Original Research Article

Species Composition and Diversity of Tree Species in Nanta Forest Region in Kota district, Rajasthan

Abstract

The objective of this work was to study species composition and diversity of tree species between two vegetation stands, one is a protected vegetation stand and the other is a non-protected vegetation stand. The tree species composition and community structure were analyzed by field visits in Nanta forest region. Random sampling was done by using a standard size of quadrat i.e., 10x10m^2. Results showed that a total of 30 species belonging to 25 genera and 11 families are present in the protected site whereas 8 species belonging to 7 genera and 5 families are present in the unprotected site. *Anogeissus pendula* (Edgew) and *Dichrostachys cinerea* (L.) were the most important species in protected and non-protected sites respectively. The Simpson's index is higher in protected vegetation stands showing greater sample diversity. Family Fabaceae is dominant in both the vegetation stand which shows the ecological importance of this family.

Keywords: Nanta, anthropogenic activities, vegetation, Fabaceae.

1. Introduction

In the present scenario, deforestation is a vivid issue worldwide. According to an estimate, 420 million hectares of forest have been lost since 1990 through conversion to other land uses. The area of primary forest has decreased by over 80 million hectares since 1990 globally. Loss of forest cover due to deforestation was estimated at 10 million per year between 2015 and 2020 (FAO & UNEP, 2020). The main causes of the destruction of forests are the fragmentation of natural habitats, urbanization, industrialization, and intensified agricultural practices of human beings. Due to the population explosion, the pressure on forests is rising to meet the demand for food, fuel, and timber. Development activities are expanding globally that directly affected the natural environment. If necessary, steps should not be taken 25 percent of all species may extinct during the next twenty to thirty years (Khera et al., 2001)

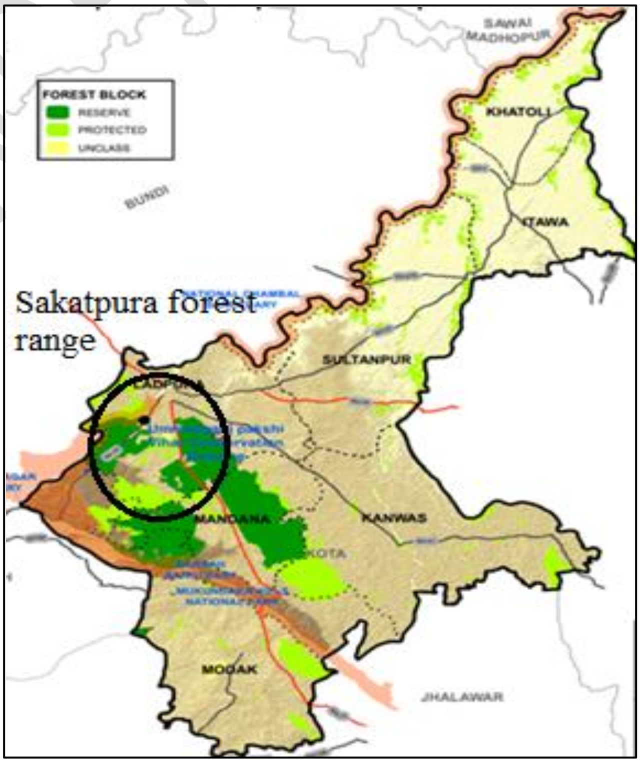
Floristic surveys are the foundation of any research in tropical community ecology (Phillips et al., 2003). Assessment of species composition and diversity is not only crucial to evaluate the complexity and resources of the forest (Kumar et al., 2006) but also acknowledges the rate of destruction of forest and human interferences (Ahmed et al., 2010). For maintaining forest cover government introduces exotic species (Alam et al., 2008) without knowing the species composition of that particular area which harms the natural habitats of native vegetation.

The study was carried out at the Nanta forest area in Kota district, Rajasthan. Due to various anthropogenic activities such as mining, dumping of industrial and household waste, deforestation, and overgrazing; the land and vegetation cover of this forest area are getting degraded or damaged which is a direct threat to biodiversity.

