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Original Article

Ecological Status of *Alternanthera philoxeroides* (Mart.) Griseb. and its Associated Plants in the Context of Assam, India

Nandini Sharma, Gunamoni Das*

Faculty of Science, Assam down town University, Sankar Madhab Path, Gandhi Nagar, Panikhaiti, Guwahati 781026, Assam, India

**Corresponding Author's Email: gunamoni09@gmail.com*

Abstract

Assam, a state rich in biodiversity, is home to *Alternanthera philoxeroides* (Mart.) Griseb., a fast-growing, seasonal weed that is also consumed as a wild edible. The study revealed that the maximum growth of this weed occurs in the mid-summer months (June to September) in Assam. The plant contains phytochemical parameters like saponin, tannin, protein, flavonoids, steroids, and carbohydrates and is a highly nutritious plant. However, due to limited studies and a lack of proper scientific documentation, the plant remains underutilised. This research aims to provide a comprehensive understanding of the ecological status of the plant in the different study areas under natural ecosystems. The ecological status of *Alternanthera philoxeroides* (Mart.) Griseb. reflects the habitat, associated plants, and phytosociological parameters in randomly placed quadrates in different locations of Assam. In the present study the quantitative ecological parameters like Relative density (RD), Relative frequency (RF), Basal area (BA), Relative dominance (R dom), Importance Index Value (IVI), Simpson's Diversity Index (D), Species richness index (Dmg), and Pielou's evenness index (I) were conducted for *Alternanthera philoxeroides* (Mart.) Griseb. by using standard methodology. The results showed that the average IVI value of this plant was 122.1, which indicated its high regeneration capacity and greater ecological amplitude among the other associated plant species. From this study, we can provide a comprehensive understanding of the ecological study, which may serve as a valuable reference for future research in this field.

Keywords: *Alternanthera philoxeroides(Mart.) Griseb., Alligator Weed; Assam; Ecological Status*

Introduction

Scientific classification of *Alternanthera philoxeroides* (Mart.) Griseb.

Kingdom - Plantae.
Order - Caryophyllales.
Family - Amaranthaceae.
Class - Magnoliopsida.
Phylum - Magnoliophyta.
Genus – *Alternanthera*
Species – *philoxeroides*

About 70% of India's population resides in the rural sector; by using natural resources in a more efficient and scientific way, the socio-economic status of local people can be raised (Jagtap, Jakhi & Kashid, 2020). Indigenous knowledge refers to traditional knowledge passed down through generations within communities, inherited from their ancestors (Bora & Das, 2015). The documentation and dissemination of ancestral knowledge of indigenous people on traditional plant formulations among the upcoming generation is necessary for protection and preservation (Namsa*et*

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al., 2011). Because of limited knowledge among the human beings, cleaning of jungle for the new projects, change of way of living, increasing rate of population growth, floods, and soil erosion are the main factors that cause extinction of many ethno-medicinal plants (Kalita & Phukan, 2010). The traditional system of herbal medicine is eco-friendly and has become a topic of universal significance (Niranjan & Prabhurajeshwar, 2021). The majority of the therapeutic plants are herbs rather than shrubs, trees, and climbers. For the cultivation and processing of medicinal plants and the production of herbal medicines, agro-industrial mechanisms are essential (Singh S., 2023). The plant products are nutritious and absorbable and do not cause any adverse effects to the body (Lalitha & Vijayalakshmi, 2018). India is the topmost manufacturer of curative herbs and is considered the botanical garden of the earth. For its therapeutic value, alligator weed (Fig. 1) is considered an important medicinal plant. Growth of Indian medicinal plants decreases due to the global climatic change, overuse, and the influence of other unwanted species. Due to the ignorance of traditional knowledge and lack of communication amongst the younger generation, the medicinal plants have become valueless (Santhan, 2020). According to some studies, there are about 170 species of *Alternanthera* in the Western Hemisphere, of which 120 form in South America alone (Vogt, McGuire & Cushman, 1979). Water primrose (*Ludwigia sp.)* is a similar species to the study plant. The home gardens of upper Assam of Northeast India are very well off with food plants (Saikia & Khan, 2011). A study found that chickens fed a diet containing 1% *Alternanthera philoxeroides* showed significant improvements in body weight, weight gain, and feed intake, along with more efficient feed utilisation, particularly during the winter months. Additionally, these chickens exhibited enhanced immune responses and greater resistance to stress, as evidenced by increased levels of beneficial immune markers and natural antioxidant enzymes (Puro *et al*., 2025). The awareness of traditional knowledge and medicinal plants can play a key role in the exploitation and discovery of natural plant resources (Rasool *et al*., 2020). Alligator weed can survive in both terrestrial and aquatic habitats. During the rainy season, mainly in the months of April to December, *Alternanthera philoxeroides* (Mart.) Griseb. regenerates. Locally known as *Pani Matikaduri* or *Pani-Khutora*, this plant species is widely recognised among various ethnic communities of Assam, including the Boro, Karbi, Deori, Ahom, Rabha, Mising, and Sonowal. It is traditionally used by elders as a remedy for various female diseases and stomach ailments like stomachache, diarrhoea, dysentery, etc.

