A comparative Study of Phytosociological Statusof Herbs and Shrubs in Nanta Forest Region, Rajasthan, India

Abstract

The purpose of this study was to compare the community structure and phytosociological status of shrubs and herbs in two different vegetation stands. The study was carried out in the Nanta forest region whichis situated between 25.21525° N and 75.8311° E and comes under the Sakatpura forest range, Ladpura tehsil,KotaDistrict, Rajasthan, India.Inthe shrub layer, *Mitragyna parviflora*. (Roxb.) Korth.has the highest IVI (21.05) followed by,*Anogeissus pendula* Edgew. (20.39) and *Hyptissuaveolens* (L.) Poit.(19.48). All these plants were reported absent from non-protected sites where *Ziziphus nummularia* (Burm.f.) Wight & Arn.has the highest IVI (66.28) followed by Prosopis *juliflora* (Swartz) DC. (60.99) and *Acacia leucophloea* (Roxb.)Willd. (40.26). In the herbaceous ground cover grass *Apluda mutica* L. hasthe highest value of IVI (18.70), followed by *Themeda quadrivalvis* (L.) Kuntze with IVI (9.19).Both these grass species were absent from non-protected vegetation sites where *Cynodon dactylon* (L.) *Pers.*has the highest IVI (22.60)followed by *Eragrostis pilosa* (L.) P. Beauv.(22.18).In the present study area, it has been observed that the stem density, basal area and species richnessare lower in non-protected vegetation stand than in protected vegetation site. In protected vegetation only 9 shrub species accounts for >50% of the IVI and 36 shrub species contribute to <50% of IVI. 19 shrub species of family Fabaceae account for nearly 1/3rd of the IVI in protected vegetation. In non-protected vegetation only 12 shrub species contribute to the total IVI whereas out of 12 species, fabaceous shrubs share the largest part (47.17%) of IVI. 12 common shrub species share almost 1/3rd IVI (112.92) in protected vegetation. Inprotected vegetation, 15 herbaceous species account for >1/3rd of the IVI (108.97), whereas in non-protected vegetation only 5 herbaceous species (4 Poaceae& 1 Euphorbiaceae) account for nearly 1/3rd of the IVI. Only 4 herbaceous species account for the largest share of IVI (80.35) in non-protected vegetation. 19 herbaceous plants of the family Poaceae account for > 1/3rd of total IVI (106.23) whereasfamily Fabaceae hasthe largest number of plant species (27) accounting for a total IVI of only 27.83. The most interesting fact is that in non-protected herbaceous vegetation *Chrozophorarottleri* (Geis) A.Juss.ex Spreng. which is not reported in protected vegetation contributes to 6.23% share of total IVI. Disturbances can cause change in species composition or sometimes total replacement of plant species. In the shrub layer share of fabaceous species increased whereas in ground layer it decreased. Overall diversity is reduced and dominance increased.

Keywords: Nanta, phytosociological,IVI,community structure

Introduction

Forests are essential for human life because they provide a wide variety of resources and ecosystem services.However, forest cover is rapidly depleting due to a variety of factors, including increased agriculture practices, timber plantation, urbanization, road construction, and expansion of industries, which pose the most serious threat to the forest and cause severe harm to the environment (**Pawar &Rothkar, 2015).**Habitat loss and fragmentation are the most important causes of biodiversity destruction.Biomass extraction by grazing, fuelwood collection, and non-timber forest product (NTFP) extraction may be the most prevalent strain on forests in developing nations.Tropical dry forest, despite accounting for a major share of the rural population's biomass demands, is particularly understudied in India.

The land of India is experiencing a significant threat of degradation. The 2016 Atlas of Land Degradation and Desertification estimates that 29.3% of India's total geographical area has been degraded or converted to deserts**(Singh& Tewari, 2022).**Forest conservation is the process of establishing and conserving forested lands for future generations' benefit and sustainability. Forest conservation serves to protect and preserve biodiversity, preventthe extinction of endangered species, and maintain ecological balance.

