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Phytosociological Study and Species Diversity of Desert Vegetation at Bikaner District North-Western Rajasthan, India

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Abstract

Phytosociology is the study of plant communities, their composition and development, and the relationship between the species within them. This is a system for classifying plant communities. Phytosociology is useful to describe the population dynamics of each plant species occurring in a particular community and to understand how they relate to the other species in the same community. The present investigation reveals the findings of different phytosociological aspects which have been undertaken at two sites of Bikaner District. The Importance value Index (IVI) is used to determine the overall importance of each species in the plant community.*Leptadenia pyrotechnica* and*Calotropis procera showed* the maximum IVI values in both study area which reveals that these community are considered as dominant in the desert ecosystem of Bikaner district. A total of 37 plant species were recorded from both study sites in present study, belonging 22 families. Poaceae was dominant family. Species Richness, Diversity and Dominance Indices were calculated using software PAST. The present study is an attempt to provide information on phytosociological aspects to understand the species diversity patterns in desert ecosystem of Bikaner district of Rajasthan.

Keywords: Desert Ecosystem, Diversity, Importance Value Index, Phytosociology.

Introduction

Biodiversity is the foundation for sustainable development which constitutes the foundation for the environmental health of planet and is the source of economic and ecological security for our future generations. In the developing country, it provides the guarantee of food, many raw materials such as fiber for clothing, materials for shelter, fertilizer, fuel and medicines, as well as source of work energy in the form of animal traction (Parveen and Hussain, 2007). In addition, biodiversity maintains balance for planetary and human survival (Jafferies, 1997). Biodiversity is continuously declining due to the activities of human being (Krishnamurthy, 2003).

Vegetation is a key factor in decisive the structure of an ecosystem. It determines many ecological parameters within a plant community such as microclimate, energy budget, photosynthesis, water regimes, surface runoff and soil temperature (Tappeiner and Cernusca, 1996). The number of species reflects the gene pool and adaptation potential of the community (Odum, 1963). Quantitative analysis of vegetation helps in understanding the structure, composition and tropic organization of any community. Species composition and diversity vary from habitat to habitat within the communities exposing identical physiognomic characteristics (Nautiyal *et al.,* 1999). Likewise, the life forms of species represent the adjustment of perennating organs and plant life history to environmental conditions (Nautiyal *et al.,* 2000).

Phytosociology is the study of the relationships, distribution, characteristics and classification of plant communities (The American Heritage Dictionary, 3rd edition). The description and classification of the plant community in an ecosystem is known as phytosociology (Braun-Blanquet, 1932; Odum, 1971). It is useful to collect such data to describe the population dynamics of each species studied and how they relate to the other species in the same community. Subtle differences in species composition and structure may point to differing biotic conditions such as soil moisture, light availability, temperature, exposure to prevailing wind, etc. Phytosociological analysis of natural vegetation is recognized as an

efficient and appropriate method to select out useful plant species from natural communities (Katsuno,1977). Phytosociological analysis of any vegetation forms an important part of ecological studies as it provides a clear picture of the vegetation and helps in understanding the community function.

Review of Literature

Review of Literature reveals a lot of information on phytosociological studies to understand the current status of vegetation,species richness, diversity, explain or predict its pattern, relationships, classification and distribution of plant communities for proper planning and conservation (Jayakumar et al., 2002; Ilorkar and Khatri, 2003). Several workers (Mishra *et al*., 1993; Awasthi *et al*., 2001; Bhadra *et al*., 2010; Misra and Sharma, 2010; Das and Menon, 2011; Hegde *et al*., 2011; Ahmed, 2012; Bajpai *et al*., 2012; Jaykumar and Nair, 2012; Sahu *et al*., 2012) worked on the phytosociology in different parts of the country.

Aim of the study

The aim of the study is to analyze the phytosociological characteristics and the diversity pattern of the desertic plants in parts of Thar Desert at Bikaner district, North-Western Rajasthan.Present investigation sheds light on the importance of the study area and also emphasizes on the species richness and diversity of plant species.

Material and Methods

Study Area

The district of Bikaner is situated in North – Western part of the Rajasthan state between 27° 11' to 29° 03' North latitudes and 71° 54' to 76° 12' East longitudes, in the middle of the Thar Desert with scanty rainfall and extreme temperatures. In summer temperature exceeds 50° C and during the winter it dips to freezing point. The climate of Bikaner is characterized by extreme variations in temperature.Both sites have a dry climate except for the south-west monsoon season. The Annual rainfalls in the study area are ranges from 260-440 millimeters (10-17 inch).

Study Sites

Two different study sites have been selected for the phytosociological studies at Bikaner district.The site I Sagar which is situated about 8 km east of Bikaner at 28°00'50.55" N latitude, and 73°24'31.07"E longitudes which acquires about 7 sq. km. area. Study site II Gajner is situated about 30 km south-west of Bikaner at 27°56'20.06" N latitude, and 73°02'54.53" E longitudes which acquires about 64 sq. km. area **(**Fig.1).The study areas are dominated by sandy tracts which are further followed by tertiary sediment of Bikaner-Nagaur basin. The study sites have undulating topography with pediments.

