Indian Journal of Ecology (2025) 52(5): 916-929
DOI: https://doi.org/10.55362/IJE/2025/4592

Manuscript Number: 4592
NAAS Rating: 5.38

Diversity of Alien Invasive Plants Species by Random Sampling Method and Impact on Local Flora at Kokrajhar, Assam

Jahnovi Brahma, Milos Daimari[1], Jwngma Narzary and Sharmistha Chakraborty

Science College, Kokrajhar-783 370, India
[1]Batasipur College, Sonitpur-784 111, India
E-mail: jahnovibrahma6@gmail.com

Abstract: Studies recorded 43 invasive alien species (IAS) belonging to 19 different families from four different sub areas of Kokrajhar town. Frequency class was studied from selected area and results were compared with Raunkiaer's frequency class to find homogeneity among the species. Random sampling methods shows highest density value with 1.2, 1.4, 2.3 and 2.4 in *Ageratum conyzoides* with least values as seen in *Cleome gynandra* (0.1), *Crotalaria pallida, Oxalis corniculata* (0.2) and *Solanum viarum, Ipomea carnea, Eichhornia crassipes* (0.3). Distributional pattern shows that majority of these invasive species are native of Tropical America. Thus, IAS recorded from the study area are found to be highly disturbed and it does not follow Raunkier's frequency class. Ethnomedicinal usage for the recorded species shows that most of them are used externally for cuts, burns and wounds with some of them also being consumed internally by the ethnic tribes residing in Kokrajhar town.

Keywords: Raunkier's frequency class, Ethnomedicine, Invasive plants

Globally invasive species have been a threat to native plants due to their allelopathic effects. Invasive species are defined as those plant species that were intentionally or unintentionally introduced to an area beyond their native habitat due to human involvement causing negative economic and ecological impacts (Gawad et al., 2021). These species due to their high reproductive rates can spread rapidly in vast areas within a very short period causing the death of many important native plants levelling them as unwanted weeds. All over the world, these invasive plants can be found in aquatic, semi-aquatic, terrestrial, and even remote and hostile ecosystems. Some of the invasive plants that are native to India have been translocated outside their natural habitats or were introduced in India from other countries or regions causing negative impacts to the entire ecosystems (Hiremath 2013).

Invasive Alien Species (IAS) have a huge negative impact mainly on forest regeneration, production of agriculture, livestock grazing and human health, and its native vegetation and ecosystems due to their allelopathic effects. Often some of these invasive alien species may provide food, fuel, or fodder to the local communities (Kull et al*.,* 2007, Roder et al*.*, 2007) and hence are also sometimes cultivated. However, their excessive growth and rapid expansion, not only cause infestation damage to vast tracts of agricultural and forest land in India but also threaten many faunal diversities present in native ecosystems including wetlands and drylands (Kalita et al,. 2019). Initially, invasive plants were distributed all over the world by trading and transportation systems of various kinds. The world's ecosystems already thrived in their role before humankind started to crisscross around the globe. The scale of the impacts of these invasive plants frequently increased because of modern technological systems. Moreover, modern intensive agriculture created the circumstances for invasive plants leading to changes in land habitat fragmentation and also increasing the persistent organic pollutants (POPs) level, ultimately linked directly or indirectly to biological invasions resulting in great biodiversity loss, and also community structure, composition and functions (Rai 2015). Various natural ecosystems, both aquatic and terrestrial, are impacted by these invasive species (Sharma et al*.,* 2005, Dawson et al*.,* 2017). In India, Reddy (2008) was the first to compile about invasive alien species reporting a total of 1599 species providing information on their diversity and distribution in different families and genera, native ranges, and also their status of invasion (Khuroo et al*.,* 2012a, b).

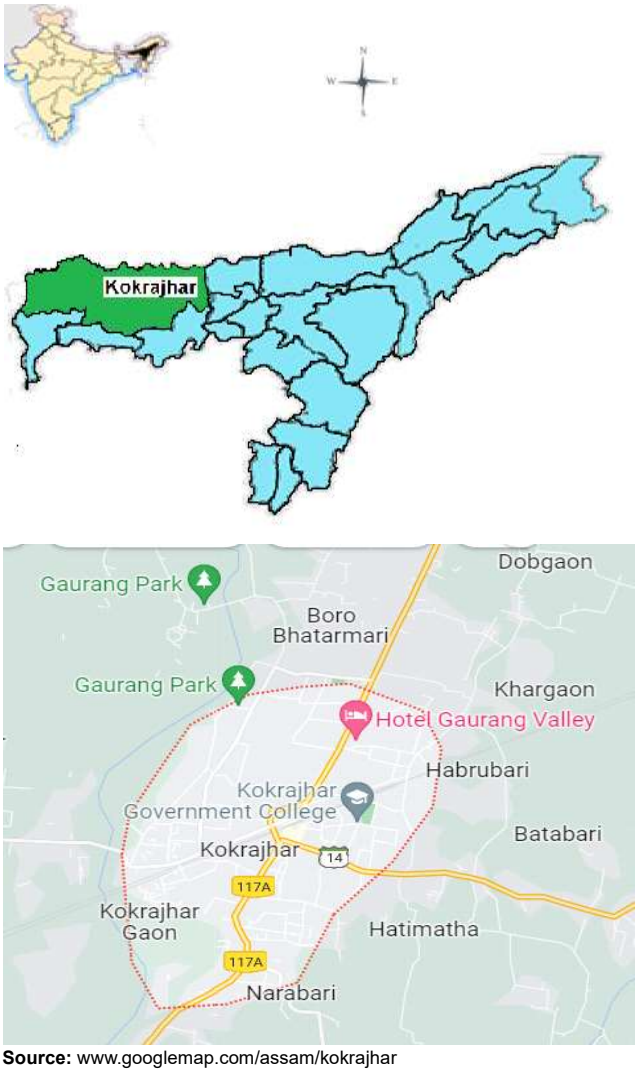
In Assam, aquatic ecosystems or wetlands which are locally known as “pukhuris”, “beels”, and “hola”, etc. are resourceful ecosystems providing many resources of faunal diversity including fishes and waterfowls to the nearby villages (Kalita et al*.,* 2019). The cover of invasive alien species on high mountain ranges is said to have a very low risk of invasion (Pauchard et al., 2009). But most invasive plants are distributed on the low land terrestrial ecosystems and well distributed on the roadside. However, invasive aquatic plants consequently change the structure of the ecosystem negatively impacting water quality and aquatic biodiversity (Chamier et al., 2012, Brundu 2015). From time to time many researchers in Assam have significantly made

contributions and reported diversity about aquatic as well as terrestrial invasive plants and their ecological impacts are also studied macrophytically (Verma 1971, Malakar 1995, Baruah et al., 1997, Kar et al., 2000, Kalita 2009). Various kinds of weeds worstly invade Assam. Management of these weeds is quite challenging to remove or avoid because of their allelochemicals present in those invasive plants entering into soil employing exudation of roots, also during tissue decomposition or leaf leachates of the plants influences the germination, growth and survival of weed plants (Inderjit and Duke 2003). Kokrajhar district of Assam is one of the regions that is greatly diversified with different plant kinds. Various kinds of invasive alien species have been established in the district spreading in massive form and colonizing its native species. The survey was undertaken at Kokrajhar town to study diversity of invasive weeds in different drylands including roadside, etc., and in different wetlands and also to identify the most widespread weed invaders.