In the present scenario, the extinction rates of biodiversity are 100 to 1000 times their pre-human level, those species that are assigned as threatened species will be extinct in the next century because the future rate of extinction will be10 times higher than current rates. The rate of eradication of endemic species is higher due to precise knowledge of regions that are particularly rich in biodiversity **(Pimm *et al*., 1995).** Approximately 500,000 species are spread over the world of which 100,000-160, 000, are still unexplored or may be threatened **(Corlett, 2016).** According to the IUCN Red Data book, more than 42,100 species are under threat and facing a high risk of extinction, resulting both directly and indirectly from human deeds.

Forest conservation aims to know the composition of tree species and age distribution in order to plan restoration accordingly. Assessment of forest composition and community structure is a very necessary tool for management and conservation planning **(Ahmad *et al*., 2020).** The floristic inventory, species diversity, and vegetational structure are important for the assessment of natural forests in a particular region and to recommend conservation planning **(Sharma & Kant, 2014).**

Community structure, composition and function are three important characteristic features of forest ecosystems that are changing in response to topography, disturbances, succession, climatic and edaphic factors **(Timilsina *et al.*,2007).**The extent of changes in forest cover is studied through phytosociological characters, usually by density and basal cover, which are the important bases of study for different vegetation types**(Mishra, *et al*., 2005).**Vegetation analysis provides detailed information about the turnover rate of species, community organization, and niche resource distribution pattern in a forest **(Mandal and Joshi, 2014).**Phytosociological studies are required for conservation planning and long-term utilization**(Krishna *et al*.,2014).**The current study offers a detailed comparative analysis of community structure and phytosociological status of the Nanta forest region, Kota district, Rajasthan.

Study area

The study was carried out in the Nanta forest region which is located in the Sakatpura forest range in forest division Kota. Nanta is situated between 25.21525°N and 75.8311° E and lies under Ladpura Tehsil of Kota district (Rajasthan). Nanta also has its historical significance as the famous "Abheda Mahal" and "Karni Mata" temple lies in its boundaries. Recently the AbhedaBiological Park has been developed here for the protection of wildlife.Data was collected from the Nanta forest region from March 2020 to April 2022,andtwo stands were taken into account one is a protected vegetation stand (control site) andthe theother is a non-protected vegetation stand (experimentalsite).