Sampling and Collection

The phytosociological analyses of herbaceous vegetation were carried out at two different sites i.e., Sagar and Gajner village. Approximately 10 quadrates ($1 \times 1\ m^2 each$) were laid per km area of both the sites. Therefore 640 quadrates were made for Gajner village site i.e. 64 km^2 area and 70 quadrates were arranged for Sagar village site with 7 km^2 area. Quantitative parameters such as percentage of frequency, density and dominance of each species present in quadrates were recorded and analyzed as per the methods of Curtis and McIntosh (1950). The importance value index was calculated by summing the three relative values, viz., relative frequency, relative density and relative dominance following the methods of Curtis (1959) and Phillips (1959). The concentration of dominance was computed by Simpson's index (Simpson, 1949). The diversity indices were calculated using the software PAST.

Data analysis

Density

Density is defined as the total number of individuals of each species in all the quadrats is divided by the total number of quadrats studied. Density is calculated by the equation:

$$Density = \frac{\text{Total number of individuals of a species in all quadrats}}{\text{Total number of quadrats studied}}$$

Frequency (%)

Frequency refers to the degree of distribution of an individual species in an area and usually expressed as percentage occurrence. It was studied by sampling the study area at several places at random and noted the name of the species that occurred in each sampling units. It is calculated by the equation:

$$Frequency\ \% = \frac{\text{Total number of quadrats in which the species occurred}}{\text{Total number of quadrats studied}} \times 100$$

Abundance

It is the study of the number of individuals of different species in the community per unit area. samplings were performed by quadrat method at random locations and the number of individuals of each species was summed up for all the quadrats divided by the total number of quadrats in which the species occurred. It is denoted by the equation:

$$Abundance = \frac{\text{Total number of individuals of a species}}{\text{Total number of quadrats in which the species occurred}}$$

Importance Value Index

The Importance value Index (IVI) is used to determine the overall importance of each species in the community. In calculating the index, the percentage values of the relative frequency, relative density and relative dominance are summed up together and this value is designated as the Importance Value Index or IVI of the species (Curtis, 1959).

Relative Density

Relative density is the study of number of individuals of a species in relation to the total number of individuals of all the species and can be stated as:

$$\text{Relative density} = \frac{\text{Num ber of individuals of the species}}{\text{Number of individuals of all the species}} \times 100$$

Relative Frequency

The degree of distribution of individual species in an area in relation to the number of all the species occurred.

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

Relative Dominance

Dominance of a species is determined by the value of the basal area. Relative dominance is the

coverage value of a species with respect to the sum of coverage of the rest of the species in the area.

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

Importance Value Index (IVI) = Rel. Frequency + Rel. Density + Rel. Dominance

Basal area = πr^2, where, $\pi = 3.14$ and r = radius of the species

Importance Value Index (IVI) was calculated separately for each species of the community. A species, which achieves highest importance value in the site, is the dominant and the species with lowest importance value is the rare/least dominant species of the site.

Species Richness, Diversity and Dominance Indices

The species richness of the vascular plants was calculated by using the method 'Margalef's index of richness' (D_{mg}) (Magurran, 1988)

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

Where, S= Total number of species.

N = Total number of individuals.

Species diversity and dominance were evaluated by using the following methods. Shannon's diversity index and Simpson's index of dominance were calculated using important value index (IVI) of species.

Shannon–Weaver (1963) Index of Diversity

The formula for calculating the Shannon diversity index is

$$H' = - \sum p_i \ln p_i$$

Where,

H' = Shannon index of diversity

p_i = the proportion of important value of the i^{th} species ($p_i = n_i / N$,

n_i is the important value index of i^{th} species and

N is the important value index of all the species).

Simpson (1949) Index of Dominance

The equation used to calculate Simpson's index was

$$D = \sum (p_i)^2$$

Where,

D =Simpson index of dominance

p_i = the proportion of important value of the i^{th} species ($p_i = n_i / N$,

n_i is the important value index of i^{th} species and

N is the important value index of all the species).

As D increases, diversity decreases and Simpson's index was therefore usually expressed as 1 – D or 1/D

Results

A total of 37 plant species were recorded from both study sites in present investigation, belonging 22 families. Poaceae was represented by 6 species followed by Mimosaceae 3 species, 2 species were each from the families Asclepiadaceae, Caesalpiniaceae, Capparidaceae, Fabaceae, Molluginaceae, Tiliaceae, Amaranthaceae and Zygophyllaceae and remaining 12 families were represented by 1 species each Chenopodiaceae, Convolulaceae, Malvaceae, Boraginaceae, Solanaceae, Euphorbiaceae, Nyctaginaceae, Aizoaceae, Rhamnaceae, Salvadoraceae, Cyperaceae and Cucurbitaceae. A total number of 35 plant species were recorded at site I and 34 plant species were recorded at site II. At site I a total of 19 herbs, 6 grasses, 5 Shrubs and 5 tree species were recorded whereas at site II also 20 herbs, 6 grasses,3 shrubs and5 tree species recorded which are shown in Table 1, Fig.2 and Fig.3. Frequency, Density, Dominance and Importance Value Index for the site I and Site II were calculated and presented in Table 2 and Table3.

