



# Assessment of Plants Biodiversity in Innerline Reserve Forest, Hailakandi, Assam, India

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## **Authors' contributions**

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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## **ABSTRACT**

The study deals with the "Assessment of Plant biodiversity of Innerline Reserve Forest, Hailakandi (Assam)" India. that was carried out in six sites. A total of 54 species of trees belonging to 32 families with 2,303 individuals, 17 species of shrubs belonging to 13 families with 2,195 individuals and 27 species of grasses and herbs belonging to 13 families with a total of 1,595 individuals were encountered. Quadrate size of 400 m<sup>2</sup> for trees, 100 m<sup>2</sup> for shrubs, 20 m<sup>2</sup> grasses and herbs. Compared to all the six sites, Site-III shows the highest Basal area (243.67 m<sup>2</sup>). In terms of IVI, *Tectona grandis* was found to be the most dominant tree species, *Clerodendrum infortunatum* was found to be the most dominant shrub species and *Oplismenus compositus* was found to be the most dominant grasses and herb species. In aspects for all the sites it can be concluded that Site-III showed the highest value for Shannon-Weiner Diversity Index (H') (3.2) for trees species, Site-V showed the highest value for Shannon- Weiner Diversity Index (H') (2.27) for shrubs species and Site-III showed the highest value for Shannon- Weiner Diversity Index (H') (2.32) for grass & herb species.

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**Keywords:** Basal area; diversity; IVI; dominant; parameter; species; *Artocarpus chaplasha*.

## 1. INTRODUCTION

Biodiversity is all the different kinds of life you'll find in one area viz. the variety of animals, plants, fungi, and even microorganisms like bacteria that make up our natural world. Each of these species and organisms work together in ecosystems, like an intricate web, to maintain balance and support life [1]. The loss of biodiversity, which also leads to ecological imbalance on a global scale, puts the natural ecosystem in any location at risk. It is vital to do study on plant biodiversity in order to know and assess the population structure [2-6]. The sustainability of the environment depends on plants since they are necessary for keeping ecosystems in balance. Because they give us food, animal feed, fibre, and medicines, plants not only have ecological relevance for us, but they also have economic and cultural significance. It is not unexpected that up to 80% of the world's human population relies on plants (or plant products) for their primary healthcare, according to estimates from the World Health Organization (WHO) (Bodeker et al., 2003). The diversity of living beings and the ecological systems in which they coexist make up biodiversity [7-12]. A measure of diversity can be considered to represent the number of unique things and their relative frequency. On a number of scales, from entire ecosystems to the chemical combinations that comprise the basic basis of heredity, these entities are arranged in terms of biological diversity [13-17]. As a result, the word includes various ecosystems, species, and genes as well as their relative richness and abundance [18-22]. Lovejoy (1980) coined the word "biodiversity" for the first time, and it is now most frequently used to refer to the quantity of species. Others elaborated on the definition by including the diversity and variability of living organisms, realizing that traditional methods of classifying and separating species were insufficient. The 1992 United Nations Earth Summit defined "biological diversity" as "the variability among living organisms from all sources, including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part: this includes diversity within species, between species and of ecosystems" [23-27]. This definition is used in the United Nations Convention on Biological Diversity [28]. Gaston & Spicer's definition in their book "Biodiversity: an introduction" is "variation of life at all levels of biological

organization" [29-33]. The Food and Agriculture Organization of the United Nations (FAO) defines biodiversity as "the variability that exists among living organisms (both within and between species) and the ecosystems of which they are part (Food and Agriculture Organization 2019) [34-39]. The North-east India is a part of foot hills of Himalayas and Indo-Burma "Biodiversity hot spot" in the world supporting about 50% of India's biodiversity and 40% of the flowering plants in this region are endemic [40-44]. Assam, a northeastern state of India, attracts many naturalists across the globe for the great variety of wildlife it possesses (Choudhury, 2006). Physiographically, the state is divided into plains constituted by Brahmaputra valley (north) and the Barak valley (south) and hilly tracts formed by NC Hills, parts of Cachar and Karbi Analog, and Barail range forms the highest hill range (1950m) in Assam [45-51].