MATERIAL AND METHODS

Study area: Kokrajhar district of Assam covers a total area of 3,169.22 km^2. The district is located on the north bank of the Brahmaputra river and shares an international boundary with Bhutan on the north and the Indian state West Bengal on the west, district Dhubri on the south, and Bongaigaon district (now known as Chirang) on the east. The district lies between 26.19" N to 26.54" N latitudes and 89.46' E to 90.38' E longitudes (Narzary G. S., 2013). The district has vast land of forest area constituting a major part of the region and the region is mainly inhabited by local tribes such as *Bodos* and *Adivasis* and some other migratory people (Nath and Mwchahary, 2012). Kokrajhar district has a humid subtropical climate with high humidity and rainfall, hot summer, wet monsoons, and dry winter climate and typically experiences about 111.34 millimetres of precipitation and the district also has average rainfall which varies between 2400 – 3000 mm annually. The district has a heterogeneous soil condition type. The northern part of the district is composed of clayey and loamy soil type, loamy and sandy type soil is present in the middle part whereas soil of southern part of the district has sandy soil. Diverse aquatic plants and ecotone plant species as well as terrestrial plant species are being harboured within the district. However, these native plants are invaded by the alien invasive plants impacting negatively.

Methodology: The result of the present study was prepared mostly based on extensive fieldwork within the study area. A total of four sub-areas within Kokrajhar town were selected *viz.,* North West, North East, South East and South West to estimate the diversity of invasive alien species. Field surveys included swamp areas, roadsides, ponds and some terrestrial habitats where these invasive alien species were dominant in habitat. The fieldwork comprises plant collection, ethnobotanical investigations, face to face interaction with local people and photographing the specimens. The survey was carried out during the mid-month of March 2022 to May 2023 at different locations of the study area site following firm procedures embraced for collection as well as characterization of plants and analysing data as per objectives. Specimens were collected and herbariums were prepared following standard protocols following the methods of Jain and Rao (1976). Plants for herbarium were collected along with additional reproductive structures such as twigs, leaves, flowers, cones etc. Voucher specimens were prepared for each plant species which were carefully numbered and deposited in the Department of Botany, Bodoland University. Further authenticity, nomenclature and



Source: www.googlemap.com/assam/kokrajhar

Fig. 1. Location of study area (Kokrajhar town), Assam

identification of the collected plant specimens were made by consulting various websites like www.bsi.gov.in, www.tropicos.org and http://www.invasiveplantsofindia.com. Several steps were made while preparing herbarium techniques (Baruah A., 2013). To achieve good durability of xerophytes and invasive succulent submerged plants, specimens were specially treated to remove a high percentage of water before drying and were placed below or mounted well in blotting paper or newspapers which is then pressed rapidly with a hot iron. To remove bulky and fleshy parts of the specimens, they were often treated with a combination of diluted acetic acid (CH_3COOH) or strong ethyl alcohol (C_2H_5OH) or 1.5-part formaldehyde (HCHO) and 1.5-part water before mounting on blotting papers to avoid decaying and fungal infections. (Baruah A., 2013). Photographs were taken on the spot where invasive plants are found. Further protection of herbarium sheets with moth balls naphthalene and dichloro-diphenyl-trichloroethene (DDT) were used to control and repel insects.

Since frequency refers to the degree of dispersion in terms of percentage occurrence and frequency distributions, frequency observation was done by random sampling methods following Raunkiaer's law (1934). The sampling procedure was carried out by sampling on stratified random places under selected areas. A quadrant size of 5 m × 5 m was laid at different places. Determination of density was done to estimate the numerical strength of a species with a definite unit space as follows -

$$\text{Population Density} = \frac{\text{Total no. of individual of a species in all the quadrant studied}}{\text{Total no. of quadrant studied}}$$

Similarly, Percentage of frequency is determined as follows –

$$\text{Percentage Frequency} = \frac{\text{Total no. of quadrants in which the species occurred}}{\text{Total no. of quadrant studied}} \times 100$$

For each family, the frequency classes were done based on Raunkiaer's method (1934). The frequency class provides an idea regarding the distribution of a species throughout a community. Therefore, frequency classes were- A: 20% (1-20), B: 40% (21-40), C: 60% (41-60), D: 80% (61-80) and E: 100% (81-100) where high frequency indicates the community was homogenous.

RESULTS AND DISCUSSION

A total of 43 invasive alien plant species belonging to 19 different families were recorded from the undisturbed areas, roadsides, wetlands, low-lying areas and crop land areas. These invasive recorded plants belong to different life forms, viz. aquatic herbs, herbs, shrubs and a few climbers. On the North-West side of the study site, a total number of 15 families were recorded and dominant family was Asteraceae and Fabaceae consisting of 5 species, followed by Amaranthaceae, Cyperaceae, Onagraceae, Polygonaceae and Malvaceae. Families like Capparidaceae, Pontederiaceae, Euphorbiaceae, Convolvulaceae, Verbenaceae, Lamiaceae, Araceae and Solanaceae, consisting of only a single species. In the North-East area, a total number of 27 invasive alien plant species were belonging to a total of 13 families were observed. The dominant family was Asteraceae consisting of a total of 6 species, followed by Fabaceae consisting of 5 total species, and Solanaceae consisting of 4 species, while Amaranthaceae and Poaceae had 2 species and the rest families had the least species consisting of only 1 species each. In the South-East area, a total number of 28 invasive plant species were belonging to 13 different families were observed . Among them, the dominant family was Asteraceae which consisted of 7 different species which is followed by Fabaceae consisting of 4 different species and Amaranthaceae had 3 species. Under South-West, a total number of 26 invasive plant species belonging to 14 different families were recorded. Asteraceae was dominant consisting of 5 species, followed by Fabaceae which consist of 4 species, and Amaranthaceae 3 species, while Convolvulaceae, Polygonaceae and Euphorbiaceae had 2 species each and the rest families had only 1 species.

Raunkiaer (1934) suggested that the number of species in frequency class A is greater than that of B, B is greater than in class C, class C is greater or lesser than class D, and D is lesser than class E. Hence, according to Raunkiaer's method (1934),

A > B > C = D < E

In the North-West area *Ageratum conyzoides* L. shows the highest density 2.4 and the least was in *Cleome gynandra* L. (0.1). The frequency class of the invasive alien species in the North-West having maximum, comparing these values with Raunkiaer's frequency class as A>B>C>D=E. Similarly, frequency class of the North-east area shows frequency class with class A (8) followed by class B (16) and class C (3) while classes D and E lack any species indicating that the maximum dominant species was in class B, hence Raunkiaer's frequency class becomes as follows A<B>C>D=E and highest density value was 1.2 of *Ageratum conyzoides* and the least was seen in *Solanum viarum* with 0.2 value. Results from frequency class of the South-East area show class A (11) followed by class B (15) and class C (2) while classes D and E show no species indicating the maximum dominant species was in class B, i.e.,

A<B>C>D=E and with 1.4 value *Ageratum conyzoides* shows highest density and *Crotalaria pallid*a shows the least density with 1.2 value. Again, in the South-West area, we find the following frequency class A>B>C>D=E, where maximum frequency was found in A (12) followed by B (11), class C has 3 value while classes D and E lacks any species and *Ageratum conyzoides* shows highest density with 2.3 value and with 0.2 value *Oxalis corniculata* shows the least density.