Highest frequency 90% is obtained for the *Heliotropium curasivicum* and minimum 10% frequency obtained for three species viz. Glinus *lotoides, Trianthema portulacastrum* and *Accacia nilotica* at Site I whereas at site IIhighest frequency attained for the *Dactyloctenium aegyptium* and *Euphorbia microphylla* as 80 % and minimum frequency attained for *Amaranthusspinosus, Salvoderapersica, Accacia nilotica* as 20%.

Highest density obtained 18.9 for *the Aristida royleana* and minimum 0.7 for the Accacia nilotica at site I and for site II highest density 166.4 was obtained for the *Dactyloctenium aegyptium* and minimum 12.8 for the *Salvodera persica* and *Accacia nilotica.*

The dominance calculated for the site I was observed 18.604 as highest for the *Leptadenia pyrotechnica* and 0.002 as minimum for *Chorchorus tridens* whereas for site II, 181.366 was highest dominance for the *Leptadenia pyrotechnica* and 0.080 as minimum for *Eragrostis minor*, *Linium indicum* and *Chorchorus tridens*.

The Importance Value Index (IVI) for the site I was obtained, the highest for the *Leptadenia pyrotechnica* as 42.11 followed by *Calotropis procera*, *Aristida royleana* and *Tribulus terrestris* as 21.29, 14.06 and 13.75 respectively, and minimum for the *Trianthema portulacastrum* and *Glinus lotoides* as 1.42 followed by *Accacia nilotica* and *Mollugo cerviana* as 1.89 and 2.32 respectively. At site II the Importance Value Index (IVI) was obtained, the highest for the *Leptadenia pyrotechnica* as 44.63 followed by *Calotropis procera, Dactyloctenium aegyptium and Crotolaria burhia* as 24.19, 13.34 and 12.28 respectively and minimum for the *Mollugo cerviana* as 2.91 followed by *Accacia nilotica* and *Salvodera persica* as 2.95 and 3.40 respectively.

The IVI value of the both sites reveals that the present area of interest could be considered as *Leptadenia pyrotechnica- Calotropis procera* community of desert of Bikaner district.

The total diversity index (H) (Shannon–Weaver, 1963) was estimated as 3.26 at site I and 3.34 at site II. The total Evenness index (e) was attained 0.75 and 0.82 at site I and II respectively. Simpson (1949) index of Dominance was attained as 0.95 and 0.96 for site I and site II respectively. The species richness of the herbaceous plant was calculated as 'Margalef's index of richness' **(**D_{mg}) (Magurran, 1988) and value attained as 4.40 for site I and 3.32 for site II as shown in Table 4 and Fig. 4.

Discussion

Phytosociology is the branch of science which deals with plant communities, their composition and development, and the relationships between the

species within them. The structure of a community is determined mainly by the dominating plant species and not by other characteristics (Odum, 1971). All these species are not equally important but there are only a few overtopping species which by their bulk and growth modify the habitat and control the growth of other species of the community as these species are called dominants (Gaston, 2000).

The present investigation is an attempt to assess composition, structure and diversity of plant species in Thar Desert of Rajasthan at Bikaner District. In the present area of study 37 species were recorded and analysis of data revealed that the study sites belonging to 22 families(Fig. 1). Poaceae was represented by the maximum species, followed by Mimosaceae. The number of species in the herb communities was 19 at site I, 20 at site II.

In the present study it was found that both sites were dominated by *Leptadenia pyrotechnica* and *Calotropis procera* with the maximum IVI value. Its dominance at the study sites was possibly an account of availability of optimum conditions for its growth in xerophytic conditions. All the available nearby resources are being utilized by the dominant species which indicates the higher value of IVI and left over are being consumed by species as the competitors and associates. Lower importance value of species is an index of low grazing pressure by herbivores on the study sites, as vegetation is a reflex of interactions between the plants, animals, soils and climate. Moreover, each species of a community plays specific role and there is a definite quantitative relationship between abundant and rare species (Bhandari *et al.,* 1999). The high IVI of a species indicated its dominance and ecological success, its power of regeneration and greater ecological amplitude. Since *Leptadenia pyrotechnica* and *Calotropis procera* showed the maximum IVI values at both the sites and therefore, emerged as dominant species of the desert ecosystem.

Diversity signifies the number of species, their relative abundance, composition, interaction among species and temporal and spatial variation in their properties. The observation in the present study showed that the both the study sites were equally diverse. Poaceae was the dominant family at both the sites.

Conclusion

The desertic vegetation diversity of the studied sites found to be represented by 37 plant species belonging to 22 families with poaceae as dominant family which represents 6 species. The study areas are mainly covered by herbaceous vegetation. Out of 22 families 12 families were represented by a single species and hence these are monotypic.