The Hailakandi district is located in the southernmost part of Assam. Between latitude 24.08' and 24.530 North and longitude 92025' to 92.460 East, it can be found. It reaches typically 21 metres above sea level. The district, which is in the middle of the Barak Valley, is bounded to the west by the districts of Karimganj and Cachar, to the north and east by Mizoram state, and to the south and west by the districts of Cachar and Cachar. Hailakandi Forest Division falls under the Southern Assam Circle, Lower Assam Zone, the boundaries of the Division are co-terminus with that of the Civil District of Hailakandi. The total geographical area is 1327 Sq. Km. Innerline reserve forest Hailakandi is a type of semi-tropical evergreen forests and are a type of forest ecosystem characterized by high levels of rainfall and warm temperatures, often found in regions with a subtropical climate. The total area of the Innerline Reserved Forest is 398.494 sq. Km (39849.45 Ha.). The three range viz. Kukicherra, Gharmura and Matijuri Range comes within the Reserved Forest. These forests are known for their lush green vegetation, rich biodiversity, and the presence of both evergreen and deciduous tree species. Semi-tropical evergreen forests are typically found in regions with moderate to high rainfall, usually between 1500 and 2500 millimeters annually. These forests are characterized by a dense canopy of trees that remain green throughout the year, although there may be some seasonal leaf shedding [52-55]. The forests have a multi-layered structure, with tall canopy trees,

understory shrubs, and a diverse array of herbaceous plants. Semi-tropical evergreen forests are renowned for their high levels of biodiversity. Naturally the forest is dominated by *Artocarpus chama* in the Gharmura Range.

## 2. MATERIALS AND METHODS

### 2.1 Study Site

The study site is located in the district of Hailakandi (Assam). The study area is Innerline Reserve Forest Hailakandi (Assam). The total area of the Innerline Reserved Forest is 398.494 sq. Km (39849.45 Ha.). The three range viz. Kukicherra, Gharmura and Matijuri Range comes within the Reserved Forest. These forests are known for their lush green vegetation, rich biodiversity, and the presence of both evergreen and deciduous tree species. Semi-tropical evergreen forests are typically found in regions with moderate to high rainfall, usually between 1500 and 2500 millimetres annually. The Reserve Forest is rich in diversity but due to illegal logging and cutting down of the forest for jum cultivating decrease the richness of the forest. No detailed study in plant diversity and phytosociology in the study area is found in the literature, however, report suggest that the site is diverse. So, it is therefore necessary to conduct the detailed survey of the site. The present study is conducted to gather information about the existing flora in the study area to better understand the plant biodiversity of the Innerline Reserve Forest, Hailakandi (Assam)

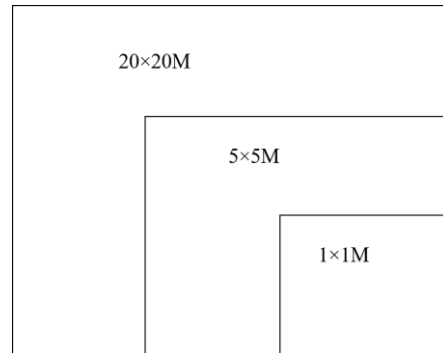
### 2.2 Map of Study Area

#### 2.2.1 Quadrat for vegetation index differencing

To compare ground data, quadrat methods is used where 10 % of the total forest is sampled through quadrat according to forest size. Each area of study was sub-divided into five categories for smaller group for sample site analysing of species distribution.

**Chart 1. Quadrat size for vegetation study**

Vegetation	Dimension
Herbaceous	1m x1m
Shrub	5m x 5m
Trees	20m x 20m



$$\text{Frequency} = \frac{\text{Number of quadrat in which species occur}}{\text{Total number of quadrat studied}} \times 100 =$$

$$\text{Density} = \frac{\text{Total number of individuals}}{\text{Total number of quadrat studies}}$$

$$\text{Abundance} = \frac{\text{Total number of individuals of the species}}{\text{Total number of quadrat in which species occurrence}}$$

$$\text{Relative Density} = \frac{\text{Number of individuals of a species}}{\text{Number of individuals of all species}} \times 100 =$$

$$\text{Dominance} = \text{Density for a species} \times \text{average basal area for species}$$