1.1. Study area:

The present work was carried out at the Nanta forest area which is situated in the Kota district, Rajasthan and it is under the Sakatpura forest range with an area of 2015 Ha. Its coordinates are 25.197496° N latitude and 75.7931599° E longitude. Two vegetation stands (protected and non-protected) were selected for sampling. The protected vegetation stand is a biological park in which human activities are prohibited and it is bounded by a huge boundary wall. The non-protected vegetation stand is an open area where anthropogenic activities are at their peak.

Figure 1: Map of Kota showing the study Site (Nanta forest area in the circle).



1.2. Objective

The main objective of the current study is to find out structural diversity in protected vegetation stand and non-protected vegetation stand by using IVI and to find out the diversity status of tree species (by using the diversity Index). Due to high anthropogenic activities, there is a risk of losing the present diversity of the study area. Studies on diversity are not yet done in this area, so the present work is a benchmark study as it provides the present status of vegetation that help out to identify the conservation strategy in the study area. It is requisite to preserve the diversity of this region

2. Material and Method

The tree species composition and community structure were analyzed by field visits in the protected sites and non-protected sites of the Nanta forest region. Simple Random sampling was done by using a standard size of the quadrat (Latpate *et al.*, 2021). A sample quadrat of $10x10m^2$ was laid down for trees and 30 such plots were taken for analysis of vegetation in both stands.

2.1. Phyto-sociological analysis of vegetation: Two stands were taken into consideration one is protected natural vegetation and the other one is adjacent non-protected vegetation. The vegetation data will be quantitatively analyzed for frequency, density, basal area, and IVI (Important Value Index) following Mishra (1968), Muller-Dombois and Ellenberg (1974), and Magurran (1988) using the formula given below.

$$\text{Basal area} = \pi r^2 \quad where, \pi = 3.14$$

$$\text{D(density)} = \frac{\text{number of above} - \text{ground stems of species counted}}{\text{Sample area (ha)}}$$

$$\text{RD(relative density)} = \frac{\text{Density of species A}}{\text{Total density of all species}} x\ 100$$

$$\text{F(frequency)} = \frac{\text{The number of plots where that species occur}}{\text{Total number of plots}} \text{x100}$$

$$\text{RF (relative frequency)} = \frac{\text{frequency of species A}}{\text{Total frequency of all species}} \text{x100}$$

$$\text{Dominance} = \frac{\text{Basal area of a species A}}{\text{Area sampled (sq. m)}}$$

$$\text{RDo (Relative Dominance)} = \frac{\text{Dominance of species A}}{\text{Total dominance of all species}} \text{x100}$$

$$\text{IVI} = \text{Relative density} + \text{Relative frequency} + \text{Relative Dominance}$$

2.2. Diversity indices: The Index of Dominance of the community is calculated by Simpson's Index of diversity (Simpson, 1949). The Shannon Diversity Index (Shannon &Wiener, 1949) is a way to measure the diversity of species in a community. The similarity index community coefficient among both stands was calculated according to Jaccard (1901). The index of species richness (D) was calculated according to Menhinick (1964).

(a) Simpson's index (D1) **=** $1 - \sum_{i=1}^{s} pi^2$

Where: ni= The number of organisms that belong to species i.

(b) Shannon Diversity Index (H) = $-\sum_{i=1}^{s} pi^2 \ln pi^2$

Where: pi: The proportion of the entire community made up of species i

(c) Jaccard Similarity index (C_j) = $\frac{j}{(j+a+b)}$

j= number of species common to both stand

a= number of species in stand A

b= number of species in stand B

(d) Species richness index (D) = $\frac{S}{\sqrt{N}}$

Where, S=number of species and N=number of individuals

3. Observation & Results:

In the protected vegetation site, 30 species belonging to 25 genera and 11 families were recorded whereas 8 species belonging to 7 genera and 5 families were observed in the non-protected site. The total Density (Table 1) of trees (stem/ha) in the protected vegetation stand is higher (15.70) in comparison to the non-protected stand (4.9). The total Basal area (Table 1) of trees in the protected stand is 0.764 m2/ha and in the non-protected stand is 0.035 m2/ha. Higher density and basal area in protected vegetation stand shows low anthropogenic pressure and have optimal conditions for the regeneration of tree species. The Simpson's index of diversity is higher in protected vegetation stands (0.899) than in non-protected stands (0.776) showing greater sample diversity in protected vegetation. The Shannon