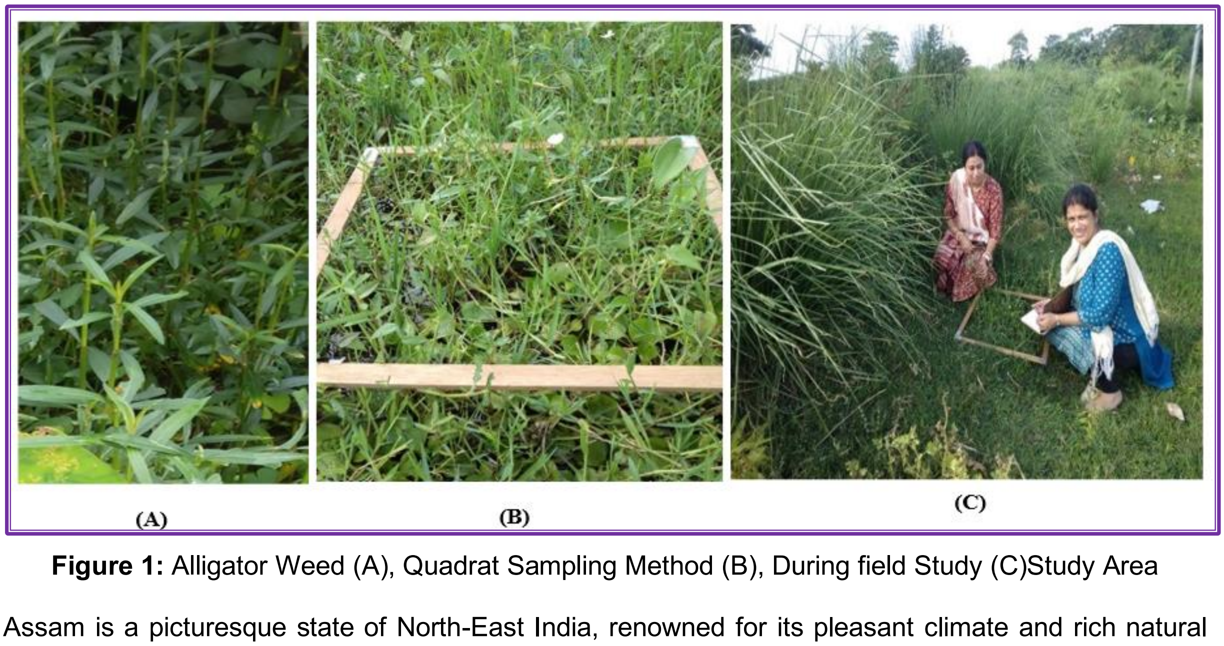

Figure 1: Alligator Weed (A), Quadrat Sampling Method (B), During field Study (C)Study Area

Assam is a picturesque state of North-East India, renowned for its pleasant climate and rich natural beauty. Assam experiences a humid subtropical climate characterised by warm summers, heavy monsoon rains, and mild winters. The state receives a heavy rainfall, especially during the monsoon season (June to September. The state is home to tropical evergreen and deciduous forests, grasslands, and wetlands. Alligator weed is available during the hot rainy season of Assam i.e, from April to October, but it can survive till the month of December also in marshy areas. Different locations of Assam (Figure 2) marked as Site 1 (Kamrup), Site 2 (Tezpur) and Site 3 (Jorhat) were selected to conduct the study following standard methods.