Table 1. Density and frequency of IAS of North-West, Kokrajhar Town

Name of the species	Family	S	N	D	F%
Ageratum conyzoides L.	Asteraceae	24	6	2.4	60
Alternanthera tenella Colla.	Amaranthaceae	12	4	1.2	40
Amaranthus spinosus L.	Amaranthaceae	4	3	1.4	30
A. viridis L.	Amaranthaceae	5	3	0.5	30
Chromolaena odorata (L.) King & Robinson	Asteraceae	3	3	0.3	30
Cleome gynandra L.	Capparidaceae	1	1	0.1	10
Crotalaria pallida Aiton.	Fabaceae	2	1	0.2	10
Cyperus rotundus L.	Cyperaceae	6	2	0.6	20
Cyperus haspan L.	Cyperaceae	3	2	0.3	20
Eichhornia crassipes (C. Martius) Solms-Loud.	Pontederiaceae	4	2	0.4	20
Euphorbia hirta L.	Euphorbiaceae	9	2	0.9	20
Gynura crepidioides (Benth.) S. Moore	Asteraceae	2	1	0.2	10
Ipomoea carnea Jacq.	Convolvulaceae	6	2	0.6	20
Lantana camara L.	Verbenaceae	10	5	1.0	50
Ludwigia erecta (L.) H. Hara	Onagraceae	6	2	0.6	20
Ludwigia octovalvis (Jacq.) Raven	Onagraceae	5	2	0.5	20
Mesosphaerum suaveolens (L.) Kuntze	Lamiaceae	6	3	0.6	30
Mikania micrantha (Willd.) Kunth.	Asteraceae	6	4	0.6	40
Mimosa pudica L.	Fabaceae	5	3	0.5	30
Parthenium hysterophorus L.	Asteraceae	8	3	0.8	30
Persicaria hydropiper L.	Polygonaceae	8	3	0.8	30
Persicaria lapathifolia L.	Polygonaceae	4	2	0.4	20
Pistia stratiotes L.	Araceae	6	2	0.6	20
Senna alata L.	Fabaceae	3	2	0.3	20
Senna occidentalis (L.) Link.	Fabaceae	2	1	0.2	10
Senna tora L.	Fabaceae	2	1	0.2	10
Sida acuta Burm. F.	Malvaceae	13	5	1.3	50
Solanum nigrum L.	Solanaceae	4	3	0.4	30
Urena lobata L.	Malvaceae	5	3	0.5	30

Total number of individuals=S; Total number of quadrants in which species occurred = N; Total number of quadrants studied = Q; Density (D) = S/Q; Percentage frequency (F) %= N/Q×100

Since Raunkiaer's frequency law states that species with low-frequency values are higher in number than the species with higher frequency values in most natural communities, thus comparing results with Raunkiaer's frequency class, it can be assumed that the invasive alien species studied in the study site are comparatively disturbed and it does not follow Raunkiaer's frequency class. The root cause for these may be over exploitation of some invasive species due to its medicinal usage, over grazing, soil erosion, pollution or ongoing road side and building constructions in the study area.

Table 2. Density and frequency of IAS of North-East, Kokrajhar Town

Name of the species	Family	S	N	D	F%
Acanthospermum hispidum DC.	Asteraceae	10	4	1.0	40
Ageratum conyzoides L.	Asteraceae	12	6	1.2	60
Alternanthera tenella Colla	Amaranthaceae	6	3	0.6	30
Amaranthus spinosus L.	Amaranthaceae	8	4	0.8	40
Chromolaena odorata (L.) King & Robinson	Asteraceae	6	3	0.6	30
Cleome gynandra L.	Capparidaceae	4	3	0.4	30
Crotalaria pallida Aiton	Fabaceae	6	3	0.6	30
Eichhornia crassipes (C. Martius) Solms-Loud	Pontederiaceae	3	1	0.3	10
Gynura crepidioides (Benth.) S. Moore	Asteraceae	4	3	0.4	30
Imperata cylindrica (L.) Raeusch	Poaceae	8	3	0.8	30
Ipomoea carnea Jacq.	Convolvulaceae	3	2	0.3	20
Lantana camara L.	Verbenaceae	5	3	0.5	30
Melastoma malabathricum L.	Melastomaceae	5	2	0.5	20
Mesosphaerum suaveolens (L.) Kuntze	Lamiaceae	8	5	0.8	50
Mikania micrantha (Willd.) Kunth.	Asteraceae	6	3	0.6	20
Mimosa diplotricha C. Wright	Fabaceae	10	3	1.0	30
*Mimosa pudica*L.	Fabaceae	6	4	0.6	40
Parthenium hysterophorus L.	Asteraceae	11	5	1.1	50
Persicaria hydropiper L.	Polygonaceae	5	4	0.5	40
Saccharum sponteneum L.	Poaceae	11	3	1.1	30
Senna alata L.	Fabaceae	6	2	0.6	20
Senna occidentalis (L.) Link	Fabaceae	4	2	0.4	20
Solanum nigrum L.	Solanaceae	5	3	0.5	30
Solanum sisymbriifolium Lam.	Solanaceae	6	3	0.6	30
Solanum torvum Sw.	Solanaceae	4	3	0.4	30
Solanum viarum Dunal.	Solanaceae	2	2	0.3	20
Urena lobata L.	Malvaceae	4	2	0.4	20

See Table 1 for details

The maximum species surveyed were herbs, followed by shrubs and a few are climbers. Some invasive alien plant species like *Ageratum conyzoides* L., *Alternanthera tenella* Colla., *Amaranthus spinosus* L., *Chromolaena odorata* (L.) King & Robinson, *Cleome gynandra* L., *Lantana camara* L., *Mikania micrantha* (Willd.) Kunth., *Mimosa pudica* L., *Parthenium hysterophorus* L., *Persicaria hydropiper* L., *Pistia stratiotes* L., *Senna occidentalis* (L.) Link., *Senna tora* L. is having herb life forms. The nativity of the recorded plant species mainly belonged to Tropical America with a maximum number of 14 and only a few belonged to the Mediterranean, Tropical Madagascar, Tropical West Asia and Europe with only a single species each.

From times memorial it has been observed that Invasive Alien plant species has caused economic or environmental harm that has offset their benefits from employing them for their cultivation. In many parts of the world like China and Taiwan a number of invasive species have been intentionally introduced for biological control of disease, weeds and insect pest. Since the general public of Kokrajhar District is not aware of the harmful effects caused by these alien species and its future potential rate to the local ecosystem, a preliminary was done to study the growth forms and its distribution in an around different part of Kokrajhar town area.

Table 3. Density and frequency of IAS of South-East, Kokrajhar Town

Name of the species	Family	S	N	D	F%
Acanthospermum hispidum DC.	Asteraceae	7	3	0.7	30
Achyranthes aspera L.	Amaranthaceae	7	3	0.7	30
Ageratum conyzoides L.	Asteraceae	14	6	1.4	60
Amaranthus spinosus L.	Amaranthaceae	9	4	0.9	40
Amaranthus viridis L.	Amaranthaceae	8	4	0.8	40
Chromolaena odorata (L.) King & Robinson	Asteraceae	8	4	0.8	40
Clerodendrum infortunatum L.	Lamiaceae	4	2	0.4	20
Crotalaria pallida Aiton	Fabaceae	2	2	0.2	20
Cuscuta chinensis Lam.	Convolvulaceae	9	1	0.9	10
Eichhornia crassipes (C. Martius) Solms-Loud	Pontederiaceae	3	1	0.3	10
Euphorbia hirta L.	Euphorbiaceae	6	4	0.7	40
Grangea maderaspatana (L.) Poir.	Asteraceae	5	2	0.5	20
Gynura crepidioides (Benth.) S. Moore	Asteraceae	3	2	0.3	20
Imperata cylindrica (L.) Raeusch.	Poaceae	20	6	2.0	60
Ipomoea carnea Jacq.	Convolvulaceae	3	2	0.3	20
Lantana camara L.	Verbenaceae	7	4	0.7	40
Melastoma malabatricum L.	Melastomaceae	5	2	0.5	20
Mesosphaerum suaveolens (L.) Kuntze	Lamiaceae	8	4	0.8	40
Mikania micrantha (Willd.) Kunth.	Asteraceae	5	3	0.5	30
Mimosa pudica L.	Fabaceae	4	3	0.4	30
Oxalis corniculate L.	Oxalidaceae	8	2	0.8	20
Parthenium hysterophorus L.	Asteraceae	9	4	0.9	40
Persicariahydropiper L.	Polygonaceae	6	3	0.6	30
Ricinus communis L.	Euphorbiaceae	5	2	0.5	20
Senna alata L.	Fabaceae	6	4	0.6	40
*Senna tora*L.	Fabaceae	6	3	0.6	30
Solanum nigrum L.	Solanaceae	6	4	0.6	40
Solanum viarum Dunal.	Solanaceae	5	2	0.5	20