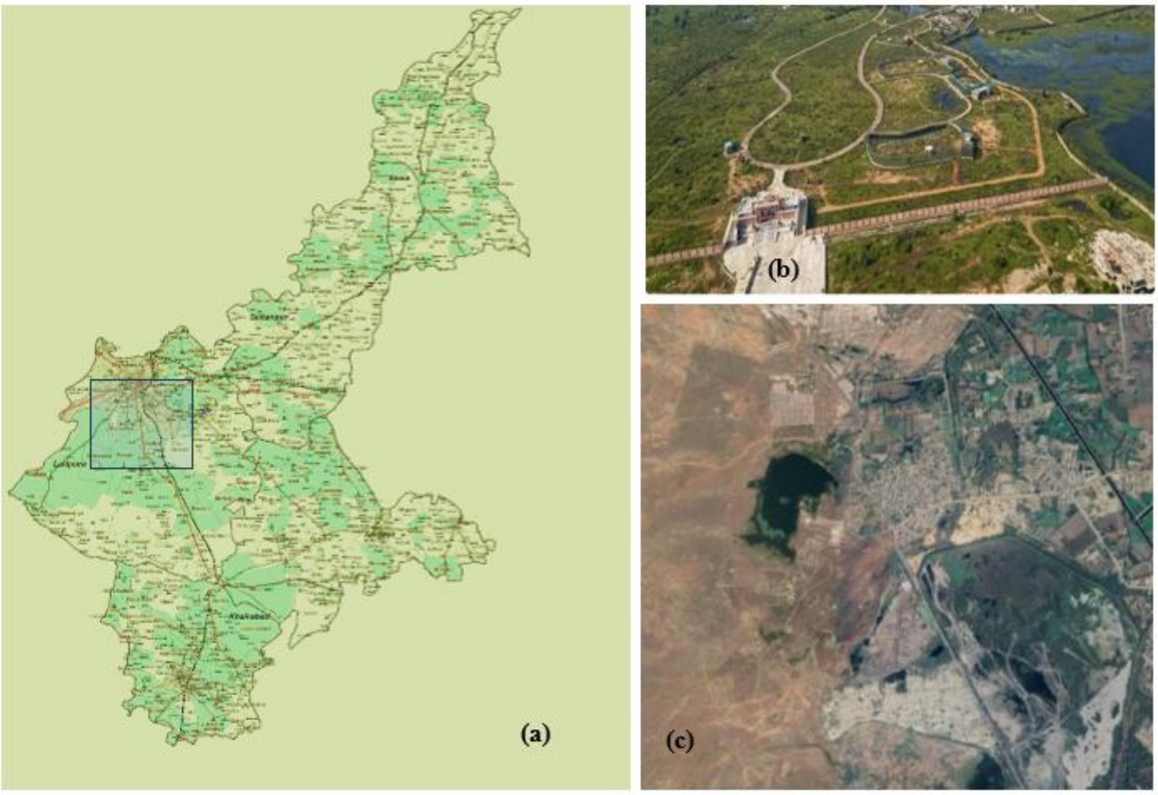

Figure 1: (a)Map of Kota District showing study area (in box). (b)Protected vegetation stand (drone view). (c) Satellite view of the study area.

Material and Method

1. Vegetation sampling: To determine the flora of the protected vegetation stand (control site) and non-protected stand (experimental site)sampling was done using quadrates of different sizes for shrubs, and herbaceous plants. The standard size of the quadrates for sampling shrubs, woody climbers + saplings, and herbs + seedlings taken are10x10m (100sq m), and 1x1m (1sq m) respectively.In each quadrat, individuals within the girth range of 10.5 to 30.0 cm at the ground level were considered as shrubs, woody climbers +saplings, and individuals < 10.5 cm girth at ground level were considered as herbs+seedlings.

2. Phyto-sociological analysis of vegetation: The vegetation data were quantitatively analyzed for frequency, density, basal area, and IVI (Importance Value Index) following **Mueller-Dombois and Ellenberg (1974)** and **Magurran (1988).** Basal areas of the shrubs were expressed as m^2/hect and herbs were expressed as cm^2/m^2. Further dominance-diversity curve was prepared for each vegetation layer separately by plotting species IVI against the species **(Whittekar, 1975).**

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

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

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

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

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

$$\text{Dominance} = \frac{\text{Basal area of a species A}}{\text{Area sampled(m2)}}$$

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

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

Observation & Results:

In protective vegetation site the total density of shrub and herbswere recorded259.33 ind./hectand 86.61 ind./m^2 respectively, where as in non-protective site respective density ofthe shrub and herbs are 141.33 ind./hectand 12.88 ind./m^2.The total basal area was calculated for shrub and herbs in control site are 1.924 m^2/hect and 1.420 cm^2/m^2, where as in non-protective site the total basal area calculated for shrub and herbs are 73.441 m^2/hect and 10.357cm^2/m^2respectively. Species richness of shrub species reduced from 45 in protected vegetation to 12 in non-protected vegetation, whereas in herbaceous layer species richness reduced from 163 to 28 (Table 1).

Table 1:A comparison of status of vegetation forming shrub layer and ground cover of the protected vegetation and non- protected vegetation in terms of phytosociological parameters.

Parameters	**Values**	
	Protected vegetation stands	**Non-protected vegetation stands**
Total density of shrub /hectare	259.33	141.33
Total density of herbs /m^2	86.61	12.88
Total basal area of shrubs (m^2/hect)	1.924	1.420

Total basal area of herbs (cm^2/m^2)	73.441	10.357
Species richness of shrub	45	12
Species richness of herbs	163	28

In shrub layer of control site *Mitragyna parviflora*. (Roxb.) Korth (21.05) has the highest IVI followed by *Anogeissus pendula* Edgew. (20.39) and *Hyptissuaveolens* (L.) Poit. (19.48)whereas in experimental site, *Ziziphus nummularia* (Burm.f.) Wight & Walk. -Arn. has the highest IVI (66.28) followed by *Prosopis juliflora* (Swartz) DC. (60.99) and *Acacia leucophloea* (Roxb.) Willd. (40.26)(Table 2).