Heliotropium curasivicum represents highest frequency at site I whereas*Dactyloctenium aegyptium* and *Euphorbia microphylla* shows highest frequency at site II.The dominance calculated for the species of study areas, where *Leptadenia pyrotechnica* attains highest dominance at both the sites.Highest density obtained for the *Aristida royleana* at site I and for site II highest density was obtained for the *Dactyloctenium aegyptium*.

The IVI helps in understanding the ecological significance of the species in a particular ecosystem. *Leptadenia pyrotechnica* and *Calotropis procera* showed the maximum IVI values in both study area which reveals that these community are considered as dominant in the desert ecosystem of Bikaner district.

The present study is an attempt to provide information on phytosociological aspects to understand the species diversity patterns in desert ecosystem of Bikaner district of Rajasthan.

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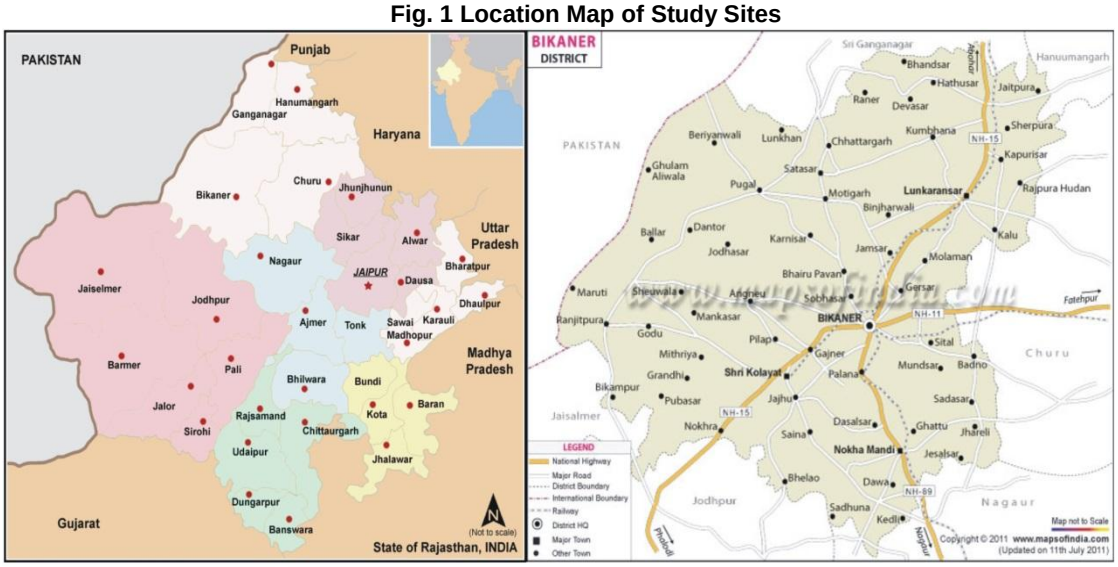
Fig. 1 Location Map of Study Sites



