i> Roxb.	Indian globe thistle	258103	Herb	W	Afghanistan	Ui	Naturalized
	<i>Eclipta prostrata</i> (L.) L.	False daisy	258140	Herb	AR	Tropical America	Ui	Naturalized
	<i>Lasagea mollis</i> Cav.	American softhead	258124	Herb	AR, CF	Tropical Cent. America	Ui	Noxious
	<i>Parthenium hysterophorus</i> L.	Congress weed	258106	Herb	W	Tropical North America	Ui	Noxious
	<i>Sonchus oleraceus</i> L.	Sow thistle	258152	Herb	RB	Mediterranean	Ui	Interfering
	<i>Synedrella nodiflora</i> (L.) Gaertn.	Node weed	258144	Herb	W, AR	West Indies	Ui	Naturalized

	<i>Tridax procumbens</i> L.	Coat button	258116	Herb	CF	Tropical Cent. America	Ui	Naturalized
	<i>Xanthium strumarium</i> L.	Common cocklebur	258143	Herb	AR	Tropical America	Ui	Noxious
	<i>Gnaphalium polycaulon</i> Pers.	Many stemmed cudweed	258105	Herb	W	Tropical America	Ui	Interfering
Cactaceae	<i>Opuntia elatior</i> Mill.	Prickly pear	258157	Shrub	AR, W	Tropical America	Ui	Noxious
Caesalpiniaceae	<i>Cassia occidentalis</i> L.	Coffee weed	258132	Shrub	W	Tropical South America	Ui	Naturalized
	<i>Cassia tora</i> L.	Sickle senna	258154	Herb	W	Tropical South America	Ui	Noxious
Capparidaceae	<i>Cleome viscosa</i> L.	Asian spider flower	258159	Herb	W	Tropical America	Ui	Naturalized
Chenopodiaceae	<i>Chenopodium album</i> L.	Goose foot	258100	Herb	CF	Europe	Fd	Interfering
	<i>Chenopodium murale</i> L.	Australian spinach	258086	Herb	CF, W	Tropical America	Ui	Naturalized
Convolvulaceae	<i>Convolvulus arvensis</i> L.	Field bind weed	258163	Herb	F, W	Europe	Ui	Naturalized
	<i>Evolvulus nummularius</i> (L.) L.	Round leaf bind weed	258156	Herb	W	Tropical America	Ui	Naturalized
	<i>Ipomoea carnea</i> Jacq.	Bush morning glory	258160	Shrub	W	Tropical America	Ui	Interfering
	<i>Ipomoea hederifolia</i> L.	Scarlet morning glory	258131	Climber	F	Tropical America	Ui	Interfering
	<i>Ipomoea nil</i> (L.) Roth	Ivy morning glory	258098	Climber	FE, W	North America	Ui	Interfering
	<i>Ipomoea pestigridis</i> L.	Tiger foot morning glory	258128	Climber	W	Tropical East Africa	Ui	Interfering
Cuscutaceae	<i>Cuscuta reflexa</i> Roxb.	Beggar weed	258062	Climber	P	Mediterranean	Ui	Interfering
Euphorbiaceae	<i>Ricinus communis</i> L.	Castor bean plant	258079	Tree	W, CF	Africa	Ui	Interfering
	<i>Croton bonpalindianus</i> Baill.	Rushfoil	258150	Herb	W	Temperate South America	Ui	Naturalized
	<i>Euphorbia heterophylla</i> L.	Fire plant	258161	Herb	CF	Tropical America	Ui	Naturalized
	<i>Euphorbia hirta</i> L.	Garden spruce	258102	Herb	CF	Tropical America	Ui	Naturalized
	<i>Jatropha curcas</i> L.	Bardados nut	258136	Shrub	AR, CF	Tropical America	Ui	Naturalized
	<i>Jatropha gossypifolia</i> L.	Black physicnut	258158	Shrub	AR	Brazil	Ui	Naturalized
	<i>Chrozophora rottleri</i> (Geiseler) A.Juss. ex Spreng.	Rottler's chrozophora	258119	Herb	W	Tropical		Interfering
Fabaceae	<i>Indigofera tinctoria</i> (L.) Retz.	Narrowleaf indigo	258126	Herb	AR	Tropical South America	Ui	Naturalized
Lamiaceae	<i>Hyptis suaveolens</i> (L.) Poit.	Chinese mint	258117	Herb	AR	Tropical America	Ui	Interfering
	<i>Ocimum americanum</i> L.	Common basil	258082	Herb	W	Tropical America	Ui	Naturalized
Liliaceae	<i>Asphodelus tenuifolius</i> Cav.	Onion weed	258127	Herb	A	Trop. America	Ui	Interfering
Malvaceae	<i>Malvastrum coromandelianum</i> (L.) Gar.	Broom weed	258094	Herb	W	Tropical America	Ui	Naturalized
	<i>Sida acuta</i> Burm. f.	Common wire weed	258091	Herb	W	Tropical America	Ui	Naturalized
	<i>Urena lobata</i> L.	Caesar weed	258149	Shrub	W	Tropical Africa	Ui	Interfering
Martyniaceae	<i>Martynia annua</i> L.	Devil's claw	258107	Herb	W	Tropical America	Ui	Naturalized
Mimosaceae	<i>Prosopis juliflora</i> (Swartz) DC.	Mesquite	258108	Tree	W	Mexico	Af	Naturalized
	<i>Leucaena leucocephala</i> (Lamk.) de Wit	White popinac	258109	Tree	W	Tropical America	Fo	Noxious
	<i>Mimosa pudica</i> L.	Touch-me-not	258155	Herb	F	Brazil	Ui	Naturalized