In terms of density, *Hyptissuaveolens*(L.) Poit.(23.33 ind/hect) has the highest density followed by *Ziziphus nummularia* (Burm.f.) Wight &Arn. (16.67ind/hect)and *Balanites aegytiaca* (L.) Delile (16.33ind/hect).As we observed that in terms of basal area *Anogeissus pendula* Edgew.(0.226 m^2/ha) top the list followed by *Azadirachta indica* A. Juss (0.201 m^2/hect) and *Mitragyna parviflora*. (Roxb.) Korth. (0.196 m^2/hect).

In the herbaceous ground cover grass species *Apluda mutica* L. has highest value of IVI (18.70), followed by *Themeda quadrivalvis* (L.) Kuntze with IVI (9.19) in protected vegetation whereas in non-protected vegetation *Cynodon dactylon* (L.) *Pers.* has the highest IVI (22.60) followed by *Eragrostis pilosa* (L.) P. Beauv. (22.18) and *Chloris virgatus* SW. (18.88) (Table 3).The species *Apluda mutica* L. also has the highest density and basal area followed by *Themeda quadrivalvis* (L.) Kuntze.

In protective vegetation site the total density of shrub and herbswere recorded259.33 ind./hectand 86.61 ind./m^2 respectively, where as in non-protective site respective density ofthe shrub and herbs are 141.33 ind./hectand 12.88 ind./m^2.The total basal area was calculated for shrub and herbs in control site are 1.924 m^2/hect and 1.420 cm^2/m^2, where as in non-protective site the total basal area calculated for shrub and herbs are 73.441 m^2/hect and 10.357cm^2/m^2respectively.

Table 2: Phytosociological analysis (Relative Frequency, Relative Density, Relative Dominance, and Important Value Index of shrub layerinthe protected stand and non-protected vegetation stand.

			Protected Vegetation				Non-Protected vegetation			
S. N	**Name of Species**	**Family**	**RF 1**	**RD1**	**RDo1**	**IVI 1**	**RF2**	**RD2**	**RDo2**	**IVI 2**
1	*Abelmoschus moschatus* Medicus	Malvaceae	1.00	1.28	1.01	3.29				
2	*Acacia catechu* (L.) (L.f.) Willd.	Fabaceae	1.99	1.28	4.04	7.31				
3	*Acacia leucophloea* (Roxb.) Willd.	Fabaceae	3.98	3.20	10.10	17.29	8.85	9.39	22.02	40.26
4	*Acacia nilotica*(L.)subsp.indica(Benth.)Brenan	Fabaceae	2.99	2.56	8.08	13.63	4.42	4.69	3.96	13.08
5	*Acacia senegal*(L.) Willd.	Fabaceae	0.40	0.26	0.81	1.46				
6	*Albizia procera*(Roxb.)Benth.	Fabaceae	1.00	0.64	2.02	3.66				
7	*Anogeissus pendula* Edgew.	Combretaceae	2.99	5.76	11.64	20.39				
8	*Azadirachta indica* A. Juss.	Meliaceae	3.98	5.12	10.34	19.45	4.42	2.35	5.50	12.28
9	*Balanites aegytiaca* (L.) Delile	Zygophyllaceae	3.98	6.27	3.17	13.43				
10	*Bauhinia racemosa Lam.*	Fabaceae	0.80	0.51	0.26	1.57				
11	*Butea monosperma*(Lam.) Taub.	Fabaceae	2.99	2.56	8.08	13.63				
12	*Calotropis procera*(Alton) W.T.Alton	Apocynaceae	4.98	3.20	0.40	8.59	6.64	5.87	1.24	13.74
13	*Capparis decidua* (Forssk.) Edgew.	Capparaceae	0.80	0.51	0.26	1.57				
14	*Cassia fistula* L.	Fabaceae	0.40	0.26	0.52	1.17				