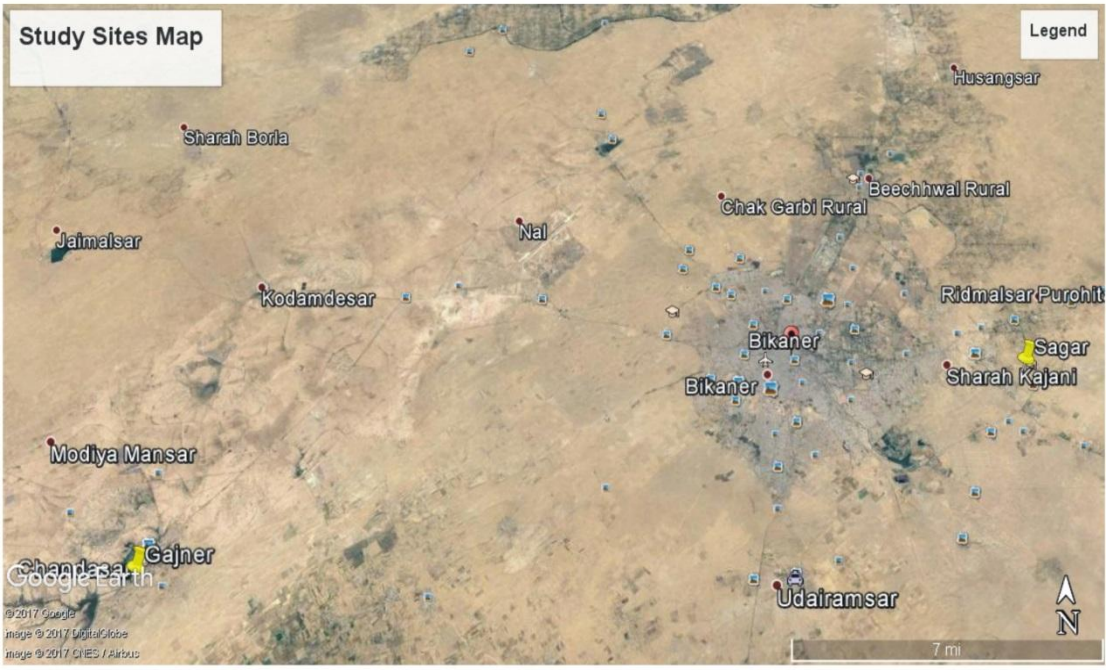


Fig. 2 Family Wise Analysis

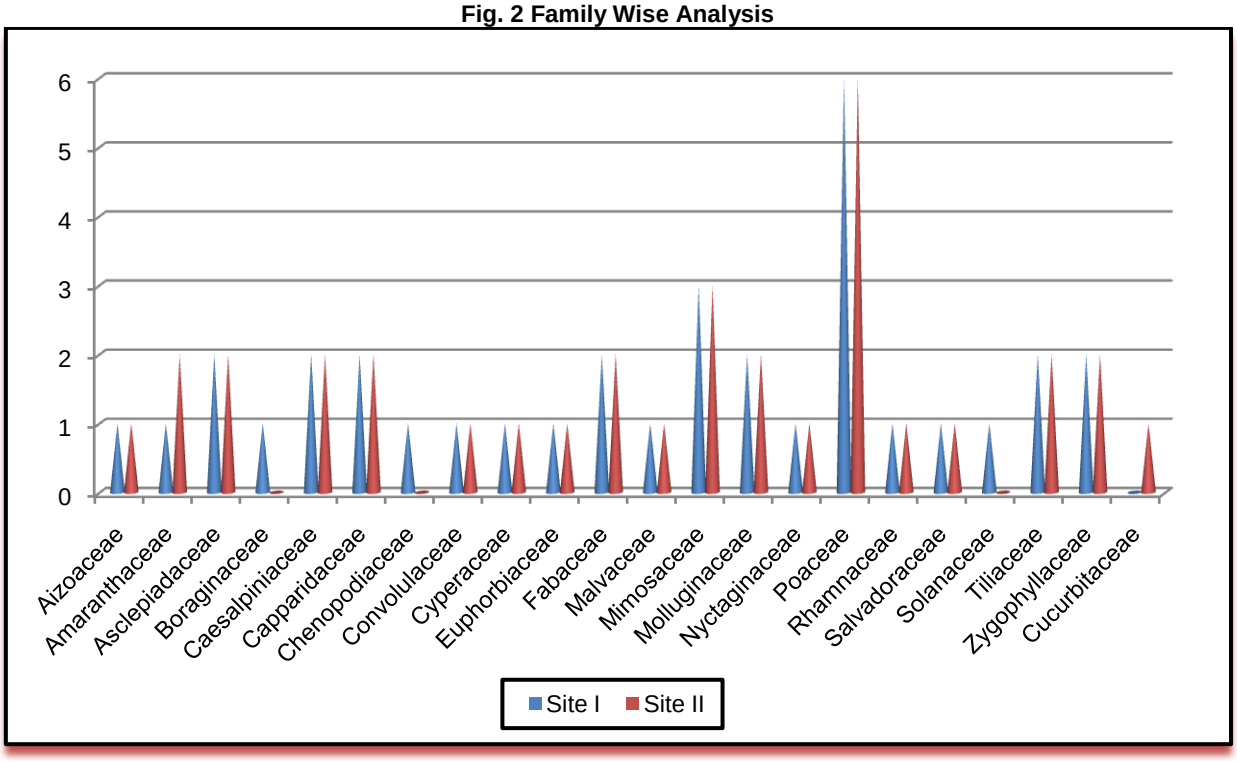


Fig. 3 Habit Wise Analysis

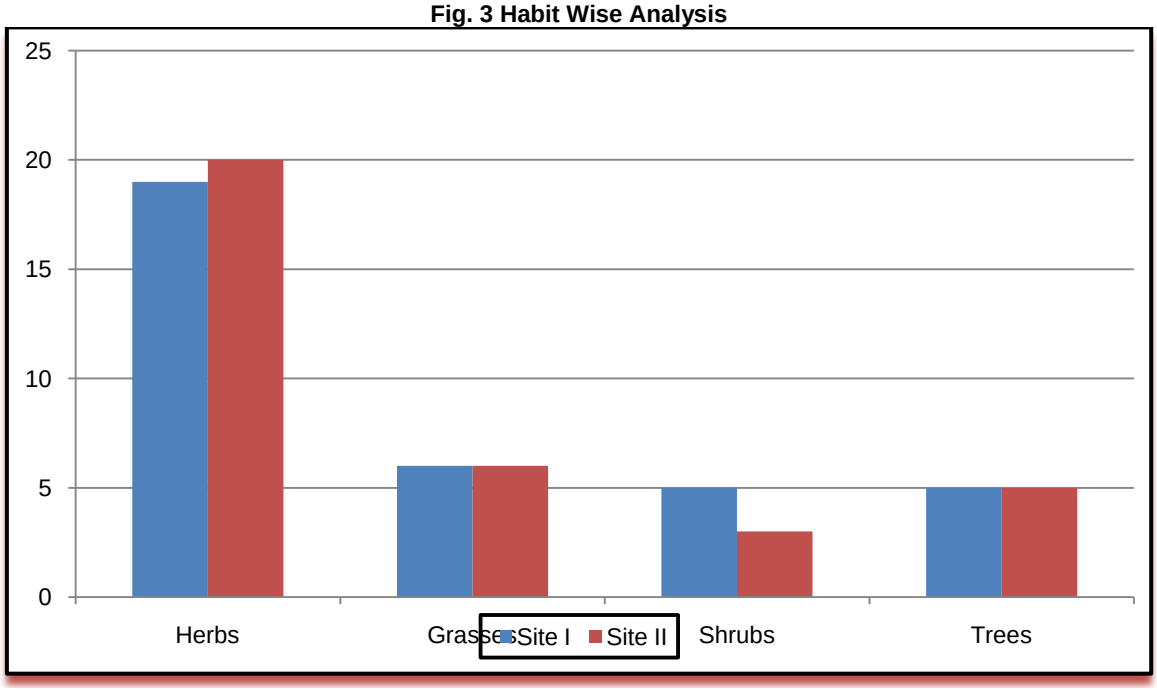


Fig. 4 Different Diversity Indices

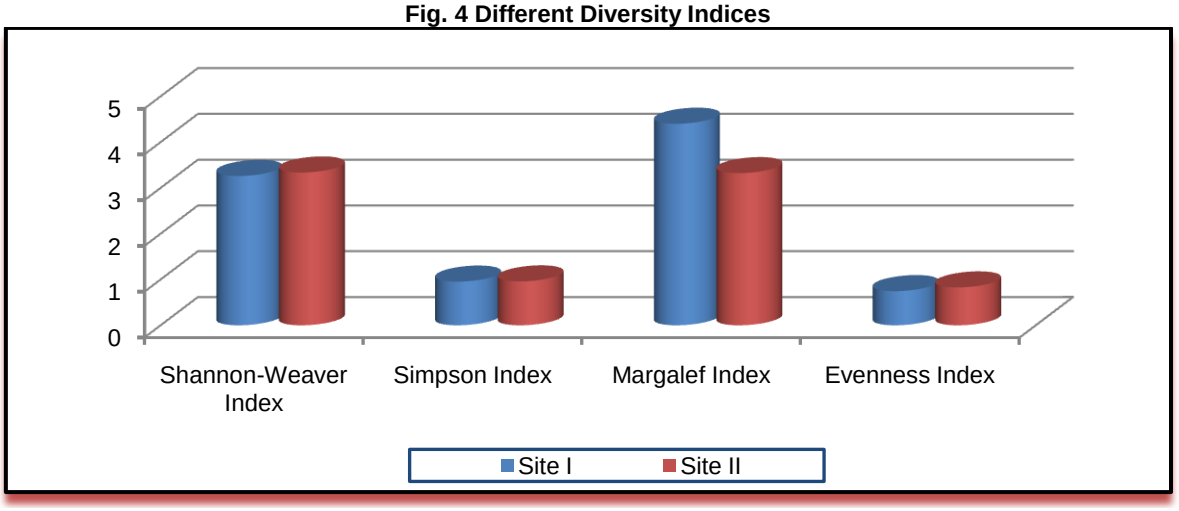


Table- 1 Phytosociological Attributes

	Site I			Site II		
S.No.	**Name of Plant Species**	**Habit**	**Family**	**Name of Plant Species**	**Habit**	**Family**
1	*Cenchrus ciliaris*	Grass	Poaceae	*Cenchrus ciliaris*	Grass	Poaceae
2	*Cenchrus biflorus*	Grass	Poaceae	*Cenchrus biflorus*	Grass	Poaceae
3	*Aristida royleana*	Grass	Poaceae	*Aristida royleana*	Grass	Poaceae
4	*Dactyloctenium aegyptium*	Grass	Poaceae	*Dactyloctenium aegyptium*	Grass	Poaceae
5	*Eragrostis minor*	Grass	Poaceae	*Eragrostis ciliaris*	Grass	Poaceae
6	*Eragrostis ciliaris*	Grass	Poaceae	*Eragrostis minor*	Grass	Poaceae
7	*Crotolaria burhia*	Herb	Fabaceae	*Crotolaria burhia*	Herb	Fabaceae
8	*Abutilon indicum*	Herb	Malvaceae	*Abutilon indicum*	Herb	Malvaceae
9	*Aerva persica*	Herb	Amaranthaceae	*Citrullus colocynthis*	Herb	Cucurbitaceae
10	*Cassia obtusifolia*	Herb	Caesalpiniaceae	*Aerva persica*	Herb	Amaranthaceae
11	*Cassia tora*	Herb	Caesalpiniaceae	*Cassia obtusifolia*	Herb	Caesalpiniaceae
12	*Fagonia indica*	Herb	Zygophyllaceae	*Cassia tora*	Herb	Caesalpiniaceae
13	*Corchorus depressus*	Herb	Tiliaceae	*Corchorus depressus*	Herb	Tiliaceae
14	*Heliotropium curasivicum*	Herb	Boraginaceae	*Fagonia indica*	Herb	Zygophyllaceae
15	*Boerhaavia diffusa*	Herb	Nyctaginaceae	*Boerhaavia diffusa*	Herb	Nyctaginaceae
16	*Cyperus rotendus*	Herb	Cyperaceae	*Indigophera hochstetteri*	Herb	Fabaceae
17	*Tribulus terrestris*	Herb	Zygophyllaceae	*Cleome viscosa*	Herb	Capparidaceae
18	*Indigophera hochstetteri*	Herb	Fabaceae	*Tribulus terrestris*	Herb	Zygophyllaceae