Diversity Index of the protected stand (2.605) is higher than the non-protected stand (1.689) it also reflects the more species diversity in the protected vegetation stand than in the non-protected vegetation stand. The Jaccard similarity index is 0.22, which shows a low similarity between the two stands.

Table 1: Diversity indices of protected stand and non-protected stand.

	Protected vegetation stand	Un-protected vegetation stand
Number of plots	30	30
Species richness	30	08
Family richness	11	5
Number of individuals in the sampling area	471	147
Total Density of trees (stem/ha)	15.70	4.9
Total Basal area of trees (m^2/ha)	0.764	0.035
Shannon Diversity Index	2.68	1.69
Simpson Diversity index (D1)	0.899	0.776
Species richness index	1.38	0.66
Shannon evenness index	0.79	0.80
Jaccard Similarity index between two stands	0.22	

The important value index reflects the phytosociological characters of a species (Hossain et al., 2004). In the protected vegetation stand *Anogeissus pendula* (Edgew) showed the maximum IVI (58.61) followed by *Azadirachta indica* A. Juss (43.19), *Mitragyna parviflora*. (Roxb.) Korth (22.36), *Dichrostachys cinerea* (L.) (20.56). In the non-protected vegetation stand *Dichrostachys cinerea* (L.) showed the maximum IVI (74.73) followed by *Acacia leucophloea* (Roxb.) (57.47), *Prosopis juliflora* (Swartz) DC. (52.52) and *Acacia nilotica* (L.) (50.95).

Table 2: Phyto-sociological analysis (Relative Frequency, Relative Density, Relative Dominance, and Important Value Index of trees in the protected stand and non-protected stands.

			Protected Vegetation				Non-Protected vegetation			
S. N	**Name of Species**	**Family**	**RF 1**	**RD1**	**RDo1**	**IVI 1**	**RF2**	**RD2**	**RDo2**	**IVI 2**
1	*Anogeissus pendula* (Edgew)	Combretaceae	7.61	21.23	29.76	58.61				
2	*Azadirachta indica* A.Juss.	Meliaceae	8.12	14.86	20.21	43.19	6.33	3.4	9.36	19.09
3	*Mitragyna parviflora*. (Roxb.)Korth.	Rubiaceae	7.61	8.49	6.25	22.36				
4	*Dichrostachys cinerea* (L.)	Fabaceae	7.61	8.49	4.45	20.56	25.32	23.81	25.6	74.73
5	*Acacia leucophloea* (Roxb.)	Fabaceae	4.06	8.49	5.62	18.17	25.32	19.05	13.11	57.47
6	*Acacia catechu* (L.)	Fabaceae	5.08	6.37	5.22	16.66				
7	*Leucaena leucocephala* (Lam.) de Wit.	Fabaceae	7.61	4.25	2.18	14.04				
8	*Acacia nilotica* (L.) subsp. *indica* (Benth.)	Fabaceae	7.61	4.25	1.86	13.72	12.66	10.2	28.09	50.95
9	*Albizia procera* (Roxb.) Benth	Fabaceae	3.55	4.25	2.2	10				
10	*Butea monosperma* (Lam.)	Fabaceae	3.55	2.12	3.05	8.73				
11	*Acacia senegal* (L.) Willd.	Fabaceae	5.08	2.12	1.23	8.43				
12	*Bombax ceiba* (L.)	Fabaceae	5.08	0.64	1.32	7.04				
13	*Securinega leucopyros* (Willd.) Müll.Arg.	Phyllanthaceae	3.55	2.12	0.57	6.24	10.13	5.44	2.11	17.68
14	*Tamarindus indica* L.	Fabaceae	1.52	1.06	2.01	4.59				
15	*Dalbergia sissoo* (Roxb.)	Fabaceae	2.54	1.06	0.83	4.43				