Basal Area:

Basal area of woody species with >5cm DBH will be calculated with the formula (Kent & Coker 1992)

$$\text{Basal area} = \pi D^2/4$$

Where,

D = The diameter of tree at Breast Height

Or

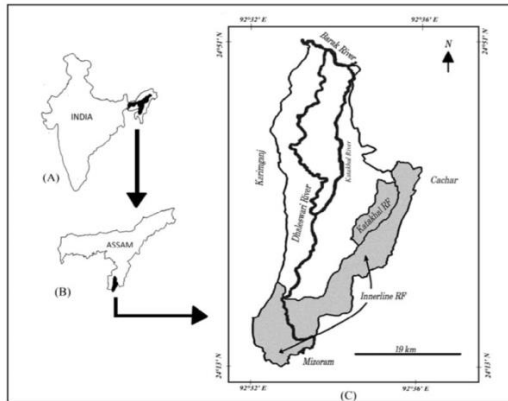
$$\text{Basal area} = Cbh^2/4\pi$$

Where,

Cbh = Circumference of tree at breast height

$$\text{Relative Frequency} = \frac{\text{Number of occurrence of a species}}{\text{Number of occurrence of all species}} \times 100 =$$

$$\text{Relative Dominance} = \frac{\text{Basal area of a species}}{\text{Basal area of all species}} \times 100$$



**Fig. 1. Map of (A) Country (B) State (C) Innerline RF**

Importance Value Index = Relative Dominance + Relative Density + Relative Frequency.

Species diversity:

$$\text{Shannon-Wiener Diversity Index (H')} = -\sum_{i=1}^s (P_i) (\log P_i)$$

Where,

s= number of species  
P= proportion of species i in the community.

Species richness:

The species richness is based solely on the number of species found in the given area (Magurran 1988)

$$D_{mg} = \frac{(S-1)}{\ln N}$$

Where,

S = Total number of species.  
N = Total number of individuals.

Index of species evenness:

$$E = \frac{H'}{\log S}$$

Where, E Index of evenness, H-Shannon-Wiener index and S- Total number of species

### 3. RESULTS AND DISCUSSION

#### 3.1 Tree Species

##### 3.1.1 Tree diversity of Innerline Reserve Forest, Hailakandi (Assam)

Upon studying the six selected sites of the Reserved Forest viz, Site I, II, III, IV, V & VI, determination of the diversity of the sites based



**Fig. 2. Map of study area Innerline Reserve Forest, Hailakandi (Assam)**

on various aspects were calculated which include Shannon and wiener index of species diversity (H'), Margalef's index of richness (D<sub>mg</sub>), Pielou index of evenness (E).

The graph shows that the tree species in all six sites concluded that Site-VI showed the highest value for Margalef's index of richness (D<sub>mg</sub>) with a value of 5.14, Site-III showed the highest value for Shannon Diversity Index (H') with a value of 3.2, Site-II showed the highest value for Pielou Index of Evenness (E) with a value of 0.96.

#### 3.2 Shrub Species

##### 3.2.1 Shrub diversity of Innerline Reserve Forest, Hailakandi (Assam)

Upon studying the six selected sites of the Reserved Forest viz, Site I, II, III, IV, V & VI, determination of the diversity of the sites based on various aspects were calculated which include Shannon and wiener index of species diversity (H'), Margalef's index of richness (D<sub>mg</sub>), Pielou index of evenness (E).

The graph shows shrub species in all six sites concluded that Site-V showed the highest value for Margalef's index of richness (D<sub>mg</sub>) with a value of 1.71, Site-V showed the highest value for Shannon Diversity Index (H') with a value of 2.27, Site-IV showed the highest value for Pielou Index of Evenness (E) with a value of 0.98.

#### 3.3 Grasses and Herb Species

##### 3.3.1 Grass and herb diversity of Innerline Reserve Forest, Hailakandi (Assam)

Upon studying the six selected sites of the Reserved Forest viz, Site I, II, III, IV, V & VI, determination of the diversity of the sites based

on various aspects were calculated which include Shannon and wiener index of species diversity (H'), Margalef's index of richness (Dmg), Pielou index of evenness (E).