See Table 1 for details

Table 4. Density and frequency of IAS of South-West, Kokrajhar Town

Name of the species	Family	S	N	D	F%
Ageratum conyzoides L.	Asteraceae	23	6	2.3	60
Alternanthera tenella Colla	Amaranthaceae	5	3	0.5	30
Amaranthus spinosus L.	Amaranthaceae	13	4	1.3	40
Amaranthus viridis L.	Amaranthaceae	6	3	0.6	30
Clerodendrum infortunatum L.	Lamiaceae	13	6	1.3	60
Chromolaena odorata (L.) King & Robinson	Asteraceae	10	3	1.0	30
Cleome gynandra L.	Capparidaceae	4	2	0.4	20
Cuscuta chinensis Lam.	Convolvulaceae	6	2	0.6	20
Cyperus haspan L.	Cyperaceae	9	2	0.9	20
Eichhornia crassipes (C. Martius) Solms-Loud	Pontederiaceae	8	2	0.8	20
Euphorbia hirta L.	Euphorbiaceae	7	3	0.7	30
Gynura crepidioides (Benth.) S. Moore	Asteraceae	5	2	0.5	20
Ipomoea carnea Jacq.	Convolvulaceae	5	2	0.5	20
Lantana camara L.	Verbenaceae	6	3	0.6	30
Mikania micrantha (Willd.) Kunth.	Asteraceae	11	3	1.1	30
Mimosa diplotricha C. Wright	Fabaceae	6	2	0.6	20
Mimosa pudica L.	Fabaceae	4	2	0.4	20
Oxalis corniculate L.	Oxalidaceae	2	2	0.2	20
Parthenium hysterophorus L.	Asteraceae	20	4	2.0	40
Persicaria hydropiper L.	Polygonaceae	13	5	1.3	50
Persicaria lapathifolia L.	Polygonaceae	7	2	0.7	20
Phyllanthus urinaria L.	Phyllanthaceae	6	3	0.6	30
Ricinus communis L.	Euphorbiaceae	6	4	0.6	40
Senna alata L.	Fabaceae	4	2	0.4	20
Senna occidentalis (L.) Link	Fabaceae	4	2	0.4	20
Solanum nigrum L.	Solanaceae	7	3	0.7	30

See Table 1 for details

A total of 43 invasive alien plant species belonging to 19 different families were recorded from the undisturbed areas, roadsides, wetlands, low-lying areas and crop fields of study sites of Kokrajhar town. These invasive recorded plants belong to different life forms, viz. aquatic herbs, herbs, shrubs and few as climbers. Among these species many of them were have medicinal values and are used by different ethnic communities as ethnomedicines. Since these species are obnoxious weeds in several crop fields, they have harmful effects including reduction of crop production, effecting grazing of livestock, allelopathic and toxic impacts on various native plants like common crops, blocks drainage system and have also great negative impacts on human health and livestock. *Ageratum conyzoides, Alternanthera tenella, Mikania micrantha. Amaranthus spinosus, Amaranthus viridis, Lantana camara,* weeds are common in the crop field which reduces production of crops. Species like *Parthenium hysterophorus* causes asthma and bronchitis in man as well as livestock. *Senna occidentalis* and *Senna tora* effects on seed germination and growth of mustard due to the presence of allelopathic in the plant. *Eichhornia crassipes* not only reduces crop production and blocks drainage system but also induce itching when eaten due the presence of alkaloid, hydrogen cyanide, triterpenoid in the plant.

Besides these species have negative impacts on environment, have also various medicinal and other uses. Juice extract from *Ageratum conyzoides* is used in jaundice and leaf juice can be applied on wounds and cuts to prevent from bleeding (Das et al., 2013, Wagh and Jain 2018). Leaf paste from *Alternanthera tenella* is medicinally useful in common weakness and in fever, leaf juice of *Amaranthus*

Table 5. Frequency class of invasive alien plant species of study site

Class frequency	North- West area
A (0 – 20)	15
B (21 – 40)	11
C (41 – 60)	3
D (61 – 80)	0
E (81 – 100)	0
Class frequency	North-East area
A (0 – 20)	8
B (21 – 40)	16
C (41 – 60)	3
D (61 – 80)	0
E (81 – 100)	0
Class frequency	South-East area
A (0 – 20)	11
B (21 – 40)	15
C (41 – 60)	2
D (61 – 80)	0
E (81 – 100)	0
Class frequency	South-West area
A (0 – 20)	12
B (21 – 40)	11
C (41 – 60)	3
D (61 – 80)	0
E (81 – 100)	0

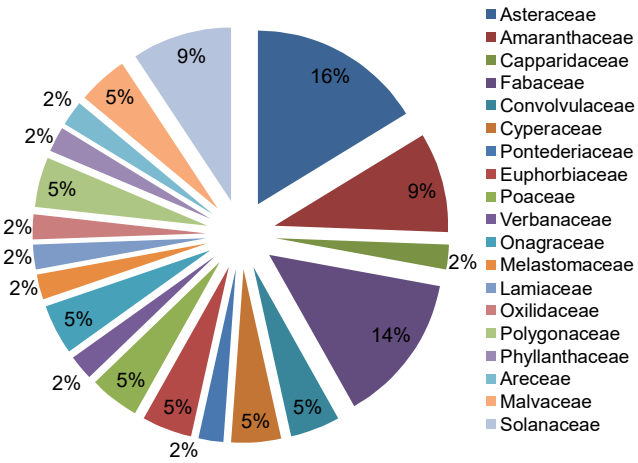


Fig. 2. Distributional pattern of total recorded plants into different families

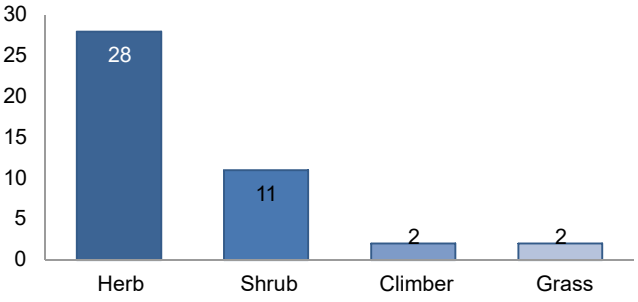


Fig. 3. Distributional pattern of total recorded plants into different habits

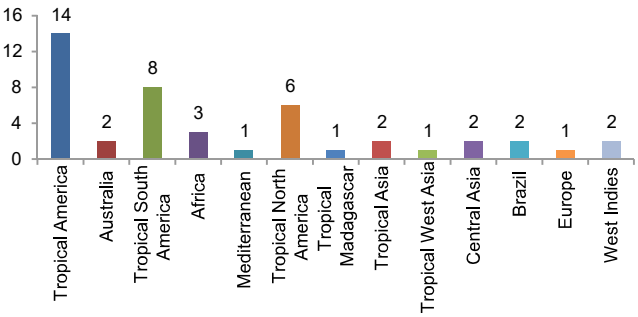


Fig. 4. Distributional pattern of different nativity of species

Table 6. Invasive plant species recorded from study site with their nativity, harmful effects and uses

