

Assessment of Plant diversity in Nawab Wajid Ali Shah Zoological Garden, Lucknow, Uttar Pradesh

ABSTRACT

The present study entitled “Assessment of Plant Diversity in Nawab Wajid Ali Shah Zoological Garden, Lucknow, Uttar Pradesh” was conducted in Nawab Wajid Ali Shah Zoological Garden, Lucknow, Uttar Pradesh state in order to investigate the plant diversity of trees, shrubs and herbs present. A total 85 tree species belonging to 32 families, 23 shrub species belonging to 16 families and 15 grass and herb species 8 families were recorded. Fabaceae is the largest family in 20 species followed by Moraceae (11), Rutaceae, Meliaceae, Rubiaceae in tree species, Asparagaceae is the largest family in 6 species followed by Apocynaceae (5), Rubiaceae (3) in shrub species and Asteraceae is the largest family in 4 species followed by Poaceae (3), Amaranthaceae (3) in grass and herb species. Overall, Site-III (South-East) showed the highest IVI parameter of dominant tree species for *Sarasa asoca* (51.21), Site-IV (South-West) showed the highest IVI parameter of dominant shrub species for *Murraya paniculata* (164.42) and Site-II (North-East) showed the highest IVI parameter of dominant grass & herb species for *Rivina humilis* (62.13).

Key point- Diversity, IVI, Dominant, Parameter, Species.

INTRODUCTION

India is one of the most diverse nations in the world. It ranks ninth in terms of plant species richness in the world. Two of the world’s twenty-five biodiversity hotspots are found in India. The country consists of ca. 19294 flowering plants (Karthikeyan, 2000) out of which ca. 2560 species have been estimated as trees (Rao, 1994).

Plant species diversity is complex in nature and its structure and composition differs from place to place Because of varying climatic condition and topography (Raturi 2012). Compared to the other ecosystems, tropical Forest ones, the most complex of all the terrestrial ecosystems are harshly exploited ecosystems of the biosphere (Bahuguna 1999). It covers 7 % of the earth’s land surface, but harbors more than half of the world’s plant and Animal biodiversity (Wilson 1988).

Plant diversity is a critical component of the earth’s biodiversity and plays an important role in maintaining the balance of the ecosystem (Myers, et.al. 2000). The number of plant species in the world is estimated to be around 390,000, and they are found in a wide range of habitats, including deserts, rainforests, and alpine regions (Wagner, 2016). Each species has its own unique adaptations and characteristics that allow it to thrive in its environment (Raven, et.al.,

1999). Some plants have deep roots to access water in arid regions, while others have developed strategies to protect themselves from herbivores (Solbrig, *et.al.*, 1976).

Uttar Pradesh is one of the largest provinces of India occupying an area of about 2,41,286 sq. Km out of which 21,291 sq. Km consists of forest and tree cover which is only about 3% of total forest cover of the country because the maximum lands have been occupied by agricultural fields and dense human population. Although the forest cover is very minimal, however, it harbours good number of flowering plants due to its varied climatic conditions.

The geographical position, climate and Physiography of the state favour high amount of biological diversity. It is bestowed with wide Range of floristic elements including many therapeutically and economically valuable plant Species. Majority of its area belongs to the Gangetic plains, which support agriculture-based Economy, dense human settlements and rich cultural diversity. It is important to document the Floristic wealth of such a large geographical land and one of the diverse agro-economic Zone for the optimum utilization of this natural resources. Several institutes, universities and Departments are engaged in documenting the floristic diversity of the state. Botanical Survey of India has also taken initiatives in publishing the State Flora of Uttar Pradesh in three volumes. The present work is aimed at compiling the bibliographic references Available which are pertaining to the floristic documentation of Uttar Pradesh. The introductory Chapter highlights the physiography, climate, topography, forest types and floristic composition of the state for a ready reference.

Lucknow is the capital of Uttar Pradesh and it is situated on the northern Gangetic Plains of India. It is surrounded on the eastern side by District Barabanki, on the Western side by district Unnao, on the southern side by Raebareli and on the northern side by Sitapur and Hardoi districts. It is situated 123 mts above sea level. It is situated on 26.30 & 27.10 North latitude and 80.30 & 81.13 East longitude. Lucknow covers an Area of 3,244 sq.km. The distance from the sea gives Lucknow an extreme type of continental climate with the prevalence of continental air during major parts of the year. Only during the four months from June to September does the air of oceanic origin penetrate to this region and causes increased humidity, cloudiness and rain. About 75 % of the total rainfall is realized during these four months. The temperature may rise up to about 46 degrees Celsius in summers, though the average temperature is around 38-39 °C. The city stands at an elevation of approximately 123mt (404 ft) above sea level. Lucknow district covers an area of 2,528 square km (976 sq mi).