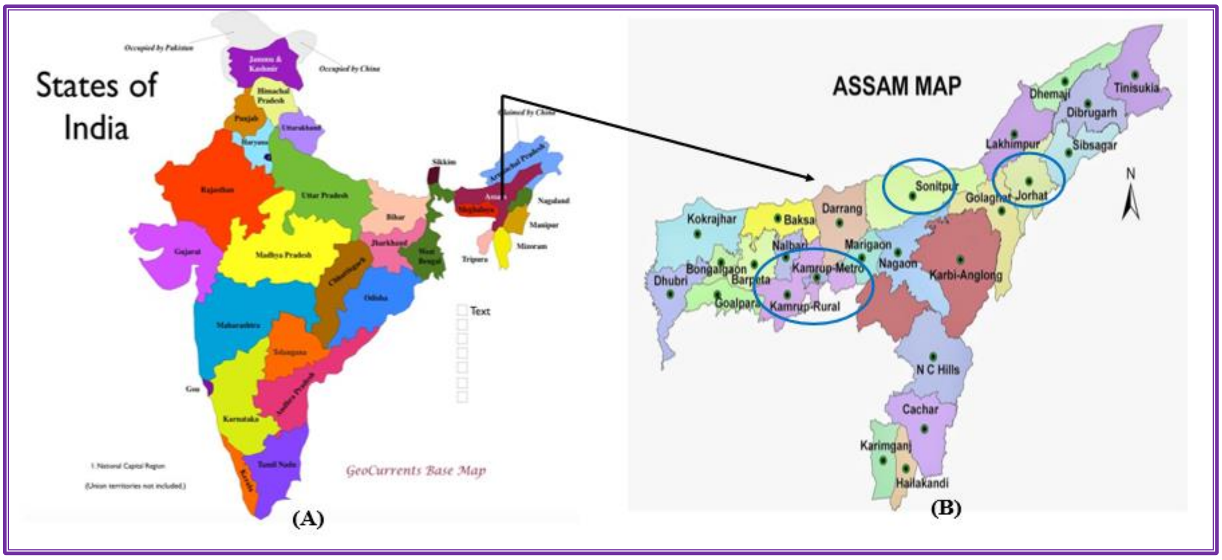

Figure 2: Map of India (A) and Assam showing Study Areas (B) (Source: Google Map)

Materials and Methods

A pair of secateurs, a polythene bag, newspaper, field notebook, pen, and quadrate was the primary tools used for this study. The quadrate method was employed to evaluate the associated plants and phyto-sociological parameters of *Alternanthera philoxeroides* (Mart.) Griseb. Data for the phyto-sociological parameters of the study plant, along with other species, were recorded from various study areas in Assam using standard formulas. The study was conducted during the periods of August to December 2022 and April to December 2024, with the height of the alligator weed ranging from 30 to 40 cm. Quadrates were randomly plotted at intervals of 3 to 6 metres in both terrestrial and semi-aquatic ecosystems. Photographs were taken with the help of GPS-enabled cameras to document the locations, and species identification was carried out for herbarium preparation. The number and names of the collected species were also recorded in the field notebook.

The following formulas were used during ecological study

A) Density = $\frac{\text{Total no. of individuals of species in all the quadrates,}}{\text{Total no. of quadrates studied.}}$

B) Frequency = $\frac{\text{No. of quadrates in which the species occur}}{\text{Total no. of quadrates studied}}$

C) Relative density (%) = $\frac{\text{Densityof a species}}{\text{Total density of all species.}} \times 100$

D) Relative Frequency (%) = $\frac{\text{Frequency of a species}}{\text{Total frequency of all species}} \times 100$

E) Basal area (BA)

Basal area of species in each quadrate= Average BA xNumber of individuals

= ($\pi d2/4$) xnumber of Individual.

d= Average basal diameter of the weed.

F) Relative dominance (%) = $\frac{\Sigma\text{BA of each species} \times 100}{\Sigma\text{BA of all the species}}$

G) Importance Value Index (IVI) = Relative Frequency (RF) + Relative Density (RD) + Relative dominance (Rdom)

H) Simpson's Diversity index(D) = 1 - {Σ n (n-1)/N (N-1)}

n= total no of organisms of a particular species.
N = total number of organism of all species.

I) Species richness index (Dmg) (Margalef, 1951)

$$Dmg = \frac{(S-1)}{LN}$$

S= Number of species.
N= Total number of individuals in the community

J) Shannon and Weiner diversity index (H)

$$H = -\Sigma Pi^*(LNPi)$$

Pi= Proportion of Individuals of the community.
LN= Natural logarithm.