Onagraceae	<i>Ludwigia octovalvis</i> (Jacq.) Raven	Mexican primrose willow	258148	Herb	RB	Tropical America	Ui	Naturalized
Oxalidaceae	<i>Oxalis corniculata</i> L.	Indian sorrel	258095	Herb	CF	Europe	Ui	Naturalized
Papaveraceae	<i>Argemone mexicana</i> L.	Mexican poppy	258099	Herb	W	Tropical South America	Ui	Noxious
Piperaceae	<i>Peperomia pellucida</i> (L.) Kunth	State pencil plant	258139	Herb	AR	Tropical South America	Ui	Naturalized
Poaceae	<i>Chloris barbata</i> Sw.	Swollen mind mill grass	258080	Herb	W	Tropical America	Ui	Naturalized
	<i>Cynodon dactylon</i> (L.) Pers.	Bermuda grass	258151	Herb	W	Africa	Ui	Naturalized
	<i>Saccharum spontaneum</i> L.	Kans grass	258147	Herb	RB	Tropical West Asia	Ui	Interfering
Pontederiaceae	<i>Eichhornia crassipes</i> (Mart.) Solms	Water hyacinth	258111	Herb	A	Tropical America	O	Naturalized
Portulacaceae	<i>Portulaca oleracea</i> L.	Purslane	258137	Herb	W	Tropical S. America	Fd	Naturalized
Primulaceae	<i>Anagalis arvensis</i> L.	Red thick weed	258097	Herb	CF	Europe	Ui	Naturalized
Rubiaceae	<i>Spermacoce hispida</i> L.	Jointed button weed	258145	Herb	AR	Tropical America	Ui	Interfering
Solanaceae	<i>Datura innoxia</i> Mill.	Thorn apple	258138	Shrub	W	Tropical America	Ui	Noxious
	<i>Datura metel</i> L.	Devil's trumpet	258112	Shrub	W	Tropical America	Ui	Interfering
	<i>Nicotiana plumbaginifolia</i> Viv.	Tex-mex tobacco	258133	Herb	W	Tropical America	Ui	Naturalized
	<i>Physalis minima</i> L.	Ground cherry	258129	Herb	W	Tropical America	Ui	Naturalized
	<i>Solanum nigrum</i> L.	Black nightshade	258113	Herb	CF	Tropical America	Ui	Naturalized
Sterculiaceae	<i>Waltheria indica</i> L.	Sleepy morning	258115	Herb	F	Tropical America	Ui	Interfering
Tiliaceae	<i>Corchorus tridens</i> L.	Fodder jute	258146	Herb	AR, W	Tropical Africa	Ui	Naturalized
	<i>Triumfetta rhomboidea</i> Jacq.	Burr bush	258142	Herb	W	Tropical America	Ui	Naturalized
Typhaceae	<i>Typha angustifolia</i> Bory & Chaub.	Lesser Indian reed mace	258135	Herb	RB	Tropical America	Ui	Naturalized
Verbenaceae	<i>Duranta repens</i> L.	Gold dew drop	258110	Shrub	CF	America	Af	Naturalized
	<i>Lantana camara</i> L.	Wild sage	258121	Shrub	F	Tropical America	O	Noxious
Zygophyllaceae	<i>Tribulus terrestris</i> L.	Puncture vine	258141	Herb	W	Tropical America	Ui	Naturalized