Name of the species	Growth habit	Nativity	Harmful effects	Uses
Acanthospermum hispidum DC.	Herb	Tropical America	It is a problem weed for almost 24 crops.	Treats various diseases including malaria, abdominal pain, stomachache, snake bite, jaundice, eruptive fever, etc. (Chakraborty et al., 2011).
Achyranthes aspera L.	Herb	Australia	It is a common weed that eliminates native plants.	Traditionally used to treat many ailments like wound, snake bite, diabetes, kidney stone, piles, rabies, toothache, asthma etc. (Dey 2011).
Ageratum conyzoides L.	Herb	Tropical America	This weed is common in the crop field which reduces crop production	Juice extract is used in jaundice and leaf juice can be applied on wounds and cuts to prevent from bleeding (Das et al., 2013, Wagh and Jain 2018).
Alternanthera tenella Colla	Herb	Tropical America	Reduces crop production in the crop field.	Leaf is medicinally useful in common weakness and in fever (Das et al., 2013).
Amaranthus spinosus L.	Herb	Tropical South America	It is a nuisance weed of row crops and vegetables occurring around livestock holding areas and roadside edges.	Plant leaf juice can be applied on scabies (Wagh and Jain 2018). Also consumed as vegetable.
Amaranthus viridis L.	Herb	Tropical America	It is a serious weed in virtually any crop.	This plant is utilized in various aspects such as pharmaceutical, agricultural and also in food applications (Kumari et al., 2018).
Chromolaena odorata (L.) King & Robinson	Herb	Tropical America	The presence of alkaloids in the flowers causes death to livestock (Sajise *et al.* 1974; McFadyen, 2004). This weed is allelopathic to tomato (Onwugbuta 2011)	Local people use leaf paste in cut and wounds.
Cleome gynandra L.	Herb	Tropical America	Grows spontaneously in paddy fields and harms the paddy (Mishra et al., 2011).	When fresh leaf of plant is macerated with goat milk can be apply on the whole body of a person suffering from jaundice (Wagh and Jain 2018).
Crotalaria pallida Aiton.	Shrub	Africa	Harmful to native vegetation.	Plants used as fodder for cattles.
Cuscuta chinensis Lam.	Climber	Mediterranean	These parasitic plants penetrate the host stem via haustoria by winding around plants ultimately.	Decoction of plant is used in jaundice.
Cyperus haspan L.	Herb	Tropical North America	Harmful to native vegetation and block drainage system.	Plants are used as fodder for domestic cattles.
Cyperus rotundus L.	Herb	Africa	Harmful to native vegetation and block drainage system	These plants are used as fodder for cattles.
Eichhornia crassipes (C. Martius) Solms-Loud	Aquatic Herb	Tropical America	It is one the most obnoxious weed that reduces crop production and blocks drainage system. The presence of alkaloid, hydrogen cyanide, triterpenoid in the plant may induce itching when eaten (Perry, 1980).	Relive backache when massaged with root paste with sesame oil on affected parts. The stem fiber is utilized in making ropes.
Euphorbia hirta L.	Herb	Tropical America	Nill	Local people used this plant to prevents worn infestations in children and pimples. Used as traditional remedies for skin ailments, asthma as well as hypertension (Wong et al., 2013).
Grangeama maderaspatana (L.) Poir	Herb	Tropical South America	Nill	In India, leaves are a valuable stomachic and antispasmodic properties and also roots are chewed after meal for 15 days for dyspepsia. It is a popular medicinal plant used for knee joint rheumatism and muscle pain (Huang, at el., 2016).
Gynura crepidioides Benth.	Herb	Tropical Madagascar	Reduces crop production.	Leaves are traditionally used to treat indigestion, stomachache and wound (Can and Tao, 2020).

Cont...

Table 6. Invasive plant species recorded from study site with their nativity, harmful effects and uses

Name of the species	Growth habit	Nativity	Harmful effects	Uses
Imperata cylindrica (L.) Raeusch.	Grass	Tropical Asia	Affects farmer practicing dry agriculture (Holm et al., 1977).	Extracted leaf effects as anti-cancer (Keshava et al., 2016).
Ipomoea carnea Jacq.	Shrub	Tropical America	Due to their dense growth habit blocks drainage system.	Shoots of plant are used by local people as vegetable.
Lantana camara L.	Shrub	Tropical South America	Greatly effects on livestock grazing, and also reduce production of crop. Seeds are toxic.	Leaves are useful in snakebite. The plant is also used as hedge and live fencing (Das et al., 2013).
Ludwigia erecta (L.) H. Hara	Herb	North America	Eliminates other native aquatic plants (Zheng 2018).	Local people consume young leaves as vegetable, used as fodder and traditionally used as medicine to treat malaria fever.
Ludwigia octovalvis (Jacq.) P.H. Raven	Herb	Central America	Eliminates other native aquatic plants (Zheng 2018).	Local people consume young leaves as vegetable, used as fodder and traditionally used as medicine to treat malaria fever.
Melastoma malabatricum L.	Shrub	Australia	Effects the crop production and reduces and eliminates its native vegetation.	Treats various type of ailments and diseases like- diarrhea, dysentery, cuts and wounds, infection during confinement, toothache and stomachache (Joffry et al., 2011).
Mesosphaerum suaveolens (L.) Kuntze	Herb	Tropical America	Colonize areas and dominates over native species (Arzoo et al., 2016).	This plant contains antibacterial, antifungal and insecticidal properties and traditionally used as treatment of various ailments (José et al., 2022).
Mikania micrantha (Willd.) Kunth.	Climber	Tropical south America	Reduces production of crops and eliminates native vegetation.	Juice is use in insect bite. Extraction of leaf is given to domestic animals to prevent from diarrhea (Wagh and Jain, 2018).
Mimosa diplotricha C. Wright	Shrub	Brazil, North America	Aggressively decline native biodiversity and negatively effect to agricultural production (Uy O, 2020).	It controls soil erosion. It fixes nitrogen and also this species is used as a fodder to cattle.
Mimosa pudica L.	Herb	Brazil	Effects greatly on livestock grazing, reduces production of crops. Eliminates native vegetation.	A decoction of root parts can be used in urinary disorders and root paste is useful in stopping in bleeding piles (Wagh and Jain, 2018). Decoction of root is applied in toothache (Das et al., 2013).
Oxalis corniculate L.	Herb	Europe	Nill	Local people of Assam use this species in preventing or may be to heal conjunctivitis of eyes (Arpita, 2019).
Parthenium hysterophorus L.	Herb	Tropical North America	It is an obnoxious weed threating to the biodiversity globally. It causes asthma and bronchitis in man as well as livestock.	Root decoction is use to prevent dysentery and juice of leaf is applied externally to prevent skin disorders. Extraction of whole are used as insecticide (Das et al., 2013; Wagh and Jain, 2018).
Persicaria hydropiper L.	Herb	Tropical America	Due to their allelopathic properties it can widespread in the crop field and effects the production and also eliminates the native plants.	In food preparations, it is used as spice and beside it is used also as medicines for snake bite (Ahmad et al., 2021).
Persicaria lapathifolia (L.) Delarbre	Herb	Tropical North America	Due to their allelopathic properties it can widespread in the crop field and effects the production and also eliminates the native plants.	Traditionally used as medicine for antiviral, anti-fungal, antiseptic, burns, dysentery, etc. (Mahanta et al. 2023).
Phyllanthus urinaria L.	Herb	Tropical Asia	Native species are removed or eliminated by the invasion of this plant.	The leaves are used as a fodder to cattle. Local used this species as oriental medicine in treating liver disease (Du et al., 2018).
Pistia stratiotes L.	Aquatic Herb	Tropical North America	This plant blocks the river current and drainage system.	The cooked leaves are used as soups, and the plant is used to treat swellings and urinary tract infections (Tripathi and Shukla, 2007).

Cont...