19	*Cleome viscosa*	Herb	Capparidaceae	*Cyperus rotendus*	Herb	Cyperaceae
20	*Glinus lotoides*	Herb	Molluginaceae	*Trianthema portulacastrum*	Herb	Aizoaceae
21	*Trianthema portulacastrum*	Herb	Aizoaceae	*Euphorbia microphylla*	Herb	Euphorbiaceae
22	*Euphorbia microphylla*	Herb	Euphorbiaceae	*Convolvulus microphyllus*	Herb	Convolulaceae
23	*Convolvulus microphyllus*	Herb	Convolulaceae	*Amaranthus spinosus*	Herb	Amaranthaceae
24	*Mollugo cerviana*	Herb	Molluginaceae	*Mollugo cerviana*	Herb	Molluginaceae
25	*Chorchorus tridens*	Herb	Tiliaceae	*Chorchorus tridens*	Herb	Tiliaceae
26	*Leptadenia pyrotechnica*	Shrub	Asclepiadaceae	*Liniumindicum*	Herb	Molluginaceae
27	*Calotropis procera*	Shrub	Asclepiadaceae	*Leptadenia pyrotechnica*	Shrub	Asclepiadaceae
28	*Dhaturastramonium*	Shrub	Solanaceae	*Calotropis procera*	Shrub	Asclepiadaceae
29	*Salsola baryosma*	Shrub	Chenopodiaceae	*Ziziphus nummularia*	Shrub	Rhamnaceae
30	*Ziziphus nummularia*	Shrub	Rhamnaceae	*Prosopis juliflora*	Tree	Mimosaceae
31	*Prosopis juliflora*	Tree	Mimosaceae	*Salvodera persica*	Tree	Salvadoraceae
32	*Salvodera persica*	Tree	Salvadoraceae	*Prosopis cineraria*	Tree	Mimosaceae
33	*Capparis decidua*	Tree	Capparidaceae	*Accacia nilotica*	Tree	Mimosaceae
34	*Prosopis cineraria*	Tree	Mimosaceae	*Capparis decidua*	Tree	Capparidaceae
35	*Accacia nilotica*	Tree	Mimosaceae			

Table-2 Phytosociological Observations of Site I Sagar Village

S. No.	Name of Plant Species	Frequency (%)	Relative Frequency	Density	Relative Density	Dominance	Relative Dominance	IVI
1	*Heliotropium curasivicum*	90	6.16	11.2	4.95	0.178	0.365	11.483
2	*Dhatura stramonium*	20	1.37	1.4	0.62	3.877	7.945	9.934
3	*Glinus lotoides*	10	0.68	1.4	0.62	0.055	0.113	1.417
4	*Salsola baryosma*	30	2.05	3.5	1.55	3.174	6.504	10.107
5	*Aristida royleana*	80	5.48	18.9	8.36	0.108	0.221	14.060