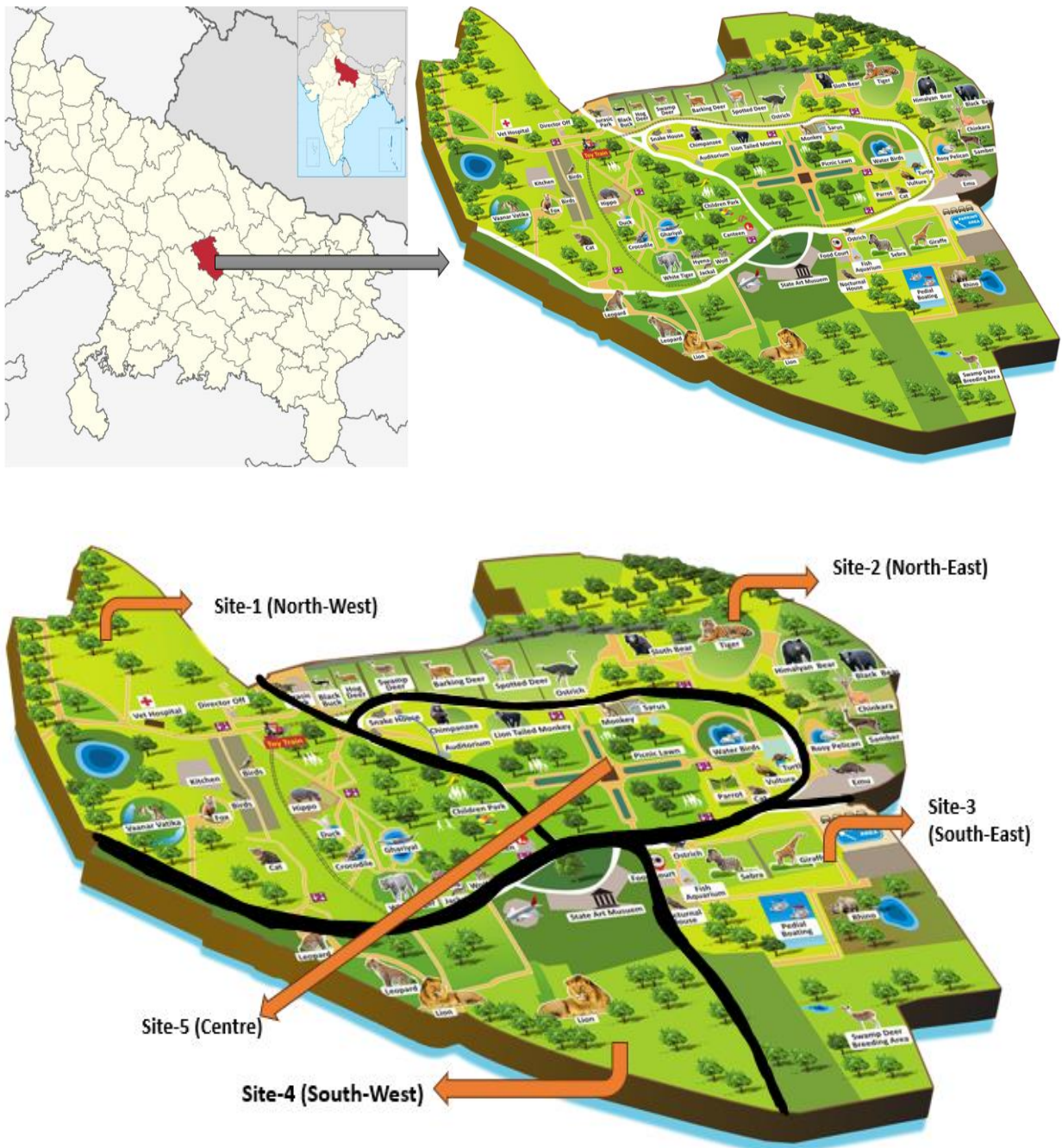
MATERIALS AND METHODS

Study Site

The study site is located at Hazratganj in Lucknow, Uttar Pradesh. The study site is *Nawab Wajid Ali Shah Prani Udyan*, earlier known as Prince of Wales Zoological Gardens or popularly known as Lucknow Zoological Garden which was constituted in the year 1921 with 71.6-acre (29 ha) area. This campus is lush green arboretum having more than 5000 trees of 100 species and act as lung of the city. The management body have added one of the best Nature Interpretation Centre in the Country, which give comprehensive information related to wild animals and its habitats of the state. No detailed study in phytosociology in the study area is