Habitat: W—Wastelands; CF—Cultivated fields; F—Forests; AR—Along roadside; A—Aquatic; P—Parasites; RB—River beds.

Mode of introduction: Af—Agroforestry; Fd—Food; Fo—Fodder; O—Ornamental; Ui—Unintentional.

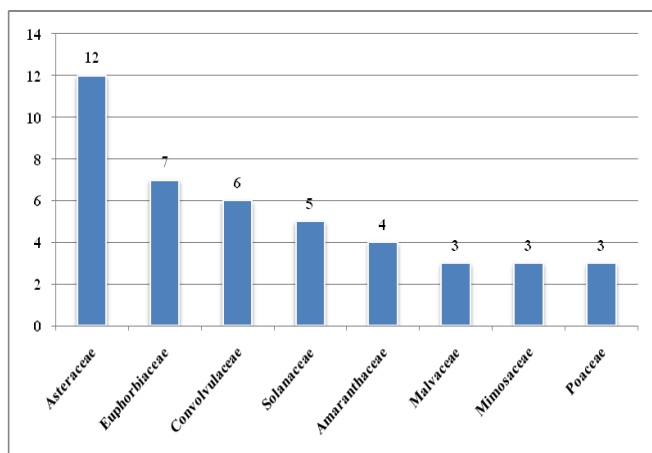


Fig. 2: Dominant families of Invasive alien plant species in SSBS.

Lantana camara and *Prosopis juliflora* are the most dominant species that acquired a large geographic area of the Soor Sarovar Bird Sanctuary. *Lantana camara* was first introduced in 1809 in Calcutta Botanical Garden for ornamental purpose (Thakur et al., 1992; Kannan et al., 2013). Now days it occurs all over the India ranging from tropical, subtropical and temperate region of the country (Kannan et al., 2013). There are several factors responsible for the successful invasion of the species like uncontrolled growth, absence of herbivores and pathogen (Keane and Crawley, 2002). *Lantana camara* is very efficient at nutrient uptake (Bhat et al., 1994) because of this potential it grow luxuriantly even in nutrient poor soil.

Prosopis juliflora was first introduced in between 1857 and 1878 in Thar desert of Northwest India used as a

fuel. *Prosopis juliflora* has shown to be tolerant to draught and salinity (Pasicznik et al., 2001) and also shows low palatability. *Prosopis juliflora* invasion speed is very high, due to this there is a reduction in fodder plants for wild as well as rearing cattle such as goat. They feed on the fruit of *Prosopis juliflora* in absence of the fodder plant that leads into the dispersal of the seed in surrounding areas. These are the factors are responsible for the successful invasion of the species and that affect the local biodiversity.

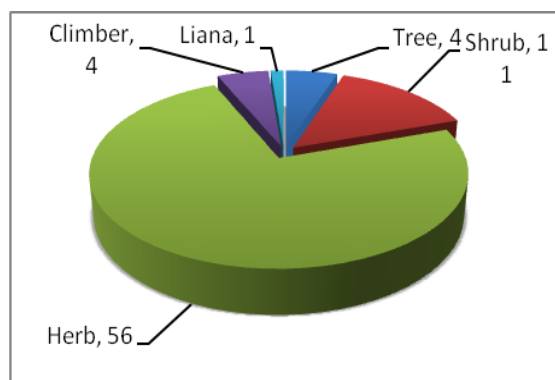


Fig. 3: Life form of invasive alien plant species in SSBS.