Table 6. Invasive plant species recorded from study site with their nativity, harmful effects and uses

Name of the species	Growth habit	Nativity	Harmful effects	Uses
Ricinus communis L.	Herb	South America, North Eastern Africa	Castor plant contain ricin that produce symptoms like fever, nausea, respiratory distress when inhaled (Worbs et al., 2011).	A vegetable oil, known as castor oil is prepared from the seed of the castor plant (Subramaniyan, 2020). Local use the leaves to feed silkworm.
Saccharum sponteneum L.	Grass	Tropical West Asia	Forest ecosystem is disturbed and it is serious weed of many agricultural fields. It's hard to get rid of, since natural regeneration is promoted by rhizomes propagation and seeds spreaded over large area that invades new land (Ganguly et al., 2019).	It prevents soil erosion. Tribal people make mats, brooms, etc. from this plant. Besides these uses it has many medicinal uses such as sexual weakness, burning sensations, mental illness, urinary tract infections (Lamba et al., 2023).
Senna alata L.	Shrub	West Indies	This plant effects crop field and reduce the production of crop as well as its native vegetation.	Leaf juice prevents ringworm infection (Thakur et al.,2024)
Senna occidentalis (L.) Link.	Herb	Tropical South America	Due to the presence of allelopathic in the plant effects on seed germination and growth of mustard. Reduces production of crops as well as native vegetation (Das et al., 2013).	Leaf paste is helpful in preventing skin diseases and decoction of root is used as anti-dote in snakebite (Das et al., 2013).
Senna tora L.	Herb	Tropical South America	Due to the presence of allelopathic in the plant effects on seed germination and growth of mustard (Sarkar et al., 2012).	Leaf juice can be applied to prevent ringworm, eczema and scabies (Das et al., 2013).
Sida acuta Burm. F.	Shrub	Tropical America	Due to the presence of allelopathic chemical it is difficult to remove this species from vegetation, moreover, this species eliminates its native plants.	Applying juice of plant cools wounds and cuts (Purkayastha & Nath, 2006).
Solanum nigrum L.	Herb	Tropical America	Vomiting, headache and other side effects when consumed.	Plant leaves and stem are used in constipation.
Solanum sisymbriifolium Lam.	Shrub	Central and South America	Aggressively invade farm lands, roadside, etc. (Julissa 2020).	Whole plant parts are used to treat diarrhea, infections in urinary tract and respiratory problems (Chidambaram et al.,2022).
Solanum torvum Sw.	Shrub	West Indies	Effects native vegetation and eliminates.	The fruit is eaten as curry by the local people (Tripathi 2013).
Solanum viarum Dunal.	Shrub	Tropical America	Consumption of fruit in excess may result in gastrointestinal problems like constipation (Chidambaram et al., 2022).	Sometimes fruit can be consumed raw directly. They are also cooked and consumed (Singh, 2023).
Urena lobata L.	Shrub	Tropical America	Plant contains allelopathic chemical which invades land plants eliminating native species.	This plant has a vast potential in curing and healing many diseases and disorders. Moreover, it also used in making ropes, mats, etc. (Islam and Uddin 2017).

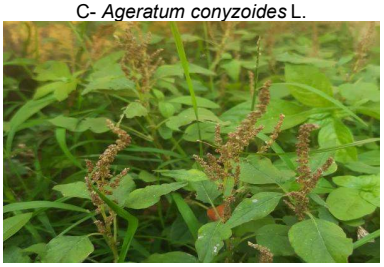
A- *Acanthospermum hispidum* DC.

B- *Achyranthes aspera* L

C- *Ageratum conyzoides* L.

D- *Alternanthera tenella* Colla

E- *Amaranthus spinosus* L



F- *Amaranthus viridis* L.

G- *Chromolaena odorata* (L.) King & Robinson

H- *Cleome gynandra* L

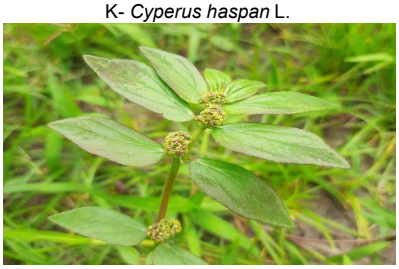
I- *Crotalaria palida* Aiton.

J- *Cuscuta chinensis* Lam.

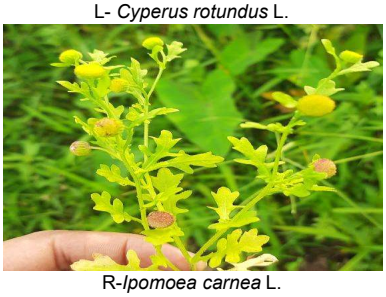
K- *Cyperus haspan* L.

L- *Cyperus rotundus* L.

M- *Eichhornia crassipes* (C. Martius) Solms-Loud.

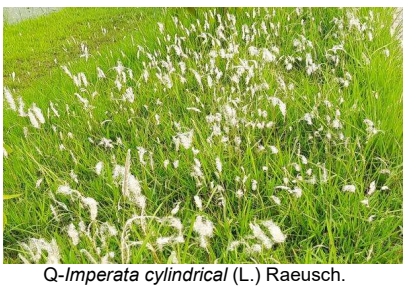


Q-*Imperata cylindrical* (L.) Raeusch.



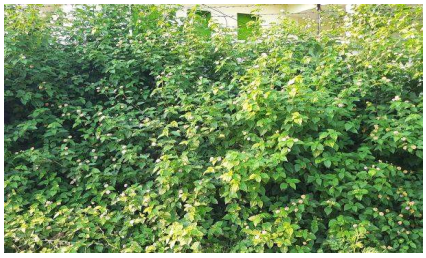
R-*Ipomoea carnea* L.

P-*Gynura crepidioides* (Benth.) S.



Q-*Imperata cylindrical* (L.) Raeusch.

R-*Ipomoea carnea* L.



S- *Lantana camara* L.

T- *Ludwigia erecta* (L.) H. Hara.

U-Ludwigia octovalvis(Jacq.)

V-Melastoma malabathricum L.

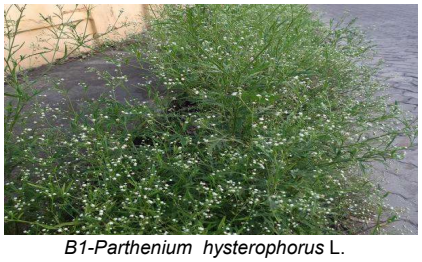
W- *Mesosphaerum suaveolens* (L.) Kuntze

X-*Mikania micrantha* (Wild.) Kunth.

Y- *Mimosa diplotricha* C. Wright

Z- *Mimosa pudica* L.

A1- *Oxalis corniculata* L.



B1-Parthenium hysterophorus L.

C1-Persicariahydropiper L.

D1-*Persicaria lafathifolia* (L) Delarbre.

E1-*Phyllanthus urinaria* L.

F1-*Pistia stratiotes* L.

G1-*Ricinus communis* L.

H1-*Saccharum sponteneum* L.

I1-*Senna alata* L.

J1-*Senna occidentalis* (L.) Link.

K1-*Senna tora*L.

L1-*Sida acuta* Burm. F.

M1-*Solanum nigrum* L.

N1-*Solanum sisymbriifolium* Lam.

O1-*Solanum torvum* Sw.

P1-*Solanum viarum* Dunal.

Q1-*Urena lobata* L.