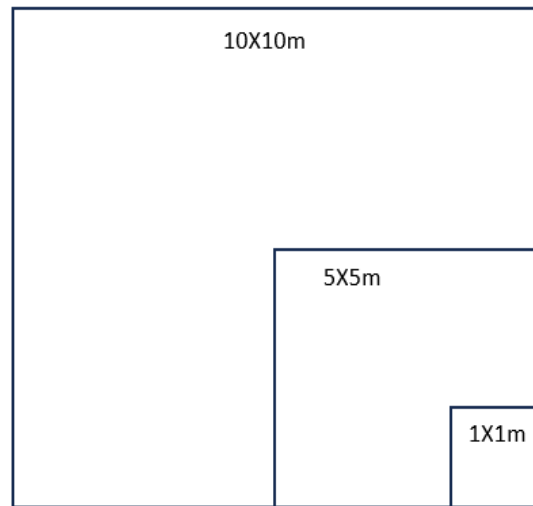
found in the literature; however, reports suggest that the site is very diverse. So, it become imperative to conduct a detailed research work in the site. The present study is designed to gather information about existing flora in the study area enabling to better understand the biodiversity of the zoological park.

Fig 1 : Map of study Area



Vegetative sampling and analysis

The vegetation analysis was carried out by using the quadrates of random sampling method. Quadrates of 10m * 10m (100 m²) size were randomly laid to examine tree species, quadrates size 5m * 5m (25m²) for shrubs and 1m * 1m size for herbs was chosen in each quadrate at selective site.



$$\text{Basal area} = \pi r^2$$

$$\text{Density} = \frac{\text{Total no of individual of a spp in all quadrate}}{\text{Total no of quadrate studied}}$$

$$\text{Frequency} = \frac{\text{no. of quadrate in which spp occurred}}{\text{Total no of quadrate studied}} \times 100$$

$$\text{Abundance} = \frac{\text{Total number of individual of a species in all quadrate}}{\text{Total number of quadrate in which species occurred}}$$

$$\text{Relative Density} = \frac{\text{Density of a spp}}{\text{Total density of all the spp}} \times 100$$

$$\text{Relative Frequency} = \frac{\text{value of frequency of a spp}}{\text{Total frequency of all the spp}} \times 100$$

$$\text{Relative Dominance} = \frac{\text{Total basal area of a spp}}{\text{Total basal area of all the spp}} \times 100$$

Importance Value Index (for tree species)

IVI = relative density+ relative frequency+ relative dominance.

Importance value index (for shrub and herb species)

IVI = Relative density+ relative frequency+ relative abundance

Species Diversity: It is defined as the number of species and abundance of each species that lives in a particular location.

It is calculated by using the formula (**Shannon Wiener, 1963**).

Diversity Index(H) = $\sum P_i (\log P_i)$

Where, $P_i = n/N$ (proportion of the important species in the community).

n = no. of individual species

N =Total no. of individuals.

Species richness: - Species richness the species richness is based solely on the number of species found in the given area (**Magurran, 1988**).

$$\text{Species Richness} = \frac{(S - 1)}{\log N}$$

Where, S= number of species

N = total number of individuals in all sample

Index of species evenness: - Species evenness (E) is the relative distribution of individuals among the species present in a community. The index of species evenness (E) was calculated by the formula developed by **Pielou (1966)** as provided below:

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

Where, E = Index of evenness,

H' = Shannon-Wiener index and

S = Total number of Species

In = Bits per individuals

RESULT AND DISCUSSION

The vegetation composition in Nawab Wajid Ali Shah Zoological Garden recorded in 25 quadrates of 100 m² in sizes shows that total of 85 species of trees were found. The species along with their attributes and other recorded parameters for phytosociological attributes are shown below in the different tables.