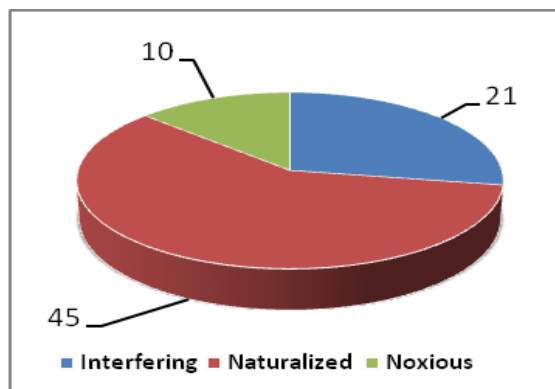


Fig. 4: Status of invasive alien plant species in SSBS.

The present study reports the dominant life form category is herbaceous species and it represent (73%) of the total invasive alien plants. The factor greater viability and withstand in adverse condition helps herbaceous species in invasion though out the SSBS. Invasive species of Asteraceae exhibited a much higher reproductive capacity than those of other families. This high reproductive potential is achieved by partitioning of reproductive capital into a large number of propagules that are minute, light, and wind dispersed (Saxena and Ramakrishnan, 1982) similar result was observed by other workers in different parts of India such as (Rao and Murugan, 2006) found that the Asteraceae is dominating family in alien flora of India, in Uttar Pradesh

(Singh et al., 2010), in Indian Himalayan region (Sekar, 2012), in Johrat, Assam (Das and Duarah, 2013), in North eastern Uttar Pradesh (Srivastava et al., 2014) and in Western Madhya Pradesh (Wagh and Jain, 2015). Biological invasions of alien plants present one of the most serious threats to the indigenous biological diversity. Invasive alien plants have caused extensive economic and ecological damage throughout the world. In India *Ageratum conyzoides*, *Parthenium hysterophorus*, *Lantana camara* and *Eupatorium adenophorum* are major invaders and causing huge loss to indigenous species diversity in this part of the world (Dogra et al., 2009). Likewise invasive plant species like *Ageratum conyzoides*, *Lantana camara*, *Prosopis juliflora*, *Parthenium hysterophorus*, etc. are poses a major threat to indigenous biological diversity of Soor Sarovar Bird Sanctuary too.

Conclusion

The vegetation of Uttar Pradesh is known for its great diversity. Uttar Pradesh is one of the richest biodiversity zones of India. Therefore study on the impact of alien invasive plants on native phytodiversity of this region and their management is a need of hour. The invasive alien species possess serious threat to local biodiversity, affects crop production and human health. Therefore systematic study about the invasive plant species is required to provide adequate knowledge of the ecological and environmental consequences caused by invasive alien species and how to address it.

Conflict of interest statement

Authors declare that they have no conflict of interest.

Acknowledgement

The author is thankful to Director, CSIR- National Botanical Research Institute Lucknow, for encouragement and providing facilities to carry out the work. The study has been carried under in house project OLP-0083.

References

- Bhatt, Y.D., Rawat, Y.S., Singh, S.P., 1994. Changes in ecosystem functioning after replacement of forest by *Lantana* shrubland in Kumaun Himalaya. *J. Veg. Sci.* 5, 67-70.
- Cooke, T., 1901-1908. *Flora of Bombay Presidency* (Ed.: Singh, B., Singh, M.P.). Dehradun, India.