(K) Pielou's evenness index (I)

$$I = H/H_{max}$$

H= Number derived from shannon's diversity index.
H_{max} = (-) Σ1/S x LN(1/S)
S= Total number of species.

Result

A total of 10 species were recorded at Site 1 (Kamrup) and Site 2 (Tezpur), while 9 species were recorded at Site 3 (Jorhat) respectively. At Site 1, the recorded species belonged to diverse botanical plant families, including Amaranthaceae (2 species), Onagraceae (1), Pontederiaceae (2), Poaceae (2), Solanaceae (1), Polygonaceae (1), and Cyperaceae (1). Site 2 exhibited a similar level of species richness, with taxa distributed across the following families: Amaranthaceae (2 species), Euphorbiaceae (1), Sapindaceae (1), Poaceae (4), Commelinaceae (1), and Polygonaceae (1). At Site 3, species composition included representatives from Amaranthaceae (1 species), Cyperaceae (1), Onagraceae (1), Pontederiaceae (1), Poaceae (2), Polygonaceae (1), Lamiaceae (1), and Fabaceae (1). This distribution reflects both family-level diversity and site-specific ecological variation among the sampled habitats. At Site 1, the families Amaranthaceae, Pontederiaceae, and Poaceae were recorded as dominant, each represented by two species. In contrast, Sites 2 and 3 showed dominance of the Poaceae family, with four and two species recorded respectively during the study.

In site 1, RD, RF, R dom, IVI (Table 1) of *Alternanthera philoxeroides* (Mart.) Griseb were found as 15.1, 33, 44.1 and 92.2. In site 2, the study plant showed the values of RD, RF, R dom, IVI as 45.7, 33.2, 12.7, 91.6 (Table 2). RD, RF, R dom, and IVI values of *Alternanthera philoxeroides* (Mart.) Griseb in site 3 were 24, 43, 56.1, 122.1 (Table 3). Based on the evaluated ecological parameters phytographs (Figure 3) were prepared for each study area. The phytographs of each site gave the idea and systematic approach presented here offers a valuable framework for conducting further ecological assessments, enhancing the overall understanding of species interactions and environmental adaptability of the study plant along with the other associate plant species.

Table 1: Quantitative Analysis of Phyto-sociological Data in Site1

Site 1	Table 1			
Species name	**Relative density (RD)**	**Relative frequency (RF)**	**Relative dominance(Rdom)**	**Importance Value Index (IVI)**
Alternanthera philoxeroides(Mart.) Griseb.	15.1	33	44.1	92.2
Ludwigiaadscendens(L.) H .Hara	14	20.2	32.1	66.3
Monochoria vaginalis. (Burm.f) C.Presl ex Kunth	12.2	20.3	30.1	62.7
Lolium multiflorum Lam	11.5	19.7	29.6	60.3
Pontederia crassipes Mart	11.3	19.6	34.1	64.6
Lycopersicon esculentum Mill.	11.2	19.1	30.2	60.2
Rumex crispus L.	10.7	17.6	15.6	43.9
Cyperus rotundus L	10.4	17.3	16.8	29.4
Chenopodium ambrosioides L.	9.7	8.8	7.1	25.6
Digitariaischaemum(Schreb.) Schreb.ex Muhi	9.2	8.5	0.7	18.4

Table 2: Quantitative Analysis of Phyto-sociological Data in Site2

Site 2	Table 2			
Species name	**Relative density (RD)**	**Relative frequency (RF)**	**Relative dominance (Rdom)**	**Importance Value Index (IVI)**
Alternanthera philoxeroides (Mart.) Griseb	45.7	33.2	12.7	91.6
Chrozophorarottleri Geiseler	40.6	30.3	9.8	81
Cardiospermum halicacabum L .	34.8	32.7	6.9	74.6
Cynodondactylon (L.) Pers.	36.1	33.8	10.8	80.6
Alternanthera sessilis (L.) R.Bx.ex	22.6	29.7	11.6	63.9
Cyperus rotundus L.	34.9	32.3	8.9	76.1
Tradescantia fluminensis Vell.	11. 6	6.5	7.7	25.8
Rumex crispus L.	37.8	34.8	6.9	79.5
*Rottboellia exaltata*L.f.	45.5	33.1	5.1	83.7
Digitaria ischaemum (Schreb.) Schreb.ex Muhi	36.9	34.5	6.8	78.2