Table .1: List of the Trees Species on Survey site

S. No.	Tree species	Common name	Family
1	<i>Acacia auriculiformis</i>	Auri	Fabaceae
2	<i>Acacia catechu</i>	Cutch tree	Fabaceae
3	<i>Acacia nilotica</i>	Babul	Fabaceae
4	<i>Aegle marmelos</i>	Bel	Rutaceae
5	<i>Albizia lebbbeck</i>	Siris	Fabaceae
6	<i>Albizia procera</i>	Siris	Fabaceae
7	<i>Alstonia scholaris</i>	Saptaparani	Apocynaceae
8	<i>Annona squamosa</i>	Custard apple	Annonaceae
9	<i>Neolamarckia cadamba</i>	Kadamba	Rubiaceae
10	<i>Archontophoenix alexandrae</i>	King palm	Arecaceae
11	<i>Artocarpus heterophyllus</i>	Kathal	Moraceae
12	<i>Artocarpus lacucha</i>	Monkey fruit	Moraceae
13	<i>Averrhoa carambola</i>	Star fruit	Oxalidaceae
14	<i>Azadirachta indica</i>	Neem	Meliaceae
15	<i>Bauhinia racemosa</i>	Bidi leaf tree	Caesalpiaceae
16	<i>Bauhinia variegata</i>	Kachnar	Fabaceae
17	<i>Ficus Benjamina</i>	Star lite	Moraceae
18	<i>Bombax ceiba</i>	Semal	Bombacaceae
19	<i>Borassus flabellifer</i>	Palmyra palm	Arecaceae
20	<i>Butea monosperma</i>	Dhak	Fabaceae
21	<i>Carica papaya</i>	Papeeta	Caricaceae
22	<i>Cassia auriculata</i>	Mature tea tree in English	Caesalpiaceae
23	<i>Cassia fistula</i>	Amaltas	Fabaceae

24	<i>Citrus aurantium</i>	Bitter orange	Rutaceae
25	<i>Citrus decumana</i>	Pomelo, shaddock	Rutaceae
26	<i>Citrus maxima</i>	Pummelo	Rutaceae
27	<i>Citrus sinensis</i>	Sweet orange	Rutaceae
28	<i>Dalbergia sissoo</i>	Sesham	Fabaceae
29	<i>Delonix regia</i>	Gulmohar	Fabaceae
30	<i>Diospyros melanoxylon</i>	Coromandel ebony	Ebenaceae
31	<i>Elaeodendron glaucum</i>	Ceylon tea	Celastraceae
32	<i>Emblica officinalis</i>	Aonla	Euphorbiaceae
33	<i>Eucalyptus Hybrida</i>	Mysore gum	Myrtaceae
34	<i>Feronia limonia</i>	Curd apple	Rutaceae
35	<i>Ficus benghalensis</i>	Bargad	Moraceae
36	<i>Ficus carica</i>	Anjeer	Moraceae
37	<i>Ficus elastica</i>	Black rubber	Moraceae
38	<i>Ficus glomerata</i>	Gular	Moraceae ae
39	<i>Ficus lacor buch- ham</i>	Java fig	Moraceae
40	<i>Ficus racemosa</i>	Goolar	Moraceae
41	<i>Ficus religiosa</i>	Peepal	Moraceae
42	<i>Gardenia latifolia</i>	Indian boxwood	Rubiaceae
43	<i>Grevillea robusta</i>	Silver oak	Proteaceae
44	<i>Grewia subinaequalis</i>	Phalsa	Malvaceae
45	<i>Hesperethusa crenulata</i>	Wood apple	Rutaceae
46	<i>Hevea brasiliensis</i>	Green rubber	Euphorbiaceae
47	<i>Holoptelea integrifolia</i>	Chilbil	Ulmaceae

48	<i>Jacaranda mimosifolia</i>	Fern tree	Bignoniaceae
49	<i>Leucaena leucocephala</i>	White popinac	Fabaceae
50	<i>Madhuca indica</i>	Mahua	Sapotaceae
51	<i>Mangifera indica</i>	Aam	Anacardiaceae
52	<i>Melia azedarach</i>	Pride of India	Meliaceae
53	<i>Milium tomentosum</i>	Hoom	Annonaceae
54	<i>Millingtonia hortensis</i>	Indian cork tree	Bignoniaceae
55	<i>Mimusops elengi</i>	Spanish cherry	Sapotaceae
56	<i>Mitragyna parvifolia</i>	Kadam	Rubiaceae
57	<i>Moringa oleifera</i>	Drumstick tree	Moringaceae
58	<i>Morinda tinctoria</i>	Taal	Rubiaceae
59	<i>Morus alba</i>	Shahtoot	Moraceae
60	<i>Nephelium litchi</i>	Lychee	Sapindaceae
61	<i>Nyctanthes arbor-tristis</i>	Tree of sorrow	Oleaceae
62	<i>Phoenix canariensis</i>	Phoenix palm	Arecaceae
63	<i>Phoenix sylvestris</i>	Wild date palm	Arecaceae
64	<i>Pithecellobium dulce</i>	Manila tamarind	Fabaceae
65	<i>Pongamia pinnata</i>	Karanja tree	Fabaceae
66	<i>Populus Species</i>	popular	Salicaceae
67	<i>Prosopis juliflora</i>	Mesquite	Mimosaceae
68	<i>Prunus cummunis</i>	Aalu bukhara	Rosaceae
69	<i>Psidium guajava</i>	Amrood	Myrtaceae
70	<i>Punica granatum</i>	Anar	Punicaceae
71	<i>Putranjiva roxburghii</i>	Putijia	Euphorbiaceae