15	*Cassia siamea*(Lam.) H.S.Irwin& Barneby	Fabaceae	0.40	0.26	0.52	1.17				
16	*Celosia argentea* L.	Amaranthaceae	1.99	3.84	0.48	6.32				
17	*Dalbergia sissoo* Roxb. exDC.	Fabaceae	1.00	0.64	0.32	1.96				
18	*Datura innoxia*Mill.	Solanaceae	1.20	0.90	0.45	2.54	6.64	4.69	1.76	13.09
19	*Dichrostachys cinerea* (L.) Wight & Arn.	Fabaceae	5.58	3.84	1.94	11.36	6.64	8.22	12.33	27.18
20	*Dolichandrone falcate* (Wall.ex Dc.) Seem.	Bignoniaceae	1.00	0.64	0.32	1.96				
21	*Echinopsechinatus*Roxb.	Asteraceae	3.98	4.48	2.26	10.73	7.52	5.63	2.11	15.27
22	*Ficus racemosa*L.	Moraceae	1.99	1.28	0.65	3.92				
23	*Grewia tenax* (Forssk.) Fiori	Malvaceae	1.00	0.64	0.73	2.36				
24	*Holoptelea integrifolia (Roxb.) Planch.*	Ulmaceae	0.40	0.26	0.13	0.78				
25	*Hyptissuaveolens* (L.) Poit.	Lamiaceae	7.97	8.96	2.55	19.48				
26	*Indigofera oblongifolia*Forssk.	Fabaceae	1.99	3.84	1.09	6.92				
27	*Indigophera tinctoria* L.	Fabaceae	0.80	1.92	0.97	3.69				
28	*Jatropha curcus* L.	Euphorbiaceae	1.00	0.64	0.18	1.82				
29	*Jatropha gossypifolia* L.	Euphorbiaceae	1.99	3.84	1.09	6.92				
30	*Kirganelia reticulata* (Poir.) Baill.	Phyllanthaceae	1.99	1.28	0.65	3.92				
31	*Lantana camara* L.	Verbenaceae	3.59	2.56	0.73	6.87	8.85	5.87	1.24	15.96
32	*Leucaena leucocephala*(Lam.) de Wit.	Fabaceae	4.98	3.20	1.62	9.80				

33	*Martynia annua* L.	Martyniaceae	1.99	1.92	2.18	6.09				
34	*Mitragyna parviflora*. (Roxb.) Korth.	Rubiaceae	5.98	4.99	10.08	21.05				
35	*Ocimumbasilicum* L.	Lamiaceae	1.99	2.56	0.32	4.88				
36	*Phoenix sylvestris* (L.) Roxb.	Arecaceae	0.60	0.38	0.44	1.42	2.21	1.17	2.75	6.14
37	*Pithecellobium dulce (*Roxb.) *Benth.*	Fabaceae	0.40	0.26	0.13	0.78				
38	*Pongamia pinnata*(L.)Pierre	Fabaceae	1.99	1.66	2.57	6.23				
39	*Prosopis juliflora* (Swartz) DC.	Fabaceae	1.00	1.28	0.65	2.92	17.70	23.47	19.82	60.99
40	*Securinegaleucopyrus (Willd.) Müll.Arg.*	Phyllanthaceae	1.99	1.28	0.65	3.92	3.98	4.69	7.05	15.72
41	*Sesbania sesban*(L.) Merr.	Fabaceae	1.00	0.64	0.32	1.96				
42	*Tamarindus indica* L.	Fabaceae	1.00	0.64	0.73	2.36				
43	*Typha elephantena*Roxb.	Typhaceae	0.60	1.28	2.59	4.46				
44	*Ziziphus mauritiana Lam.*	Rhamnaceae	0.40	0.26	0.13	0.78				
45	*Ziziphus nummularia* (Burm.f.) Wight &Arn.	Rhamnaceae	5.98	6.40	1.82	14.20	22.12	23.94	20.21	66.28

Table 3: Phytosociological analysis (Relative Frequency, Relative Density, Relative Dominance, and Important Value Index of the herbaceous layerin the protected stand and non-protected vegetation stand.