16	*Aegle marmelos* (L.)Correa	Rutaceae	1.52	0.64	2.18	4.34				
17	*Terminalia bellirica* (Geartn.)	Combretaceae	1.52	1.06	1.75	4.33				
18	*Dolichandrone falcate* (Wall.ex Dc.)	Bignoniaceae	1.52	0.64	1.75	3.91				
19	*Holoptelea intestrifolea* (Roxb.)	Ulmaceae	2.03	0.85	0.87	3.75				
20	*Ficus religiosa* L.	Moraceae	1.02	0.64	2.09	3.75				
21	*Ficus racemosa* (L.)	Moraceae	2.03	0.85	0.65	3.53	2.03	0.85	0.65	3.53
22	*Manilkara hexandra* (Roxb.) Dubard	Sapotaceae	1.02	0.42	1.75	3.19				
23	*Phoenix sylvestris* (L.) Roxb.	Arecaceae	1.52	0.64	0.92	3.08	3.8	2.04	7.11	12.95
24	*Sesbania sesban* (L.)	Fabaceae	1.52	0.64	0.1	2.26				
25	*Cassia siamea* (Lam.)	Fabaceae	1.02	1.06	0.052	2.13				
26	*Cassia fistula* (L.)	Fabaceae	1.02	1.06	0.044	2.12				
27	*Pithelobium dulce* (Roxb.)	Fabaceae	1.02	0.42	0.46	1.9				
28	*Limonia acidissima* (L.)	Rutaceae	1.02	0.42	0.44	1.88				
29	*Kirganelia reticulate* (Poir.) Baill.	Phyllanthaceae	1.02	0.42	0.095	1.54				
30	*Pongamia pinnata* (L.) Pierre	Fabaceae	1.02	0.42	0.09	1.53				
31	*Prosopis juliflora* (Swartz) DC.	Fabaceae					12.66	34.01	5.85	52.52

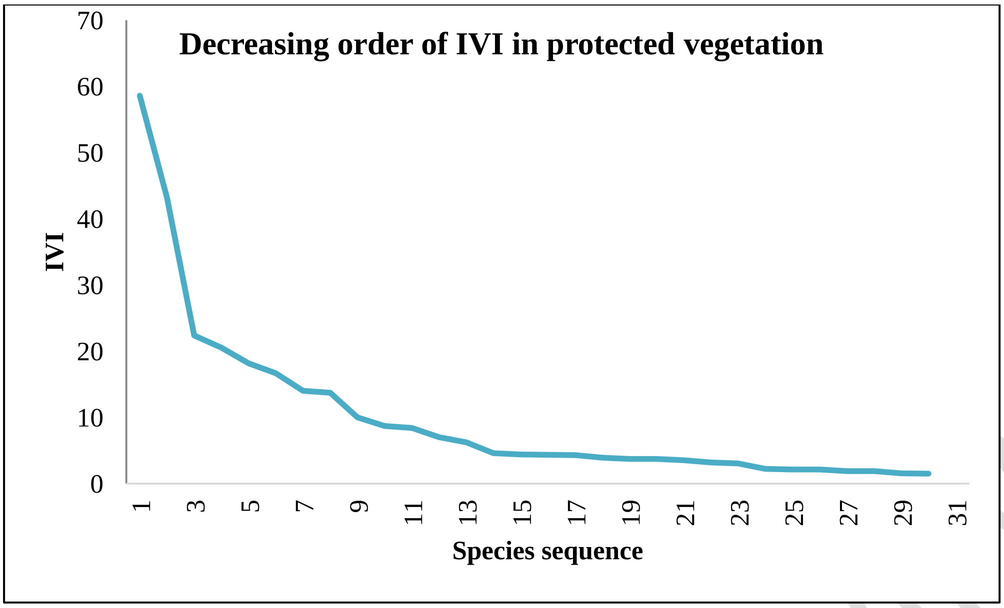


Figure 2: Decreasing order of IVI in protected vegetation.