72	<i>Pyrus communis</i>	Common pear	Rosaceae
73	<i>Sanctum album</i>	Chandan	Fabaceae
74	<i>Saraca asoca</i>	Ashok	Fabaceae
75	<i>Sapindus emarginatus</i>	Notched leaf soapnut	Sapindaceae
76	<i>Sesbania grandiflora</i>	Agasti	Fabaceae
77	<i>Shorea robusta</i>	Saal	Dipterocarpaceae
78	<i>Syzygium cumini</i>	Java plum	Myrtaceae
79	<i>Tamarindus indica</i>	Imli	Fabaceae
80	<i>Tamarix aphylla</i>	Athel pine	Tamaricaceae
81	<i>Tectona grandis</i>	Shagaun	Lamiaceae
82	<i>Terminalia arjuna</i>	Arjun	Combretaceae
83	<i>Terminalia chebula</i>	Chebulic Myrobalan	Combretaceae
84	<i>Tonna ciliate</i>	Red cedar	Meliaceae
85	<i>Ziziphus mauritiana</i>	Ber	Rhamnaceae

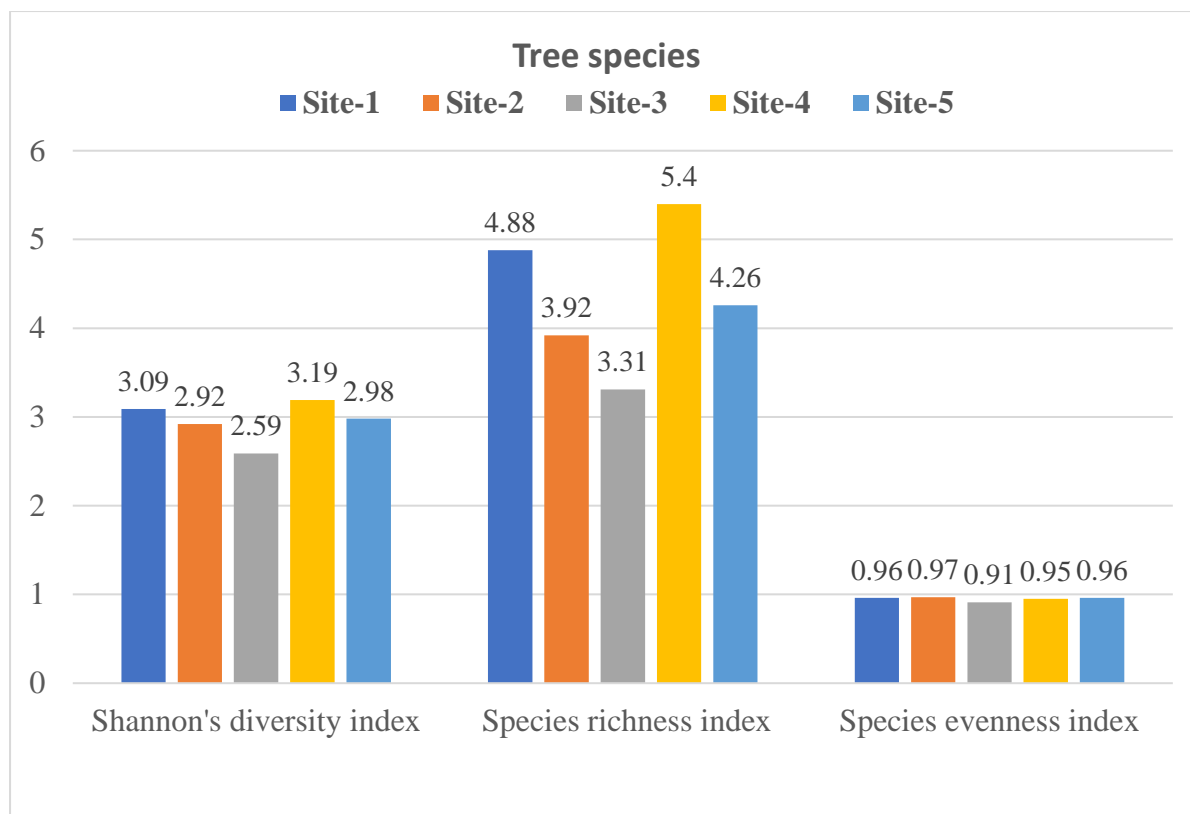


Fig.2- Diversity parameters of tree species in all V sites

The graph shows the comparative study of Shannon – Weiner Diversity Index, Margaret’s Species Richness Index and Pielou’s Species Evenness Index for tree species. According to this study work (South-West) site IV shows highest value of Diversity Index (H') (3.19) but (South-East) site III showed lowest value of Diversity Index (H') (2.59). On the other hand (South-West) site IV shows highest species richness (5.4) followed by (North-West) site IV (4.88) while South-East site (3.31) shows lowest species richness. In terms of species Evenness North-West site & Centre. site (0.96) shows highest as well as same values while South-East site (0.91) shows lowest value for species Evenness Index.

List of the Shrub Species on Survey site