			Protected Vegetation				**Non-Protected vegetation**			
S. N	**Name of Species**	**Family**	**RF 1**	**RD1**	**RDo1**	**IVI 1**	**RF2**	**RD2**	**RDo2**	**IVI 2**

1	*Abelmoschus moschatus*Medicus	Malvaceae	0.60	0.46	0.62	1.67				
2	*Abutilon hirtum* (Lam.) Sweet	Malvaceae	0.60	0.15	0.14	0.88				
3	*Acacia catechu* (L.)	Fabaceae	0.24	0.05	0.04	0.33				
4	*Acacia leucophloea* (Roxb.) Willd.	Fabaceae	0.30	0.06	0.05	0.41				
5	*Acacia nilotica*(L.)*subsp.indica(Benth.)Brenan*	Fabaceae	0.60	0.35	0.32	1.26				
6	*Acacia senegal*(L.) Willd.	Fabaceae	0.06	0.01	0.01	0.08				
7	*Acalypha indica* L.	Euphorbiaceae	0.60	0.23	0.31	1.13	1.72	2.71	2.65	7.07
8	*Achyranthes aspera* L.	Amaranthaceae	2.38	0.81	0.75	3.94	3.44	2.71	2.65	8.79
9	*Aerva lanata*(L.)Juss.	Amaranthaceae	0.71	0.23	0.21	1.16				
10	*Aeschynomene indica* L.	Fabaceae	0.30	0.75	0.84	1.89				
11	*Ageratum conyzoids* L.	Asteraceae	0.24	0.12	0.13	0.48				
12	*Ageratum houstonianum* L.	Asteraceae	0.12	0.12	0.11	0.34				
13	*Albizia procera(Roxb.) Benth.*	Fabaceae	0.12	0.02	0.02	0.16				
14	*Alloteropsiscimicina* (L.) Stapf	Poaceae	0.60	1.15	0.89	2.64				
15	*Alternanthera sessilis*(L.) R. Br.	Amaranthaceae	1.79	0.69	0.64	3.12	2.58	3.25	3.17	9.01
16	*Alysicarpus vaginalis* (L.) DC.	Fabaceae	0.12	0.06	0.05	0.23				
17	*Amaranthus hybridus* L.	Amaranthaceae	0.54	0.29	0.17	1.00				
18	*Ammanniabaccifera* L.	Lythraceae	0.60	0.35	0.26	1.20				
19	*Anagallis arvensis* L.	Primulaceae	1.19	0.57	0.52	2.28	1.72	2.56	2.49	6.77

20	*Andrographis paniculata* (Burm.f) Nees	Acanthaceae	1.79	0.58	0.90	3.27				
21	*Anogeissus pendula* (Edgew)	Combretaceae	0.60	0.29	0.27	1.15				
22	*Apluda mutica* L.	Poaceae	1.19	7.50	10.00	18.70				
23	*Argemone mexicana* L.	Papaveraceae	0.60	0.23	0.26	1.09	1.37	2.32	2.27	5.97
24	*Argyreia nervosa(Burm.f.) Bojer*	Convolvulaceae	0.06	0.01	0.01	0.08				
25	*Aristida adscensionis L.*	Poaceae	0.60	2.86	2.15	5.61				
26	*Azadirachta indica* A.Juss.	Meliaceae	0.60	0.23	0.31	1.13				
27	*Balanites aegytiaca* (L.) Delile	Zygophyllaceae.	0.60	0.12	0.11	0.82				
28	*Bauhinia racemosa Lam.*	Fabaceae	0.06	0.02	0.02	0.10				
29	*Blastaniagarcinii* (Burm. F.)	Cucurbitaceae	0.30	0.12	0.11	0.52				
30	*Blumea laciniata* (Wall. ex Roxb.) DC.	Asteraceae	1.19	0.58	0.53	2.30	3.44	3.18	3.10	9.71
31	*Bombax ceiba* L.	Malvaceae	0.06	0.01	0.01	0.08				
32	*Borreria pusilla* (Wall.) DC.	Rubiaceae	0.12	0.33	0.38	0.83				
33	*Bothriocholapertusa*(L.) A.Camus	Poaceae	0.60	3.46	2.05	6.11				
34	*Brachhariamutica* (Forssk.) Stapf	Poaceae	0.60	1.13	1.05	2.77				
35	*Brachiariaramosa* (L.) Stapf	Poaceae	0.48	3.93	3.63	8.04	4.81	7.59	4.74	17.14
36	*Butea monosperma*(Lam.) Taub.	Fabaceae	0.30	0.06	0.05	0.41				
37	*Caesuliaaxillaris*Roxb.	Asteraceae	0.36	0.58	0.53	1.47				
38	*Calotropis procera* (Alton) W.T.Alton	Apocynaceae	0.30	0.06	0.05	0.41				