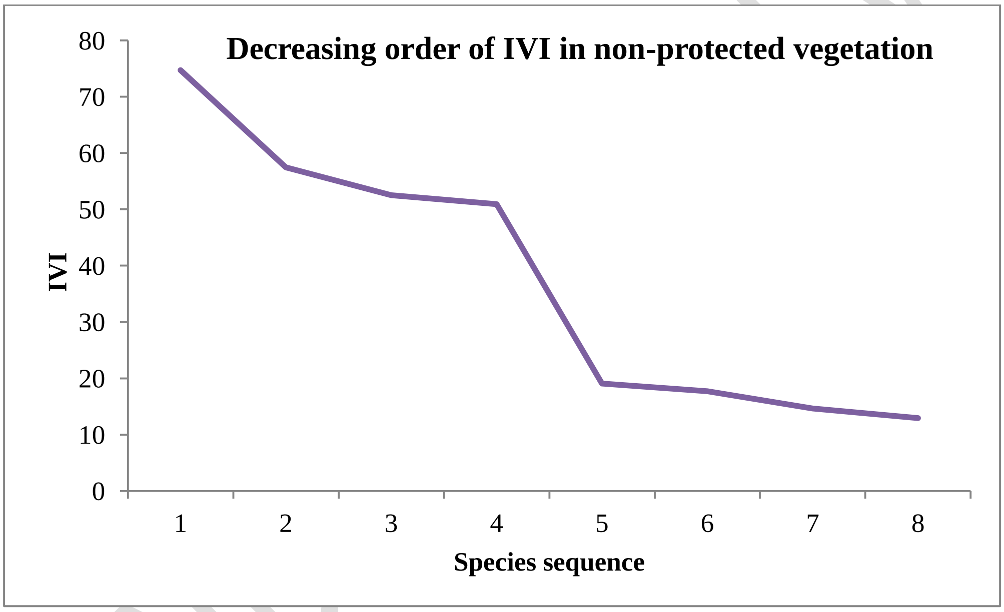


Figure 3: Decreasing order of IVI in non-protected vegetation.