The vegetation composition in Nawab Wajid Ali Shah Zoological Garden, Lucknow recorded in 5 quadrates of 25 m² in size, shows that a total of 23 species of shrubs were found. The species along with their attributes and other recorded parameters for phytosociological attributes are shown below in the different tables.

Table .2: List of the shrubs on survey site:

S. No.	Shrubs name	Common name	Family
1	<i>Allamanda cathartica</i>	Almanda	Apocynaceae
2	<i>Bougainvillea glabra</i>	Bougainvillea	Nyctaginaceae

3	<i>Calliandra riparia</i>	Red powder puff	fabaceae
4	<i>Calotropis procera</i>	Madaar	Apocynaceae
5	<i>Carissa spinarum</i>	Karaunda	Apocynaceae
6	<i>Cascabela thevetia</i>	Peela bans	Apocynaceae
7	<i>Codiaeum variegatum</i>	Petro caroten	Euphorbiaceae
8	<i>Dracaena draco</i>	Dragon tree	Asparagaceae
9	<i>Dracaena kedarnath</i>	Corn plant	Asparagaceae
10	<i>Dracaena Mahatma</i>	Dragon plant	Asparagaceae
11	<i>Gardenia jasminoides</i>	Gandhraj champa	Rubiaceae
12	<i>Hibiscus rosasinensis</i>	Gudhal	Malvaceae
13	<i>Ixora coccinea</i>	Ixora pink	Rubiaceae
14	<i>Ixora singaporensis</i>	Ixora singapori	Rubiaceae
15	<i>Jasminum sambac</i>	Bela, mogra	Oleaceae
16	<i>Lantana camara</i>	Lantana	Verbenaceae
17	<i>Magnolia champaca</i>	Sward champa	Magnoliaceae
18	<i>Murraya paniculata</i>	Manokamini	Rutaceae
19	<i>Solanum chenopodioides</i>	White tip nightshade	Solanaceae
20	<i>Tecoma stans</i>	Tecona parmal	Bignoniaceae
21	<i>Thuja occidentalis</i>	Mor pankhi	Cupressaceae
22	<i>Tibouchina semidecandra</i>	Begam bahar	Melastomataceae
23	<i>Zamia furfuracea</i>	Zamia palm	Zamiaceae