**Table 1. List of the tree species on survey site**

Sr. No.	Scientific Name	Common Name	Local Name	Family
1	<i>Ailanthus grandis</i>	Tree of heaven	Buva	Simaroubaceae
2	<i>Albizia censis</i>	Chinese albizia	Sau-koroi	Mimosaceae
3	<i>Albizia procera</i>	Siris	Sirsi	Mimosaceae
4	<i>Alstonia scholaris</i>	Devil tree	Chatim	Apocynaceae
5	<i>Aquilaria malaccensis</i>	Agarwood	Agor	Thymelaeaceae
6	<i>Artocarpus chaplash</i>	Chaplash	Cham	Moraceae
7	<i>Artocarpus laucha</i>	Monkey jack	Bohot	Moraceae
8	<i>Bacaurea sapida</i>	Burmese grape	Bubhi	Phyllanthaceae
9	<i>Bischofia javanica</i>	Bishop wood	Kainjal	Euphorbiaceae
10	<i>Bombax ceiba</i>	Red silk-cotton tree	Shimul	Bombacaceae
11	<i>Bombax insigne</i>	Showy silk cotton tree	Bon simul	Bombacaceae
12	<i>Cassia fistula</i>	Golden shower tree	Bandar lathi	Fabaceae
13	<i>Chukrasia tabularis</i>	Chukrasia	Poma	Meliaceae
14	<i>Cinnamomum tamala</i>	Indian bay leaf	Tejpata	Lauraceae
15	<i>Crateva religiosa</i>	Sacred garlic-peaer	Borun	Capparaceae
16	<i>Cynometra polyandra</i>		Ping	Caesalpiniaceae
17	<i>Dillinia indica</i>	Elephant apple	Otenga	Dilleniaceae
18	<i>Dipterocarpus turbinatus</i>	Common gurjun oil tree	Gurjan	Dipterocarpaceae
19	<i>Duabanga grandiflora</i>	Duabanga	Ramdala	Sonneratiaceae
20	<i>Dysoxylum binectariferum</i>		Bandar fela	Meliaceae
21	<i>Elcocarprue floribundus</i>		Belphai	Elaeocarpaceae
22	<i>Syzygium cumini</i>	Jam	Jam	Myrtaceae
23	<i>Syzygium jambos</i>			
24	<i>Ficus auriculata</i>	Roxburgh fig		Moraceae
25	<i>Ficus hispida</i>	Hairy fig	Madar	Moraceae
26	<i>Ficus racemose</i>			Moraceae
27	<i>Gmelina arborea</i>	Gmelina	Gmair	Verbenaceae
28	<i>Hevea brasiliensis</i>		Rubber	Euphorbiaceae
29	<i>Hydnocarpus kurzii</i>		Chalmugra	Flacourtiaceae
30	<i>Kayea floribunda</i>		Korail	Clusiaceae
31	<i>Largerstroemia speciosa</i>		Jarul	Lythraceae
32	<i>Mallotus tetracoccus</i>	Rusty kamlā		Euphorbiaceae
33	<i>Mangifera sylvatica</i>		Bon Am	Anacardiaceae
34	<i>Messua ferrea</i>		Nageswar	Clusiaceae
35	<i>Neolamarckia cadamba</i>	Burflower-tree	Kadam	Lauraceae
36	<i>Oxoxylum indicum</i>	Indian trumpet tree	Phonur/Noka	Bignoniaceae
37	<i>Palaquium polyanthum</i>		Kurta	Sapotaceae
38	<i>Parkia speciosa</i>		Jongchak	Fabaceae
39	<i>Phocbe goalparensis</i>		Bonsum	Lauraceae
40	<i>Samanea saman</i>		Rain tree	Papilionaceae
41	<i>Sapium baccatum</i>	Milktrees	Bella/Java	Euphorbiaceae
42	<i>Sapindus mukorossi</i>			Sapindaceae
43	<i>Saraca asoca</i>	Ashoka	Ashok	Caesalpiniaceae
44	<i>Schima khasiana</i>		Banak	Theaceae
45	<i>Shorea robusta</i>	Sal tree	Sal	Dipterocarpaceae
46	<i>Spondias mombin</i>	Hog plum	Amra	Anacardiaceae
47	<i>Sterculia foetida</i>			Malvaceae
48	<i>Sterculia urens</i>		Odla	Sterculiaceae
49	<i>Sterculia villosa</i>		Udal	Sterculiaceae
50	<i>Tectona grandis</i>	Teak	Shagun	Verbenaceae
51	<i>Terminalia chebula</i>		Hartaki	Combretaceae
52	<i>Terminallice bellerica</i>	Belliric myrobalan	Bohera	Combretaceae
53	<i>Trewia nudiflora</i>		Bhuri	Euphorbiaceae
54	<i>Vitex spp.</i>		Awal	Verbenaceae