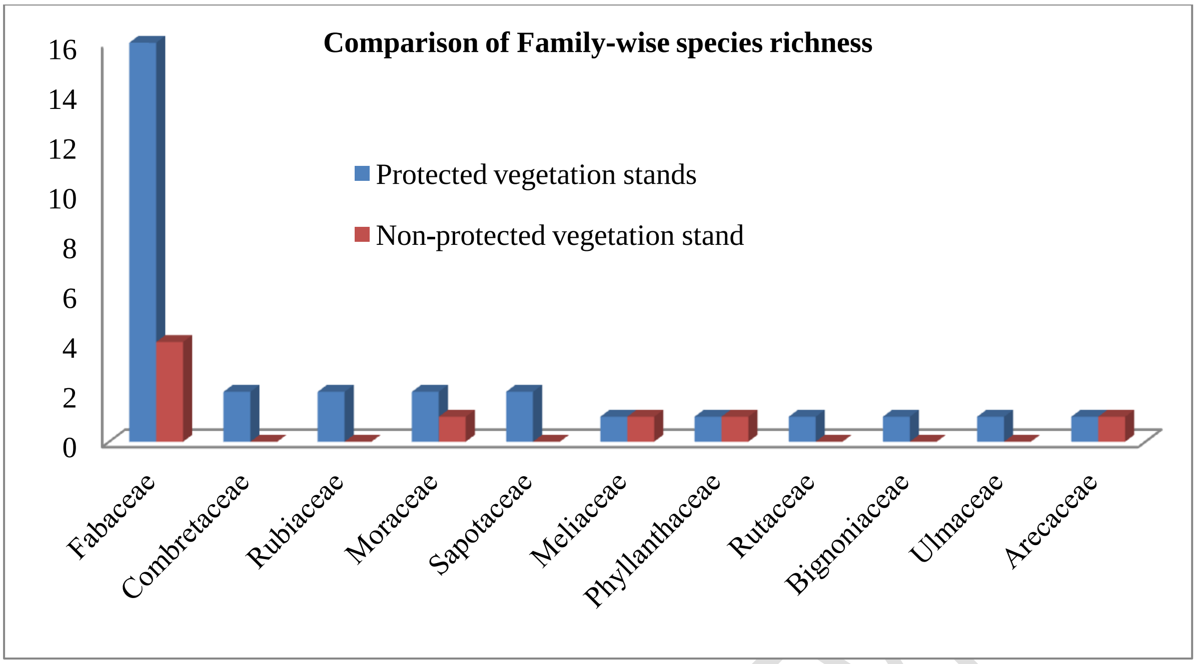


Figure 4: Family-wise Species richness in two vegetation stands.

4. Discussion: Forests possess the greatest diversity in terms of species, genetic material, and ecological processes of all ecosystems (Adekunle et al 2013). The composition and diversity of tree species provide information for better planning and management for the restoration of native species and it is a useful tool in forestry for comparing the composition of different species (Ahmad et al., 2020). Reduction in population sizes may lead to adverse consequences (Sukumar et al., 1992). For ecological studies, patterns of forest communities and their controlling factors play an important role. For assessment of current species performance and anticipation of future community composition, knowledge of plant species diversity draw more attention than any other ecological parameters (Sharma & Kant 2014; Thakur et al., 2022).

The higher values of the diversity indices revealed a forest with high tree species diversity and abundance (Akindele et al., 2013). The tree species composition of the protected stand is higher in comparison to the non-protected stand. In protected vegetation stand *Anogeissus pendula* (Edgew) and non-protected vegetation stand *Dichrostachys cinerea* (L.) show maximum IVI, which reveals that these species are more relatively ecologically important in the forest region of Nanta. Family Fabaceae is the most taxonomically diverse family and dominant in both stands. Fabaceae is the most specious family in the neo-tropical deciduous forests of the world (Gentry, 1995). The presence of Fabaceae is reported in several deciduous forests in south India (Sukumar et al., 1992) and in tropical deciduous forests in Rajasthan (Jaiswal and Dadhich, 2010). Fabaceae is regarded as one of the most successful families of flowering plants due to its extreme flexibility in the adaptive response to different environments (Rundel, 1989).

Tree density can be affected by natural calamities, anthropogenic activities, and soil properties (Sukumar et al., 1992). The basal area and density in the non-protected region are very low which shows that this region is highly disturbed and due to human intervention, the native vegetation is not regenerating at its full potential. Native plants evolved slowly over time with relatively little interference from humans. Native plants provide the foundation for a healthy ecosystem. If they are properly getting their desired soil and light requirements, they can require less water, fertilizer, and maintenance to thrive. For the integrity of ecosystem regeneration and restoration of native species is very necessary. Therefore, there is a great need to protect and conserve the forest of the study area.

Forests are the assets of any country, but their degradation at an alarming rate is a matter of concern. The present scenario demands urgent attention to conserve the diversity of this region to avoid the risk of extinction of the plant species.

Conclusion: The diversity of tree species in unprotected areas is very low; the reason may be anthropogenic disturbances. The major threats of this region are wood cutting, grazing, clearing forests for farming, etc. It can be concluded that anthropogenic disturbances may lead to reduced diversity, reduction in species richness as well as family richness.