Fig. 5. Alien invasive species recorded from the study area

spinosus can be applied on scabies, decoction of *Cuscuta chinensis* is used in jaundice and fresh leaves of *Cleome gynandra* plant is macerated with goat milk and applied on the whole body of a person suffering from jaundice (Wagh and Jain 2018). Local people use leaf paste of *Chromolaena odorata* in cut and wounds. Root paste of *Eichhornia crassipes* relive backache when massaged with sesame oil on affected parts, the stem fiber is utilized in making ropes. Shoots of *Ipomoea carnea* are used by local people as vegetable. *Lantana camara* are useful in snakebite and as hedge for live fencing (Das et al*.,* 2013). *Mikania micrantha* juice is use in insect bite and extraction of leaf is given to domestic animals to prevent from diarrhea (Wagh and Jain, 2018). The decoction of *Mimosa pudica* root parts can be used in urinary disorders and root paste is useful in stopping in bleeding piles and in toothache (Das et al*.,* 2013). Root decoction of *Parthenium hysterophorus* is use to prevent dysentery and juice of leaf is applied externally to prevent skin disorders and extraction of whole plant are used as insecticide (Das et al*.,* 2013, Wagh and Jain 2018). Leaf juice of *Senna alata* prevents ringworm infection, leaf juice of *Senna tora* can be applied to prevent ringworm, eczema and scabies (Das et al*.,* 2013*)*. Leaf paste *Senna occidentalis* is helpful in preventing skin diseases and decoction of root is used as anti-dote in snakebite. Many local people still rely on these species on medicinal purposes and some ethnobotanically purposes. Moreover, few species are used as ornamentally in many local households.

CONCLUSION

There is a lack of general understanding about the impacts of invasive species on ecosystem functioning, local people should be made aware of the outcompeting native species and damaging ecosystem caused by these alien species. The critical need for public awareness and education is required among the local people. The balanced approach should be conducted to provide knowledge and guidance about the threats, benefits and harmful effects of these invasive species. Knowledge gained on invasive species and control in one country can be valuable to other countries in making decisions on prevention and control of the same species. Hence invasive species should be put on India's

National Agenda immediately and action should be taken with appropriate exposure to cover substantial economic loss and damage to endemic flora and rich biological heritage. Thus, can conclude that it is particularly important to strengthen international communication and co-operation in sharing, linking and integrating invasive species databases and information systems should be strengthened and research should be conducted to support effective prevention and control strategies about these invasive species.

REFERENCES

Abd-El Gawad AM, Bonanomi G, Al-Rashed, SA and Elshamy, Al 2021. *Persicaria lapathifolia* essential oil: Chemical constituents, antioxidant activity, and allelopathic effect on the weed *Echinochloa colona. Plant Invasion Ecology* **10**(9): 1798.

Ahmad R, Rashid I, Hamid M, Malik AH and Khuroo AA 2021. Invasion shadows in soil system overshadow the restoration of invaded ecosystems: Implications for invasive plant management. *Ecological Engineering* **164**: 106219.

Arpita M 2019. *Oxalis corniculata*: A wonder plant. *World Journal of Pharmacy and Pharmaceutical Sciences* **8**(6): 634-642.

Arzoo P and Parle M 2017. Fennel: A Brief review. *European Journal of Pharmaceutical and Medical Research* **4**(2): 668-675.

Baruah A 2013. *Plant Taxonomy*, EBH Publishers (India), pp. 357.

Baruah P, Gogoi R, Bordoloi S, Ahmed S, Sharma K, Goswami DC, Murthy TVR, Shing TS and Garg JK 1997. *Wetland of Assam*: A project Report: Assam Remote Sensing Application Centre, Guwahati and Space Application Centre (ISRO), Ahmedabad.

Brundu G 2015. Plant invaders in European and Mediterranean inland waters: Profiles, distribution, and threats. *Hydrobiologia* **746**(1): 61-79;

Can NM and Thao DTP 2020. Wound Healing Activity of *Crassocephalum crepidioides* (Benth.) S. Moore. Leaf Hydroethanolic Extract. *Oxidative Medicine and Cellular Longevity,* Vol. 2, pp. 1-10, DOI:10.1155/2020/2483187.

Chamier J, Schachtschneider K, Maitre le DC, Ashton PJ and Wilgen van BW 2012. Impacts of invasive plants on water quality, with particular emphasis on South Africa. *Water SA* **38**(2): 345-356.

Chidambaram K, Alqahtani T, Alghazwani Y, Aldahish A, Annadurai S, Venkatesan K, Dhandapani K, Thilagam E, Venkatesan K, Paulsamy P and Vasudevan R 2022. Medicinal plants of solanum species: The promising sources of phyto-insecticidal compounds. *Journal of Tropical Medicine* (1): 4952221.

Das K and Duarah P 2013. Invasive Allien plant species in the roadside areas of Jorhat, Assam: Their harmful effects and beneficial uses. *International Journal of Engineering Research and Publications* **3**(5): 353-358.

Dawson W, Moser D, Van Kleunen M, Kreft H, Pergl J, Pyšek P, Weigelt P, Winter M, Lenzner B, Blackburn TM and Dyer EE 2017. Global hotspots and correlates of alien species richness across taxonomic groups. *Nature Ecology & Evolution* **1**(7): 0186.

Dey A 2011. *Achyranthes aspera* L: Phytochemical and Pharmacological Aspects. *International Journal of Pharmaceutical Sciences Review and Research* **9**(2): 72-82.

Du G, Xiao M, Yu S, Wang M, Xie Y and Sang S 2018. *Phyllanthus urinaria*: A potential phytopharmacological source of natural medicine. *International Journal of Clinical and Experimental Medicine* **11**(7): 6509-6520.

Ganguly B, Imayavaramban V and Murugan G 2019. Effect of integrated nutrient management on rice yield parameter's and nutrient uptake. *Journal Pharmacogn Phytochemistry* **8**: 3910-3912.

Hiremath AJ and Sundaram B 2013. In book: *Invasive plant species in Indian protected areas: Conserving biodiversity in cultural landscapes.* In: Plant Invasions in Protected Areas. Springer India, New Delhi, pp. 241-266. ISBN 9789400777491

Holm LG, Plucknett DL, Pancho JV and Herberger JP 1977. *The world's worst weeds. Distribution and biology.* East-West Center, University Press of Hawaii, pp.609

Huang M, Deng S, Dong H, Dai W, Pang J and Wang X 2016. Impacts of atmospheric mercury deposition on human multimedia exposure: Projection from observations in the Pearl River Delta Region, South China. *Environmental Science and Technology* **50**(19): 10625-10634.

Inderjit and Duke SO 2003. Eco-physiological aspects of allelopathy. *Planta* **217**(4): 529-539.

Islam MT and Uddin MA 2017. A revision on *Urena lobata* L. *International Journal of Medicine* **5**(1):126-131.

Jain SK and Rao RR 1977. *A Handbook of Field and Herbarium Methods*. *Scholarly Publications, Science,* pp. 1-150.

Joffry SM, Yob NJ, Rofiee MS, Affandi MM, Suhaili Z, Othman F, Akim AM, Desa MM and Zakaria ZA 2012. *Melastoma malabathricum* (L.) smith ethnomedicinal uses, chemical constituents, and pharmacological properties: A review. *Evidence-Based Complementary and Alternative Medicine* **2012**(1): 258434.

Jose S, Rajeev R, Thadathil DA, Varghese A and Hegde G 2022. A road map on nanostructured surface tuning strategies of carbon fiber paper electrode: Enhanced electrocatalytic applications *Journal of Science: Advanced Materials and Devices* **7**(3): 100460.

Julissa RS 2020. *Solanum sisymbriifolium* (sticky nightshade). *CABI Compendium,* PlantwisePlus Knowledge Bank 117241 https://doi.org/10.1079/pwkb.species.117241.

Kalita G, Singha ND and Sarma SK 2019. Exotic & invasive plants (Aquatic & Ecotone) of Nalbari district of Assam. *International Journal of Pharmacy and Biological Sciences* 9(3): 954-965.

Kalita G 2009. *An Ecological study of Wetlands of Kamrup district of Assam*. *Ph.D. Thesis, Gauhati University*.

Kar D and Barbhuiya M 2000. *Studies on the Aquatic Macrophytes of Chatla Haor floodflian wetland in Cachar district in Assam*. *Indian Science Congress, New Delhi*.