6	*Eragrostisciliaris*	70	4.79	9.8	4.33	0.020	0.041	9.170
7	*Cenchrus biflorus*	60	4.11	9.1	4.02	0.635	1.301	9.436
8	*Dactyloctenium aegyptium*	80	5.48	15.4	6.81	0.020	0.041	12.332
9	*Eragrostis minor*	60	4.11	11.2	4.95	0.020	0.041	9.104
10	*Cenchrus ciliaris*	70	4.79	12.6	5.57	0.793	1.625	11.992
11	*Tribulus terrestris*	80	5.48	18.2	8.05	0.108	0.221	13.750
12	*Euphorbia microphylla*	40	2.74	7.7	3.41	0.035	0.072	6.217
13	*Boerhaavia diffusa*	40	2.74	9.1	4.02	0.178	0.365	7.129
14	*Fagonia indica*	50	3.42	9.8	4.33	0.220	0.451	8.210
15	*Abutilon indicum*	20	1.37	2.1	0.93	1.163	2.383	4.682
16	*Indigophera hochstetteri*	60	4.11	14	6.19	0.108	0.221	10.523
17	*Convolvulus microphyllus*	30	2.05	6.3	2.79	0.020	0.041	4.882
18	*Crotolaria burhia*	40	2.74	4.9	2.17	2.112	4.328	9.235
19	*Cassia obtusifolia*	30	2.05	3.5	1.55	0.793	1.625	5.228
20	*Mollugo cerviana*	20	1.37	2.1	0.93	0.009	0.018	2.317
21	*Corchorus depressus*	30	2.05	9.1	4.02	0.220	0.451	6.530
22	*Trianthema portulacastrum*	10	0.68	1.4	0.62	0.055	0.113	1.417
23	*Ziziphus nummularia*	30	2.05	2.1	0.93	2.394	4.906	7.890
24	*Calotropis procera*	40	2.74	2.8	1.24	8.449	17.315	21.293
25	*Prosopis cineraria*	30	2.05	2.1	0.93	0.431	0.883	3.867
26	*Leptadenia pyrotechnica*	40	2.74	2.8	1.24	18.604	38.125	42.103
27	*Aerva persica*	50	3.42	7.7	3.41	0.879	1.801	8.632
28	*Cassia tora*	60	4.11	4.2	1.86	0.495	1.014	6.982
29	*Chorchorustridens*	40	2.74	4.2	1.86	0.002	0.004	4.601
30	*Prosopis juliflora*	20	1.37	1.4	0.62	1.978	4.054	6.043
31	*Cleome viscosa*	40	2.74	8.4	3.72	0.108	0.221	6.676
32	*Accacia nilotica*	10	0.68	0.7	0.31	0.431	0.883	1.878
33	*Salvodera persica*	30	2.05	2.1	0.93	0.563	1.154	4.137
34	*Capparis decidua*	20	1.37	1.4	0.62	0.451	0.924	2.913
35	*Cyperus rotendus*	30	2.05	3.5	1.55	0.111	0.227	3.830