39	*Capparis decidua* (Forssk.) Edgew.	Capparaceae	0.12	0.05	0.04	0.21					
40	*Capparis sepiaria* L.	Capparaceae	0.12	0.22	0.25	0.58					
41	*Cardiospermum halicacabum* L.	Sapandaceae	0.30	0.29	0.27	0.85					
42	*Cassia fistula* L.	Fabaceae	0.06	0.01	0.02	0.09					
43	*Cassia occidentalis* L.	Fabaceae	0.30	0.30	0.47	1.07					
44	*Cassia siamea*(Lam.) H.S.Irwin& Barneby	Fabaceae	0.06	0.02	0.02	0.10					
45	*Cassia tora* L.	Fabaceae	1.07	0.27	0.25	1.58	1.72	2.71	2.65	7.07	
46	*Cayratiatrifolia* (L.) Domin	Vitaceae	0.60	0.22	0.25	1.06					
47	*Celosia argentea* L.	Amaranthaceae	0.60	0.46	0.43	1.48					
48	*Chloris virgatus* SW.	Poaceae	0.54	2.27	2.11	4.92					
49	*Chrozophora rottleri* (Geis) A.Juss.ex Spreng.	Euphorbiaceae					5.15	7.67	6.06	18.88	
50	*Chrozophora rottlerin* (Geiseler) A.Juss. ex Spreng.	Euphorbiaceae	0.60	0.46	0.52	1.57					
51	*Cleome viscosa*L.	Cleomaceae	0.48	0.12	0.15	0.75	1.72	0.77	0.76	3.25	
52	*Coccinia grandis* (L.) Voigt	Cucurbitaceae	0.48	0.12	0.04	0.63					
53	*Commelinaalbescens*Hassk	Commelinaceae	0.60	0.23	0.21	1.04					
54	*Commelinabenghalensis* L.	Commelinaceae	0.48	0.35	0.32	1.14					
55	*Convolvulus prostrates*Forsk.	Convolvulaceae	0.60	0.24	0.14	0.98					
56	*Conyza bonariensis* L.	Asteraceae	0.30	0.35	0.32	0.96					

57	*Corchorus olitorius* L.	Malvaceae	0.60	0.45	0.50	1.55				
58	*Corchorus trilocularis* L.	Malvaceae	0.30	0.35	0.32	0.96				
59	*Croton bonplandianus*Baill.	Euphorbiaceae	0.60	0.23	0.26	1.09				
60	*Cucumis callosus* (Rott.) Cogn.	Cucurbitaceae	0.60	0.21	0.19	1.00				
61	*Cucumis maderaspatanus* L.	Cucurbitaceae	0.60	0.22	0.20	1.02				
62	*Cyanotisaxillaris*(L.) D.Don ex Sweet	Commelinaceae	0.30	0.46	0.43	1.19				
63	*Cynodon dactylon (L.) Pers.*	Poaceae	1.19	0.46	0.35	2.00	6.53	8.13	7.94	22.60
64	*Cyperus alulatus*Kern.	Cyperaceae	0.89	2.31	2.14	5.34				
65	*Cyperus iria* L.	Cyperaceae	0.83	2.30	2.13	5.26				
66	*Cyperus rotundus* L.	Cyperaceae	1.19	1.14	1.06	3.39				
67	*Dactylocteniumaristatum* Link	Poaceae	0.54	3.23	2.42	6.19				
68	*Dalbergia sissoo* Roxb. ex DC.	Fabaceae	0.30	0.06	0.06	0.42				
69	*Datura innoxia*Mill.	Solanaceae	1.79	0.35	0.32	2.45				
70	*Dichanthiumannulatum*(Forssk.) Stapf	Poaceae	1.19	2.31	2.59	6.09	3.44	7.59	7.41	18.43
71	*Dichrostachys cinerea* (L.) Wight & Arn.	Fabaceae	0.60	0.27	0.25	1.11				
72	*Digera muricata* (L.)	Amaranthaceae	0.30	0.12	0.11	0.52				
73	*Dolichandrone falcate* (Wall.ex Dc.) Seem.	Bignoniaceae	0.06	0.01	0.01	0.08				
74	*Echinochloacolona* (L.) Link	Poaceae	0.60	2.31	2.14	5.04				
75	*Echinochola crus-galli* (L.) P. Beauv	Poaceae	0.89	2.42	2.24	5.56				