Table 3: Quantitative Analysis of Phyto-sociological Data in Site3

Site 3	Table 3			
Species Name	**Relative density (RD)**	**Relative frequency (RF)**	**Relative dominance (Rdom)**	**Importance Value Index (IVI)**
Alternanthera philoxeroides (Mart.) Griseb.	24	43	56.1	122.1
*Cyperus difformis*L	20.1	33.7	53.1	106
Ludwigia adscendens (L.) H .Hara	17.1	44.6	44.2	105
Monochoria vaginalis (Burm.f) C.Presl ex Kunth.	15.6	32.2	36.1	83.2
Panicum repens L	18.2	30.2	50.1	98.7
Lolium multiflorum Lam.	20.2	36	46.1	102.1
Rumex crispus L.	23.3	33.7	55.1	111.3
Pogostemon cablin (Blanco) Benth.	19.6	22.5	34.1	76
Galega officinalis L.	10.1	34.5	30.1	74.7

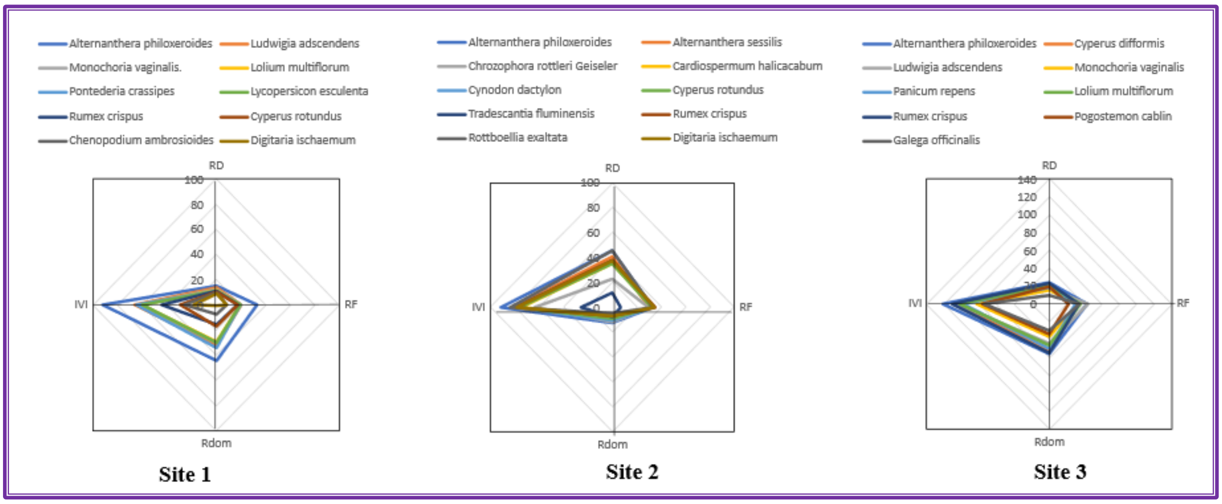

Figure 3: The Phytographs Signifies the Phyto-sociological Data of Sites 1, 2 and 3 Respectively for Alternanthera Philoxeroides (Mart.) Griseb

In this study we have covered all the ecological features and based on these data we have calculated Simpson׳s Diversity index, Species richness index (Dmg), Pielou's evenness index (I) of the study plant in 3 different sites and presented in a tabular form (Table 4) and presented in graph (Figure 4).

Table 4: Site-wise Ecological Diversity Indices for Associated Plant Communities

Site	Simpson׳s Diversity Index (D)	Species richness index (Dmg)	Pielou's evenness index (I)
1	0.81	2.41	0.35
2	0.84	4.57	0.71
3	0.76	4.15	0.31