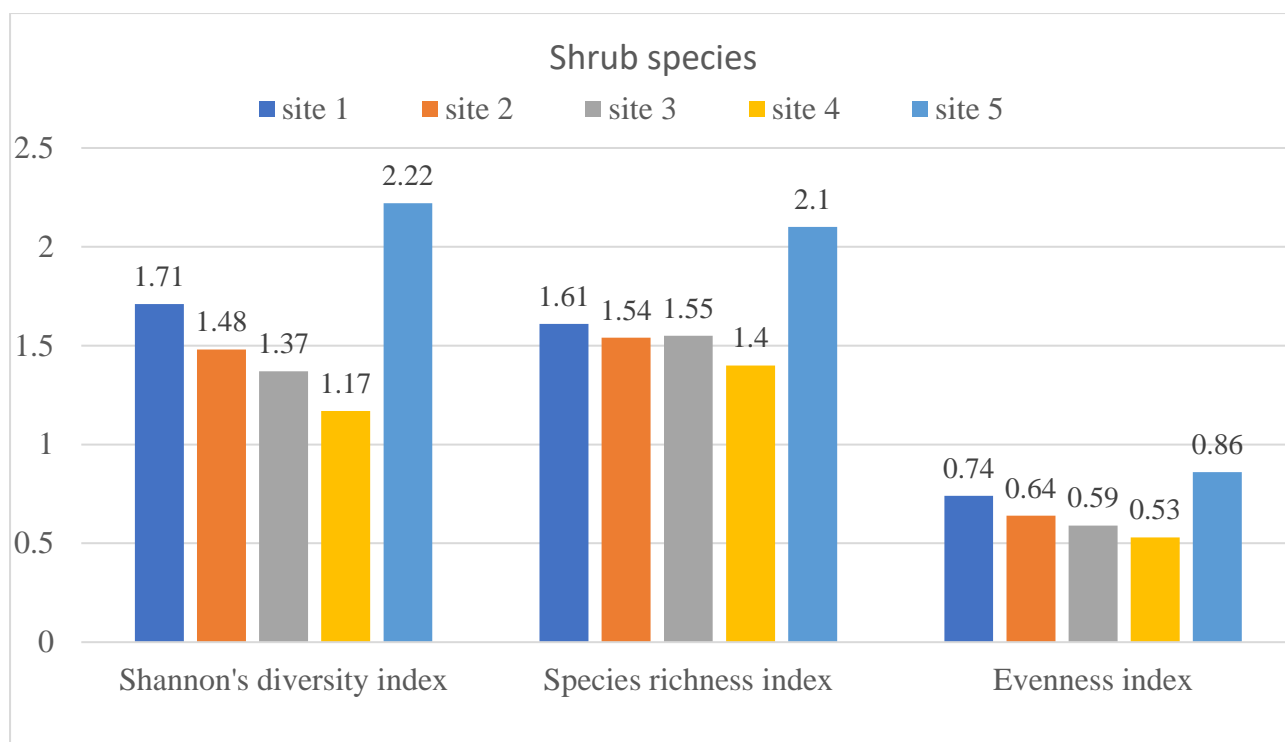


Fig.3- Diversity parameters of Shrub species in all V sites

The graph shows the comparative study of Shannon – Weiner Diversity Index, Margaret’s Species Richness Index and Pielou’s Species Evenness Index for shrub species. According to this study work site V (Centre) shows highest value of Diversity Index (H') (2.22) but site IV (South-West) showed lowest value of Diversity Index (H') 1.17. On the other hand, site V (Centre) shows highest species richness (2.1) followed by site I (North-West) (1.61) while site IV (South-West) (1.4) shows lowest species richness. In terms of species Evenness site V (Centre) (0.86) shows highest values while site IV (South-West) (0.53) shows lowest value for species Evenness Index.

List of the Grass and Herb Species on Survey site

The vegetation composition in Nawab Wajid Ali Shah Zoological Garden, Lucknow recorded in 5 quadrates of (1*1) m² in size, shows that a total of 15 species of herbs & grasses were found. The species along with their attributes and other recorded parameters for phytosociological attributes are shown below in the different tables.

Table 3: List of the Grass and Herbs on survey site

S.No.	Scientific Name	Common Name	Family
1	Acalypha indica	Indian copper leaf	Euphorbiaceae
2	Ageratum conyzoides	Goat weed	Asteraceae
3	Ageratum houstonianum	Flossflower	Asteraceae

4	<i>Alternanthera bettzickiana</i>	Red calico plant	Amaranthaceae
5	<i>Alternanthera pungens</i>	Khaki weed	Amaranthaceae
6	<i>Alysicarpus bupleurifolius</i>	SweetAlice clover	Fabaceae
7	<i>Amaranthus viridis</i>	Slender amaranth	Amarathaceae
8	<i>Anagallis arvensis</i>	Scarlet pimpernel	Primulaceae
9	<i>Argemone mexicana</i>	Mexican prickly poppy	Papavaraceae
10	<i>Brachiaria eruciformis</i>	Sweet signal grass	Poaceae
11	<i>Chloris barbata</i>	Purple chloris	Poaceae
12	<i>Chromolaena odorata</i>	Siam weed	Asteraceae
13	<i>Cynodon dactylon</i>	Doob	Poaceae
14	<i>Parthenium hysterophorus</i>	Santa maria	Asteraceae
15	<i>Rivina humilis</i>	bloodberry	Phytolaccaceae