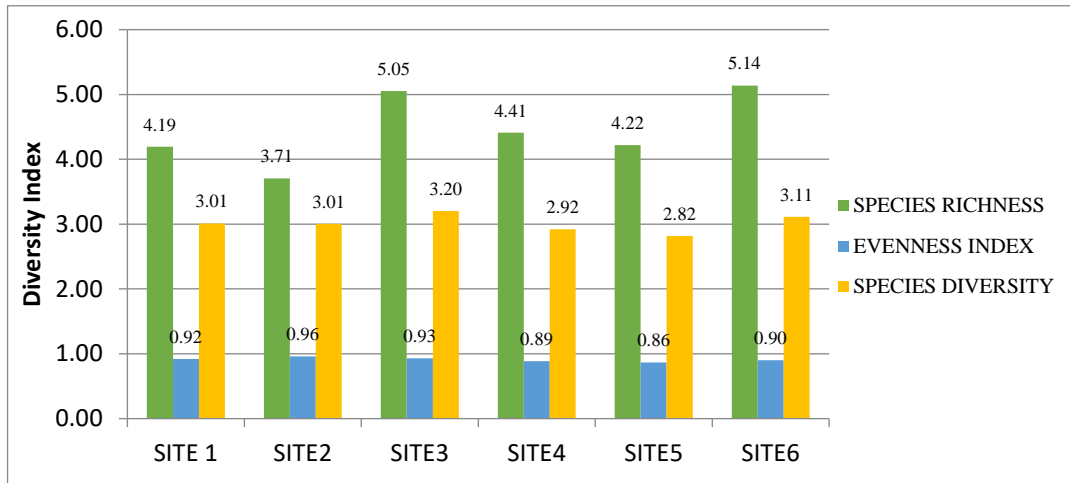


Fig. 3. Diversity parameter of tree species in different sites

Table 2. List of shrubs species

Sr. No.	Scientific name	Common name	Family
1	<i>Boehmeria penduliflora</i>	Boehmeria	Urticaceae
2	<i>Calamus tenuis</i>	Jati-bet	Arecaceae
3	<i>Calamus viminalis</i>	Rattan	Arecaceae
4	<i>Chromolaena odorata</i>	Chromolaena	Asteraceae
5	<i>Clerodendrum infortunatum</i>	Bhat/hill glory bower	Verbenaceae
6	<i>Goniothalamus cardiopetalus</i>	Ghat goniothalamus	Annonaceae
7	<i>Lantana camera</i>	Lantana	Verbenaceae
8	<i>Leea indica</i>	Bandicoot berry	Vitaceae
9	<i>Licuala lauterbachii</i>	Bougainville palm	Arecaceae
10	<i>Measa perlaria</i>	Maesa	Primulaceae
11	<i>Melastoma malabathricum</i>	Indian Rhododendron	Melastomataceae
12	<i>Phlogacanthus curviflorus</i>	Wild Nongmangkha	Acanthaceae
13	<i>Ricinus communis</i>	Castor oil plant	Euphorbiaceae
14	<i>Senna altata</i>	Candle bush	Fabaceae
15	<i>Tabernaemontana divaricata</i>	Pinwheelflower	Apocynaceae
16	<i>Triumfetta rhomboidea</i>	Diamond burbark	Malvaceae
17	<i>Urena lobata</i>	Caesarweed	Malvaceae