- Corlett, R.T., 1998. The naturalized flora of Singapore. *J. Biogeogr.* 15, 657-663.
- Das, K., Duarah, P., 2013. Invasive alien plant species in the roadside areas of Jhurat, Assam: Their harmful effects and beneficial uses. *J. Engg. Res. Appl.* 3(5), 353-358.
- Dogra, K.S., Kohli, R.K., Sood, S.K., 2009. An assessment and impact of three invasive species of Himanchal Pradesh, India. *Int. J. Biodiv. Conser.* 1, 4-10.
- Duthie, J.F., 1903-1922. Flora of Upper Gangetic Plain and the Adjacent of Siwalik and Sub-Himalayan Tracts. Vols. 1-3. Botanical Survey of India, Calcutta.
- Enmoto, T., 1999. Naturalized weeds from foreign countries into Japan. In: *Biological Invasions of Ecosystem by Pests and Beneficial Organisms* (Eds.: Yano, E., Matsuo, K., Shiyomi, M., Andow, D. A.). National Institute of Agro-Environmental Science, Tsukuba, Japan. 1-14.
- Gamble, G.S., Fischer, C.F.C., 1957. Flora of Presidency of Madras. Vols. 1-3. Botanical Survey of India, Calcutta, India.
- Gautam, R., Gautam, R.K., 2008. Variation in Physiochemical characteristic in Sur Sarovar. *J. Natcon.* 20(2), 343-348.
- Hooker, J.D., 1822-1883. The Flora of British India. 7 Vols. L. Reeve & Co., London.
- Kannan, R., Shackleton, C.M., Uma Shaanker, R., 2013. Reconstructing the history of introduction and spread of the invasive species, *Lantana*, at three spatial scales in India. *Biol. Invasions.* 15, 1287-1302.
- Keane, R.M., Crawley, M.J., 2002. Exotic plant invasions and the enemy release hypothesis. *Trends Ecol. Evol.* 17, 164-170.
- Khanna, K.K., Kumar, A., 2000. Additions to the taxa of Angiosperms: Flora of Madhya Pradesh Vol. II. *J. Econ. Tax. Bot.* 24, 177-180.
- Khanna, K.K., Kumar, A., Dixit, R.D., Singh, N.P., 2001. Supplement to the Flora of Madhya Pradesh. Botanical Survey of India, Calcutta.
- Kshirsagar, S.R., 2005. Origin, present status and distribution of exotic plants in South Gujarat. *Ind. J. Forestr.* 28, 136-143.
- Lawrence, G.H.M., 1951. *Taxonomy of Vascular Plants.* Macmillan, New York.
- Maheshwari, J.K., 1963. The Flora of Delhi. Gossain & Co. Pvt. Ltd., Calcutta.
- McGeoch, M.A., Butchart, S.H.M., Spear, D., Marais, E., Kleyhans, E.J., Symes, A., Chanson, J., Hoffmann, M., 2010. Global indicators of biological invasion: Species numbers, biodiversity impact and policy responses. *Diver. Distrib.* 16(1), 95-108.
- Meyer, J.Y., 2000. Preliminary review of the invasive plants in the Pacific islands. In: *Invasive Species in the Pacific: A Technical Review and Draft Regional Strategy* (Ed.: Sherley, G.). South Pacific Regional Environmental Programme, Samoa. pp.85-114.
- Mooney, H.A., Hobbs, R.J., 2000. *Invasive Species in a Changing World.* Island Press, Washington, DC, USA.
- Negi, P.S., Hajra, P.K., 2007. Alien flora of Doon Valley, Northwest Himalaya. *Curr. Sci.* 92(7), 968-978.
- Pandey, R.P., Parmar, P.J., 1994. The exotic flora of Rajasthan. *J. Econ. Taxon. Bot.* 18, 105-121.
- Pasicznik, N.M., Felker, P., Harris, P.J.C., et al. 2001. *The Prosopis juliflora–Prosopis pallida* complex: a monograph. HDRA, Coventry Proceedings of a Conference held at the Central Arid Zone Research Institute, Jodhpur, Rajasthan, India. November 21–23, 1993. The *Prosopis* Society of India and The Henry Doubleday Research Association. pp.17-20.