References:

1. Ahmad M, Uniyal S K, Batish D R, Singh H P, Jaryan V, Rathee S, Sharma P and Kohli RK. (2020). Patterns of plant communities along vertical gradient in Dhauladhar Mountains in Lesser Himalayas in North-Western India. *Science of the Total Environment*, 716, 136919.
2. Ahmed M, Nazim K, Siddiqui M F, Wahab M, Khan N, Khan M U, & Hussain S S (2010). Community description of Deodar forests from Himalayan range of Pakistan. *Pak. J. Bot*, 42(5): 3091-3102.
3. Akindele S O (2013). Tree species diversity and structure of a Nigerian strict nature reserve. *Tropical Ecology*, 54(3): 275-289.
4. Alam M, Furukawa Y, Sarker S K, & Ahmed R (2008). Sustainability of Sal (*Shorea robusta*) forest in Bangladesh: past, present and future actions. *International Forestry Review*, 10(1), 29-37.

5. Muller-Dombois D, & Ellenberg H. (1974). Aims and methods of vegetation ecology. John Willey and Sons. *Inc.*, *New York*.
6. FAO and UNEP. (2020). The State of the World's Forests 2020. Forests, biodiversity and people. Rome. https://doi.org/10.4060/ca8642en
7. Gentry A H (1995). Diversity and floristic composition of neotropical dry forests. *Seasonally dry tropical forests*, 146-194.
8. Hossain M K, Rahman M L, Hoque A T M, & Alam M K (2004). Comparative regeneration status in a natural forest and enrichment plantations of Chittagong (south) forest division, Bangladesh. *Journal of Forestry Research*, 15(4): 255-260.
9. Jaccard P (1901). Comparative study of floral distribution in a portion of the Alps and Jura. *The Company Vaudoise Bulletin of Natural Sciences*, *37*(5), 547-579.
10. Jaiswal Poonam and Dadhich L K (2010). Floristic inventory of the protected vegetation-stands amidst stone mining areas of Ramganjmandi, Kota, Rajasthan, *Research Analysis and Evaluation*, 8: 12-18
11. Khera N, Kumar A, Ram J, & Tewari A (2001). Plant biodiversity assessment in relation to disturbances in mid-elevational forest of Central Himalaya, India. *Tropical Ecology*, 42(1); 83-95.
12. Kumar A, Marcot B G, & Saxena A (2006). Tree species diversity and distribution patterns in tropical forests of Garo Hills. *Current science*, 1370-1381.
13. Latpate R, Kshirsagar J and Chandra G. (2021). Advanced Sampling Methods, Springer, Singapoor.
14. Magurran A E (1988). Ecological diversity and its measurement. Princeton University Press.
15. Menhinick E F (1964). A comparison of some species-individuals diversity indices applied to samples of field insects. *Ecology*, 45(4): 859-861.
16. Mishra R. (1968). Ecology Workbook. Oxford and IBH.
17. Phillips O L, Martínez R V, Vargas P N, Monteagudo A L, Zans M E C, Sánchez W G & Rose S (2003). Efficient plot-based floristic assessment of tropical forests. *Journal of Tropical Ecology*, 19(6): 629-645.
18. Rundel RW (1989) Ecological success in relation to plant form and function in the woody legumes. *In*: Stirton CH & Zarucchi JL (Eds) *Advances in Legume Biolog*y Monogr. Syst. Bot. Missouri Bot. Gard. 29: 377-398
19. Shannon C E, Wiener W (1949). The Mathematical Theory of Communication. Urbana, University of Illinois Press, 177.

20. Sharma, N., & Kant, S. (2014). Vegetation structure, floristic composition and species diversity of woody plant communities in sub-tropical Kandi Siwaliks of Jammu, J & K, India. *International Journal of Basic and Applied Sciences*, 3(4), 382.
21. Simpson E H (1949). Measurement of diversity. Nature, 163:688
22. Sukumar R, Dattaraja H S, Suresh H S, Radhakrishnan J, Vasudeva R, Nirmala S, & Joshi, N V (1992). Long-term monitoring of vegetation in a tropical deciduous forest in Mudumalai, southern India. *Current Science*, 608-616.
23. Thakur, S., Negi, V. S., Dhyani, R., Bhatt, I. D., & Yadava, A. K. (2022). Influence of environmental factors on tree species diversity and composition in the Indian western Himalaya. *Forest Ecology and Management*, 503, 119746