Table-3 Phytosociological Observations of Site II Gajner Village

S. No.	Name of Plant Species	Frequency (%)	Relative Frequency	Density	Relative Density	Dominance	Relative Dominance	IVI
1	*Linium indicum*	30	1.94	44.8	2.181	0.080	0.018	4.134
2	*Citrullus colocynthis*	40	2.58	38.4	1.869	11.575	2.645	7.095
3	*Amaranthus spinosus*	20	1.29	57.6	2.804	0.181	0.041	4.135
4	*Aristida royleana*	70	4.52	128	6.231	1.286	0.294	11.041
5	*Eragrostisciliaris*	70	4.52	76.8	3.738	0.322	0.074	8.328
6	*Cenchrus biflorus*	60	3.87	128	6.231	5.145	1.176	11.277
7	*Dactyloctenium aegyptium*	80	5.16	166.4	8.100	0.322	0.074	13.335
8	*Eragrostis minor*	70	4.52	102.4	4.984	0.080	0.018	9.519
9	*Cenchrusciliaris*	60	3.87	83.2	4.050	8.038	1.837	9.758
10	*Tribulus terrestris*	70	4.52	147.2	7.165	1.286	0.294	11.975
11	*Euphorbia microphylla*	80	5.16	89.6	4.361	0.502	0.115	9.637
12	*Boerhaavia diffusa*	50	3.23	76.8	3.738	2.010	0.459	7.423
13	*Fagonia indica*	60	3.87	76.8	3.738	2.894	0.661	8.271
14	*Abutilon indicum*	30	1.94	25.6	1.246	12.560	2.870	6.052
15	*Indigophera hocshtetteri*	60	3.87	83.2	4.050	1.628	0.372	8.293
16	*Convolvulus microphyllus*	40	2.58	76.8	3.738	0.322	0.074	6.393
17	*Crotolari aburhia*	50	3.23	70.4	3.427	24.618	5.626	12.279
18	*Cassia obtusifolia*	30	1.94	38.4	1.869	8.038	1.837	5.642
19	*Mollugo cerviana*	30	1.94	19.2	0.935	0.181	0.041	2.911
20	*Corchorus depressus*	50	3.23	64	3.115	3.396	0.776	7.117
21	*Trianthema portulacastrum*	40	2.58	51.2	2.492	0.985	0.225	5.298
22	*Ziziphus nummularia*	40	2.58	25.6	1.246	27.511	6.287	10.114
23	*Calotropis procera*	50	3.23	32	1.558	84.906	19.405	24.188
24	*Prosopis cineraria*	40	2.58	25.6	1.246	4.522	1.033	4.860
25	*Leptadenia pyrotechnica*	30	1.94	25.6	1.246	181.366	41.450	44.631
26	*Aerva persica*	50	3.23	38.4	1.869	9.726	2.223	7.318
27	*Cassia tora*	50	3.23	32	1.558	5.808	1.327	6.111
28	*Chorchorustridens*	50	3.23	44.8	2.181	0.080	0.018	5.425
29	*Prosopis juliflora*	30	1.94	19.2	0.935	20.578	4.703	7.573
30	*Cleome viscosa*	30	1.94	64	3.115	1.628	0.372	5.423
31	*Accacia nilotica*	20	1.29	12.8	0.623	4.522	1.033	2.947
32	*Salvodera persica*	20	1.29	12.8	0.623	6.511	1.488	3.401
33	*Capparis decidua*	50	3.23	32	1.558	3.939	0.900	5.684
34	*Cyperus rotendus*	40	2.58	44.8	2.181	1.010	0.231	4.992

Table- 4 Diversity Indices

Site	Shannon-Weaver Index	Simpson Index	Margalef Index	Evenness Index
I	3.26	0.95	4.40	0.75
II	3.34	0.96	3.32	0.82