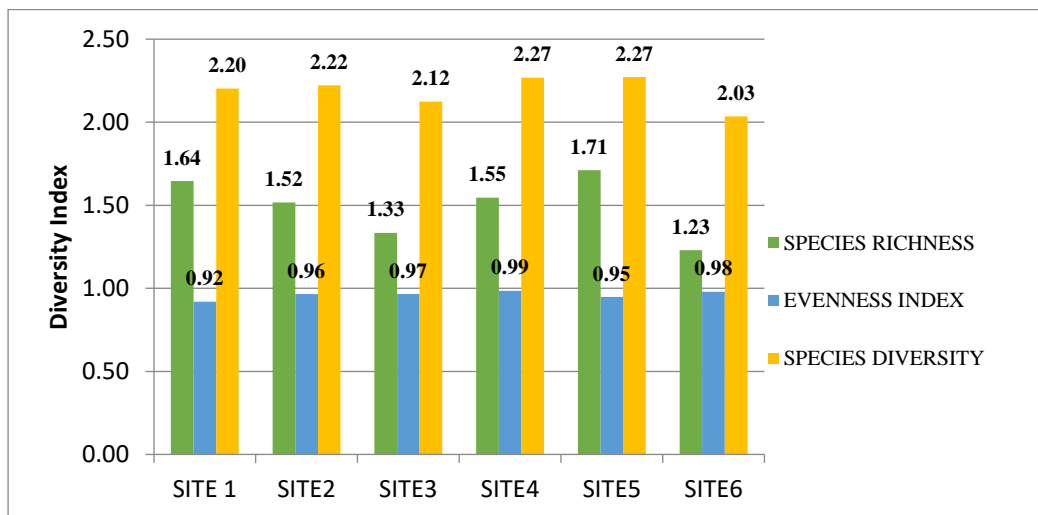
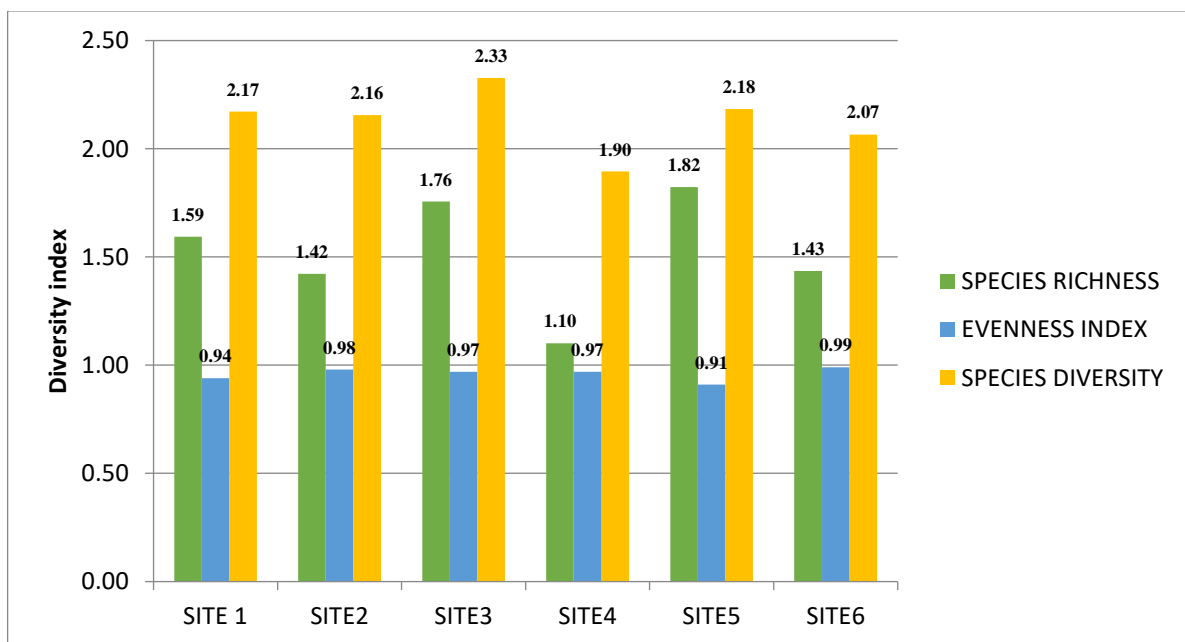