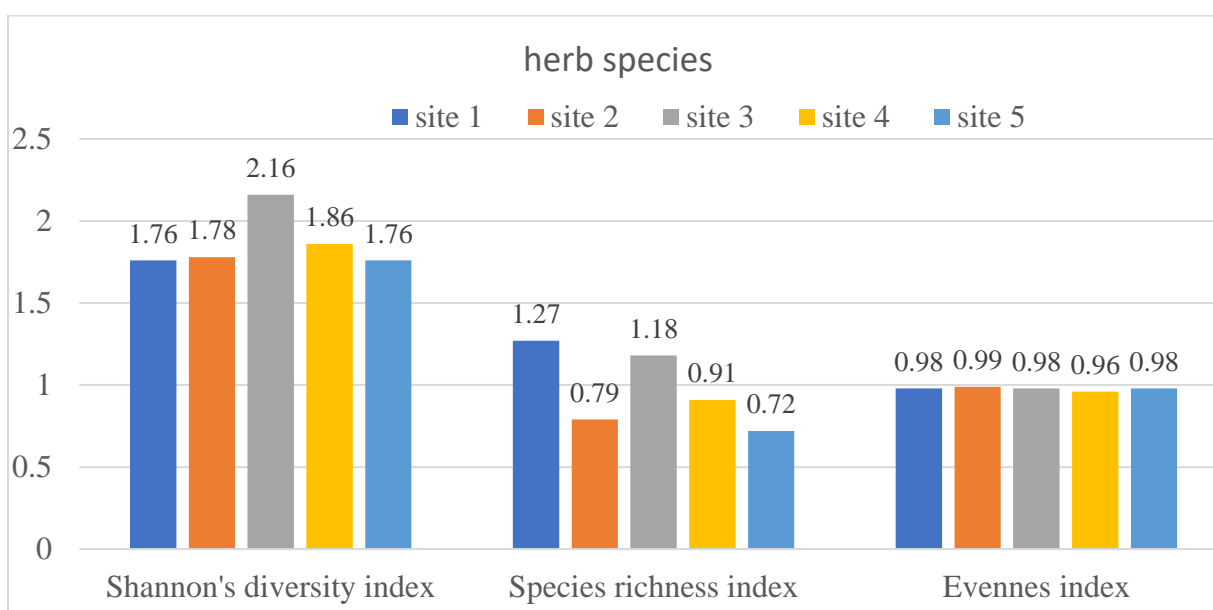


Fig.4- Diversity parameters of Herb Species in all V sites

The graph shows the comparative study of Shannon – Weiner Diversity Index, Margaret’s Species Richness Index and Pielou’s Species Evenness Index for herb and grass species. According to this study work site III (South-East) shows highest value of Diversity Index (H') (2.16) but site I (North-West) and site V (Centre) showed lowest as well as same value of Diversity Index (H') (1.76). On the other hand site-I (North-West) shows highest species richness (1.27) followed by site III (South-East) (1.18) while site V (Centre) (0.72) shows lowest species richness value. In terms of species Evenness site II (North-East) (0.99) shows highest values followed by site I (North-West), site III (South-East) and site V (Centre) (0.98) shows the same values for species Evenness Index while site IV (South-West) (0.96) shows lowest value for species Evenness Index.

CONCLUSION

From the present research work it can be concluded based on the results, the study area is abundantly populated by *Murraya paniculata*. Overall, Site-III (South-East) showed the highest IVI parameter of dominant tree species for *Saraca asoca* (51.21), Site-IV (South-West) showed the highest IVI parameter of dominant shrub species for *Murraya paniculata* (164.42) and Site-II (North-East) showed the highest IVI parameter of dominant grass & herb species for *Rivina humilis* (62.13). Result of the phytosociological aspects for all the sites concluded that Site-IV (South-West) showed the highest value for Shannon-Weiner Diversity Index (H') (3.19) for trees species, Site-V (Centre) showed the highest value for Shannon-Weiner Diversity Index (H') (2.22) for shrub species and Site-III (South-East) showed the highest value for Shannon-Weiner Diversity Index (H') (2.16) for grass & herb species.

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