- Pyšek, P., Sádlo, J., Mandák, B., 2002. Catalogue of alien plants of the Czech Republic. *Preslia.* 74(2), 97-186.
- Raghubansh, A.S., Rai, L.C., Gaur, J.P., Singh, J.S., 2005. Invasive alien species and biodiversity in India. *Curr. Sci.* 88(4), 539-540.
- Rani, R., Gautam, R., Gautam, R.K., 2009. Floristic survey of medicinal plants in Sur Sarovar wet land, Keetham, Agra India. *J. Appl. Nat. Sci.* 1(2), 196-200.
- Rao, R.R., Murugan, R., 2006. Impact of exotic adventives weeds on native biodiversity in India: Implications for Conservation. In: *Invasive Alien Species and Biodiversity in India* (Eds.: Rai, L.C., Gaur, J.P.). Banaras Hindu University, Varanasi. pp.93-109.
- Richardson, D.M., Pyšek, P., Rejmánek, M., Barbour, Dane Panetta, M.G. F., West, C.J., 2000. Naturalization and invasion of alien plants: concepts and definitions. *Diver. Distrib.* 6(2), 93-107.
- Sawarker, V.B., 1984. *Lantana camara* on wildlife habitats with special reference to the Melaghat Tiger Reserve. *Cheetal.* 26, 24-38.
- Saxena, K.G., 1991. Biological invasion in the Indian sub-continent: review of invasion by plants. In: *Ecology of Biological Invasion in the Tropics* (Ed.: Ramakrishnan, P.S.). International Scientific Publications, New Delhi, India. pp.53–73.
- Saxena, K.G., Ramakrishnan, P.S., 1982. Partitioning of biomass and nutrients in the secondary successional herbaceous population subsequent to slash and burn. *Proc. Indian Nat. Sci. Acad.* 8, 807-818.
- Sekar, K.C., 2012. Invasive alien plants of Indian Himalayan region diversity and implication. *Amer. J. Plant Sci.* 3, 177-184.
- Singh, K.P., Shukla, A. N., Singh, J.S., 2010. State level inventory of invasive alien plants, their source regions and use potential. *Curr. Sci.* 99(1), 107-114.
- Singh, P., 1976. *Lantana* weed and *Lantana* lace bug. *Ind. Forestr.* 102, 474-478.
- Sinha, P.M., 1976. Studies on the use of some weedicides on *Lantana camara*. *Ind. Forestr.* 102, 298-305.
- Srivastava, S., Dvivedi, A., Shukla, R.P., 2014. Invasive alien species of terrestrial vegetation of north eastern Uttar Pradesh. *Int. J. For. Res.* Article ID 959875, 9p. doi: 10.1155/2014/959875.
- Sujay, Y.H., Sattagi, H.N., Patil, R.K., (2010). Invasive alien insects and their impact on agroecosystem. *Karnataka J. Agric. Sci.* 23, 26-34.
- Thakur, M.L., Ahmad, M., Thakur, R.K., 1992. *Lantana* weed (*Lantana camara* var. *aculeata* inn.) and its possible

- management through natural insect pests in India. *Ind. Forestr.* 118, 466-486.
- Tripathi, S., 1999. Plant diversity of grassland of north-eastern U.P. with emphasis on population of *Parthenium hysterophorus* L. (Ph.D. thesis), Gorakhpur University, Gorakhpur, India.
- Verma, D.M., Balakrishnan, N.P., Dixit, R.D., 1993. Flora of Madhya Pradesh – Vol. I. Botanical Survey of India, Calcutta.
- Wagh, V.V., Jain, A.K., 2015. Invasive alien flora Jhabua district, Madhya Pradesh, India. *Int. J. Biodiver. Conserv.* 7(4), 227-237.
- Wu, S. H., Hsieh, C. F., Rejmánek, M., 2004. Catalogue of the naturalized flora of Taiwan. *Taiwania.* 49, 16-31.

How to cite this article:

Wagh, V. V., 2016. Diversity of invasive alien plants in Soor Sarovar Bird Sanctuary (SSBS), Keetham, Agra, India. *Int. J. Curr. Res. Biosci. Plant Biol.* 3(3), 62-69.
doi: <http://dx.doi.org/10.20546/ijcrbp.2016.303.012>