Fig. 4. Diversity parameter of shrub species in different sites

**Table 3. List of all grasses and herbs found in all six sites**

Sr. No.	Scientific Name	Common Name	Family
1	<i>Acmella uliginosa</i>	Marsh para cress	Asteraceae
2	<i>Ageratum houstonianum</i>	Bluemink	Asteraceae
3	<i>Aglaonema simplex</i>	Malayan Sword	Araceae
4	<i>Alocasia acuminata</i>	Pia/Gaint alocasia	Araceae
5	<i>Axonopus compressus</i>	Cow Grass	Poaceae
6	<i>Begonia obliqua</i>	Begonia	Begoniaceae
7	<i>Blumea lacera</i>	Blumea	Asteraceae
8	<i>Chrysopogon aciculatus</i>	Love grass	Poaceae
9	<i>Cladium mariscus</i>	Sawtooth sedge	Cyperaceae
10	<i>Colocasia esculenta</i>	Yam	Araceae
11	<i>Cynodon dactylon</i>	Bermuda grass	Poaceae
12	<i>Digitaria ciliaris</i>	Summer grass	Poaceae
13	<i>Diplazium esculentum</i>	Fiddlehead fern	Athyriaceae
14	<i>Dryopteris cristata</i>	Crested wood fern	Dryopteridaceae
15	<i>Dryopteris sublacera</i>	Male fern	Dryopteridaceae
16	<i>Eranthemum pulchellum</i>	Blue sage	Acanthaceae
17	<i>Gynura crepidioides</i>	Thickhead weed	Asteraceae
18	<i>Hedychium flavescens</i>	Yellow ginger	Zingiberaceae
19	<i>Imperata cylindrica</i>	Cogongras	Poaceae
20	<i>Lygodium japonicum</i>	Japanese climbing fern	Lygodiaceae
21	<i>Macrothelypteris torresiana</i>	Mariana maiden fern	Thelypteridaceae
22	<i>Memosa pudica</i>	Touch-me-not/Shameplant	Fabaceae
23	<i>Oplismenus hirtellus</i>	Basket grass	Poaceae
24	<i>Oplismenus undulatifolius</i>	Wavyleaf basketgrass	Poaceae
25	<i>Paspalum conjugatum</i>	Hilo grass	Poaceae
26	<i>Phragmites karka</i>	Tall reed	Poaceae
27	<i>Phrynium pubinerve</i>	Packing leaf	Marantaceae
28	<i>Thysanolaena maxima</i>	Tiger grass/ Broom grass	Poaceae
29	<i>Xanthium orientale</i>	Common cocklebur	Asteraceae



**Fig. 5. Diversity parameters of grass and herb species in different sites**

The graph shows that the grass & herb species in all six sites concluded that Site-V showed the highest value for Species richness (Dmg) with a value of 1.82, Site-III showed the highest value for Shannon Diversity Index (H') with a value of 2.32, Site-VI showed the highest value for Pielou Index of Evenness (E) with a value of 0.99.

#### 4. CONCLUSION

From the present research work in Innerline Reserve Forest, Hailakandi (Assam) can be concluded that the forest is abundantly populated by *Tectona grandis* & *Artocarpus chaplasha*. Where in overall, Site-III showed the highest IVI parameter of dominant tree species for *Tectona grandis* (36.14) comprised of 31 species of trees, Site-I showed the highest IVI parameter of dominant shrub species for *Clerodendrum infortunatum* (48.23) comprised of 11 species of shrub and Site-V showed the highest IVI parameter of dominant grass & herb species for *Oplismenus compositus* (54.05) comprised of 11 species of grass & herb species.

In aspects for all the sites it can be concluded that Site-III showed the highest value for Shannon-Weiner Diversity Index (H') (3.2) for trees species, Site-V showed the highest value for Shannon-Weiner Diversity Index (H') (2.27) for shrubs species and Site-III showed the highest value for Shannon-Weiner Diversity Index (H') (2.32) for grass & herb species.

#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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