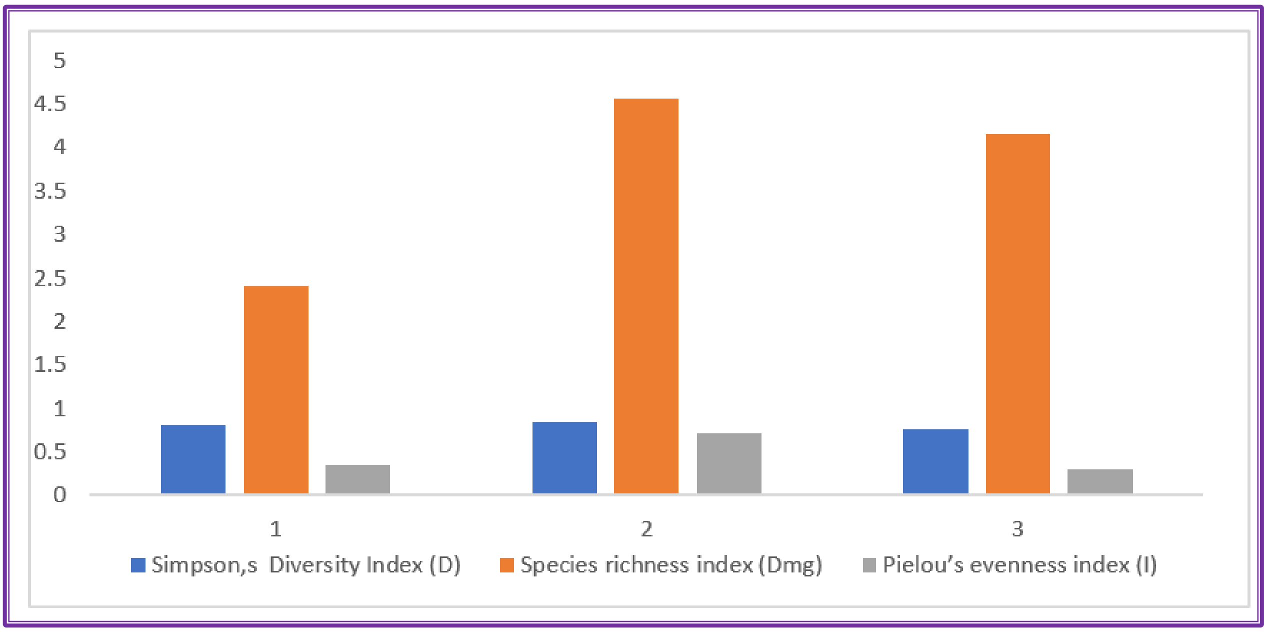

Figure 4: Simpson's Diversity Index (D), Species Richness Index (Dmg) and Pielou's Evenness Index (I) were Presented in a Graphical Form

Discussion

Although *Alligator weed* typically thrives in marshy or waterlogged environments, it has also been observed growing in terrestrial habitats such as roadsides, garden areas, and agricultural fields, particularly during the monsoon season. During the study period, it was noted that *Alternanthera philoxeroides* can overwinter in warm climates or aquatic environments, whereas in colder regions, the aerial parts senesce by December, leaving only the roots and subterranean stems viable (National Agriculture and Food Research Organization, 2025). The findings of the study further support that the target species releases allelopathic compounds, which suppress the growth of neighbouring crop plants, potentially leading to reduced yield and quality (Huang *et al*., 2025). This is also evidenced by the limited number of associated plant species found growing in proximity to it. The ecological status of *Alternanthera philoxeroides* (Mart.) Griseb. reveals its adaptability, ecological plasticity, and capacity to invade diverse habitats.

The results of the study also indicated that the study plant intensifies interspecific competition and alters soil properties, thereby influencing plant growth differently in areas with and without its invasion (Wu *et al*., 2024). Field observations revealed that *Alligator weed* coexists with a wide range of plant types, including herbs, shrubs, climbers, and creepers. However, it does not usually associate with large trees, indicating a possible preference for open or semi-open habitats with ample light availability. Among the associated species, *Ludwigia adscendens* (L.) H. Hara and *Monochoria vaginalis* (Burm.f) C. Presl ex Kunth were found to be common companion plants, particularly in Site 1 and Site 3.

The Important Value Index (IVI) data further emphasised the dominance of *Alligator weed* in Site 3, where it recorded the highest IVI value of 122.1. This high IVI reflects its strong ecological presence and competitiveness in that site. Interestingly, despite the high IVI in Site 3, regeneration of the species appeared to be more vigorous in Site 2, suggesting that Site 2 may offer more favourable conditions for seed germination or vegetative propagation, such as optimal moisture, soil nutrients, or less competition from other plant species.

These findings collectively indicate that the study plant is highly adaptive and capable of establishing itself in multiple ecological niches, which contributes to its invasive nature and challenges in management. The high IVI of *Alternanthera philoxeroides* (Mart.) Griseb. in the study area suggests that it has a strong ability to regenerate and remains ecologically dominant, even in the face of human disturbances (Sharma & Das, 2024). Although this plant prefers marshy areas as its habitat, terrestrial species are also found in roadside areas, gardens, and between the crops of agricultural land in Assam during the monsoon season. A study showed that *Alligator weed* invasion will alter the types of microbes in the soil, as fewer native plants may lead to reduced plant-microbe relationships, which can lower overall soil microbial diversity (Fang *et al*., 2024).