Keshava R, Muniyappa N, Gope R and Ramaswamaiah A S 2016. Anti-cancer effects of *Imperata cylindrica* leaf extract on human oral Squamous Carcinoma cell line SCC-9 in Vitro. *Asian Pacific Journal of Cancer Prevention* **17**(4): 1891-1898.

Khuroo AA, Reshi ZA, Dar GH and Hamal IA 2012a. Plant invasions in Jammu and Kashmir state India. In: Bhatt et al (eds) *Invasive alien plants: An ecological appraisal for the Indian Subcontinent.* CABI, Wallingford, pp. 216-226.

Khuroo AA, Reshi ZA, Malik AH, Weber E, Rashid I and Dar GH 2012b. Alien fora of India: Taxonomic composition, invasion status and biogeographic affiliations. *Biol Invasions* **14**(1): 99-113.

Kull C A, Tassin J and Rangan H 2011. Multifunctional, scrubby, and invasive forests? Wattles in the highlands of Madagascar. *Mountain Research and Development* **27**(3): 224-231.

Kumari S, Elancheran R and Devi R 2018. Phytochemical screening, antioxidant, ant tyrosinase, and antigenotoxic potential of *Amaranthus viridis* extract. *Indian Journal of Pharmacology.* **50**(3): 130-138.

Lamba D, Kumar SYR and Yadav M 2023. Pharmacological activities of Saccharum spontaneum: A Review. *World Journal and Pharmaceutical Sciences* **12**(5): 1945-1955.

Mahanta DK, Samal I, Komal J, Bhoi TK, Majhi PK and Ahmad MA 2023. Understanding anthropogenic climate change, its consequences on insect pests, and techniques in forecasting and monitoring pest dynamics: A contemporary scenario. In *Climate change and insect biodiversity*, pp. 44-67. CRC Press.

Malakar NC 1995. *The Systematic studies on the Aquatic*

Angiosperms of Cachar District of Assam, Ph.D. thesis. Gauhati University, Assam.

McFadyen RC 2004. *Chromolaena* in East Timor: History, Extent and Control. In: Day, M.D. and McFadyen, R.E. (eds). *Proceedings of the Sixth International Workshop on Biological Control and Management of Chromolaena odorata,* ACIAR Technical Reports. O Canberra, Australia. 55, pp. 8-10.

Mishra SS, Moharana SK and Dash MR 2011. Review on *Cleome gynandra. International Journal of Research in Pharmacy and Chemistry* **1**(3): 2231-2781.

Narzary GS 2013. Detecting forest cover changes of Kokrajhar district using remote sensing and GIS techniques. *Journal of Environmental Science, Toxicology and Food Technology* **3**(1): 43-47.

Nath DC and Mwchahary DD 2012. Population increase and deforestation: A study in Kokrajhar district of Assam, India. *International Journal of Scientific and Research Publications,* **2**(10): 1-12.

Onwugbuta EJ 2011. Allelopathic Effects of *Chromolaena Odorata* L. (R. M. King and Robinson – (Awolowo Plant') Toxin on Tomatoes (*Lycopersicum esculentum* Mill). *Journal of Applied Sciences and Environmental Management* **5**(1): 69-73.

Pauchard A, Kueffer C, Dietz H, Daehler CC, Alexander J, Edwards PJ, Arevalo JR, Cavieres LA, Guisan A, Jakobs G, McDougall K, Millar CI, Naylor BJ, Parks CG, Rew LJ and Seipel T 2009. Ain't no mountain high enough: Plant invasions reaching new elevations. *Frontier in Ecology and the Environment* **7**(9): 479-486.

Perry LM 1980. *Medicinal plants of east and southeast Asia*. MIT Press, Cambridge, Vol. 620.

Purkayastha J and Nath SC 2006. Biological activities of ethnomedicinal claims of some plant species of Assam. *Indian Journal of Traditional Knowledge* **5**(2): 229-236.

Rai PK 2015. Concept of plant invasion ecology as prime factor for biodiversity crisis. *International Research Journal of Environment Science* **4**(5): 85-90.

Reddy CS, Bagyanarayana G, Reddy KN and Raju VS 2008. Invasive Alien Flora of India. *National Biological Information Infrastructure, US Geological Survey, USA.*

Raunkiaer C 1934. *The life forms of plants and statistical plant geography:* Being the collected papers of C. Raunkiaer. Clarendon press, Oxford, England, pp. 634.

Rodger W, Dorji K and Wangdi K 2007. Implications of white clover introduction in East Himalayan grasslands. *Mountain Research and Development* **27**(3): 268-273.

Sajise PE, Palis RK, Norcio NV and Lales JS 1974. The Biology of *Chromolaena odorata* (L.) RM King and H Robinson. I. Flowering behavior, pattern of growth and nitrate metabolism. Philippine *Weed Science Bulletin* **1:** 17-24.

Sarkar E, Chatterjee SN and Chakraborty P 2012 Allelopathic effect of Cassia tora on seed germination and growth of mustard. *Turkish Journal of Botany* **36**(5): 488-494.

Sharma GP, Singh JS and Raghubanshi AS 2005. Plant invasions: Emerging trends and future implications. *Current Science* **88**(5): 726-734.

Singh M, Kumar R, Sharma S, Kumar L, Kumar S, Gupta G, Dua K, Kumar D 2023. *Hedychium spicatum*: A comprehensive insight into its ethnobotany, phytochemistry, pharmacological and therapeutic attributes. *South African Journal of Botany* **161:** 638-47.

Snehlata Tripathi ST and Shukla RP 2007. *Effect of clipping and grazing on various vegetational parameters of grassland communities of Gorakhpur*, UP.

Subramaniyan V 2020. Therapeutic importance of Castor Seed oil. In book: *Nuts and Seeds in Health and disease Prevention* (second Edition). pp. 485-495.

Thakur M, Verma R, Kumar D, Das PP, Dhalaria R, Kumar A, Kuca K, Azizov S and Kumar D 2024. Revisiting the ethnomedicinal, ethnopharmacological, phytoconstituents and phytoremediation of the plant *Solanum viarum* Dunal. Naunyn-Schmiedeberg's *Archives of Pharmacology* **397**(8): 5513-5531.

Tripathi, RS 2013. *Alien plant invasion and its ecological implications: An Indian perspective with particular reference to biodiversity rich region. Invasive plant Ecology*. CRC Press, ISBN 9780429111082.

Uyi O 2020. *Mimosa diplotricha*: A review and synthesis of its problem and control options. *CABI Reviews* (2020).

Verma DM 1071. Cyperaceae of Assam and Neighboring areas: *Ph.D. Thesis. Gauhati University, Guwahati, Assam*; http://hdl.handle.net/10603/68154.

Waugh VV and Jain AK 2018. Status of ethnobotanical invasive plants in Western Madhya Pradesh, India. *South Africa Journal of Botany* **114**(4): 171-180.

Wong JY, Chen YS, Chakravarthi S, Judson JP, Raj L, Er HM 2013. The effects of *Euphorbia hirta* on the ultrastructure of the murine liver, kidney and aorta. *Experimental and Therapeutic Medicine* **6**(5): 1247-1250.

Worbs S, Kohler K, Pauly D, Avondet M, Schaer M, Dorner MD and Dorner B 2011. *Ricinus communis* Intoxications in Human and Veterinary Medicine: A summary of real cases. *Medicine, Environmental Science* **3**(10): 1332-1372.

Zheng Y, Ji X, Yu B, Ji K, Gallo D, Csizmadia E, Zhu M, Choudhury MR, De La Cruz L K, Chittavong V, Pan Z 2018. Enrichment-triggered pro-drug activation demonstrated through mitochondria-targeted delivery of doxorubicin and carbon monoxide. *Nature Chemistry* **10**(7): 787-794.

Received 14 July, 2025; Accepted 23 September, 2025