The results also showed that *Alligator weed* grows with different categories of plants, including herbs, shrubs, climbers, and creepers, but not with large trees. *Ludwigia adscendens* (L.) H. Hara and *Monochoria vaginalis* (Burm.f) C. Presl ex Kunth were common plants in Site 1 and Site 3. The study plant exhibited the highest IVI value of 122.1 in Site 3, indicating that its rate of regeneration was highest in this site compared to the others.

The value of Simpson's Diversity Indexsuggests that Site 2 (0.84) supports a more ecologically stable and heterogeneous environment, capable of sustaining a more evenly distributed and diverse species assemblage. Site 1 (0.81) shows moderately high diversity, suggesting a slightly less even or less rich species distribution compared to Site 2 and the relatively lower diversity in Site 3 (0.76) may be due to habitat disturbance, resource limitation, or competitive exclusion, which can lead to dominance by fewer species and reduced ecosystem complexity. Overall, the higher Simpson's index in Site 2 reflects a greater ecological resilience and possibly higher habitat quality, making it an important site from a biodiversity conservation perspective.

The species richness follows the trend: Site 2 > Site 3 > Site 1, this indicates that Site 2 (4.57) is the most biologically rich, possibly making it a priority site for conservation and ecological monitoring and Site 1, with the lowest richness (2.41), may require further investigation to determine limiting factors or anthropogenic impacts affecting its biodiversity and Site 3 (4.15) has slightly lower richness than Site 2, but still indicates a relatively diverse community.

The results derived from the above experiments and the quantitative analysis of phyto-sociological data signifies that ecological observations in understanding and preserving natural habitats is necessary. These observations play a fundamental role not only in protecting individual genetic stocks but also in safeguarding entire species from environmental threats and extinction. By analysing the composition, structure and dynamics of plant communities, ecologists can make informed decisions regarding biodiversity conservation and sustainable ecosystem management. A report (Li & Denich, 2024) stated that, if environmental conditions change, alligator weeds in stable land ecosystems can still trigger further invasions. A good way to use these weed plants is by turning them into feed for livestock and poultry. This helps reduce agricultural waste in an eco-friendly, low-cost, and sustainable way (Puro *et al*, 2025). Alligator weed harms water flow, water quality, native plants and animals and also causes serious economic and social problems (Snowy Monaro Regional Council 2024). The findings indicate that elevated water temperatures could intensify outbreaks of this invasive plant, especially in nutrient-rich freshwater environments (Xie *et al*, 2025).

Limitations

A. philoxeroides (Mart.) Griseb. is a seasonal plant, so field data were collected during specific seasons, which might not capture the year-round variations in plant growth, species interactions or regeneration patterns. Secondly, the role of human activities such as agriculture, land use change and pollution were observed but not deeply analysed, though these factors may significantly affect the spread and impact of the study plant.

Future Scope

To study the associate plant communities, identification and record of the plant species that commonly grow alongside *A. philoxeroides* (Mart.) Griseb and analysis of how the presence of this weed affects their diversity and abundance.In case of management strategies, finding data can support future control or management efforts aimed at minimising the invasive impact of *A. philoxeroides* in Assam's ecosystems.

Conclusion

The ecological status of *Alternanthera philoxeroides* (Mart.) Griseb. in this study reflects its associated plant species and phytosociological parameters, as observed through randomly placed quadrats across different locations in Assam.From this study we can provide a comprehensive understanding of the ecological characteristics of the plant which may be helpful to the other researchers to carry out their study in this related field. After frequently visiting the study areas it was observed that, deforestation, climatic change, flood, rapid urbanisation including various types of development works such as construction of buildings, industry, road etc. and growth of population, influence of other unwanted species destroys the natural habitat of Alligator weed. More attention including regular supervision of the areas, awareness programs among public, newspaper article, seminar, different types of projects with reliable data should be focused on the conservation of ethno-botanical information of this plant in rural and urban areas is highly needed.

Authors Contribution

Ms. Nandini Sharma and Dr. Gunamoni Das conceptualised and gathered all the field data and performed laboratory activities related to the identification of the plants and prepared the manuscript on the basis of original research work.

Conflict of Interest

The authors declare that they have no competing interests.

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