76	*Echinopsechinatus*Roxb.	Asteraceae	1.79	2.54	3.97	8.30	3.09	3.87	3.78	10.74
77	*Eclipta alba* (L.)Hassk.	Asteraceae	0.30	0.12	0.11	0.52				
78	*Elytraria acaulis* (L.f.) Lindau	Acanthaceae	0.30	0.35	0.32	0.96				
79	*Enicostemaaxillare*(Poir.ex Lam.) A.Raynal	Gentianaceae	0.30	0.35	0.32	0.96				
80	*Eragrostisgangetica*(Roxb.)Steud.	Poaceae	0.60	1.15	0.87	2.62				
81	*Eragrostis pilosa* (L.) P.Beauv.	Poaceae	1.07	2.31	2.59	5.97	6.87	7.75	7.56	22.18
82	*Euphorbia hirata* L.	Euphorbiaceae	1.49	1.15	1.07	3.71	4.30	2.40	5.27	11.97
83	*Euphorbia hypericifolia* L.	Euphorbiaceae	0.66	0.24	0.22	1.12	4.64	2.32	2.27	9.23
84	*Evolvulusalsinoides* L.	Convolvulaceae	0.30	0.24	0.22	0.76				
85	*Ficus racemosa*L.	Moraceae	0.30	0.06	0.05	0.41				
86	*Ficus religiosa L.*	Moraceae	0.18	0.03	0.03	0.25				
87	*Gomphrena celosoides* Mart.	Amaranthaceae	0.30	0.22	0.29	0.81				
88	*Grewia tenax* (Forssk.) Fiori	Malvaceae	0.12	0.02	0.03	0.17				
89	*Hedyotishispida* Retz.	Rubiaceae	0.12	0.12	0.11	0.34				
90	*Holoptelea integrifolia (Roxb.) Planch.*	Ulmaceae	0.06	0.02	0.02	0.10				
91	*Hyptissuaveolens*(L.) Poit.	Lamiaceae	1.19	1.14	1.06	3.39				
92	*Imperata cylindrica* (L.) Raeuschel.	Poaceae	0.30	1.10	0.86	2.25				
93	*Indigofera cordifolia* Heyne. ex Rot	Fabaceae	0.60	0.45	0.42	1.46				
94	*Indigofera linnaei* Ali	Fabaceae	0.60	0.46	0.43	1.48				

95	*Indigofera oblongifolia*Forsk.	Fabaceae	0.60	0.35	0.32	1.26				
96	*Indigophera tinctoria* L.	Fabaceae	0.42	0.35	0.32	1.08				
97	*Ipomea pes-tigridis* L.	Convolvulaceae	0.60	0.22	0.20	1.02				
98	*Ipomoea erirocarpa* R.Br.	Convolvulaceae	1.19	0.35	0.32	1.86				
99	*Jatropha gossypifolia* L.	Euphorbiaceae	1.19	0.46	0.43	2.08				
100	*Justicia simplex* D. Don	Acanthaceae	0.60	0.58	0.53	1.71				
101	*Kirganelia reticulata* (Poir) *Baill.*	Phyllanthaceae	0.12	0.03	0.03	0.19				
102	*Kyllinga bulbosa* P. Beauv.	Cyperaceae	0.24	0.69	0.64	1.57				
103	*Lablab purpureus* (L.) Sweet	Fabaceae	0.89	0.23	0.21	1.34				
104	*Lantana camara* L.	Verbenaceae	1.07	0.23	0.86	2.16	1.72	3.10	3.02	7.84
105	*Launaea procumbens* (Roxb.)	Asteraceae	0.89	0.23	0.26	1.38	6.01	2.94	2.87	11.83
106	*Leucaena leucocephala*(Lam.) de Wit.	Fabaceae	0.30	0.23	0.21	0.74				
107	*Leucas aspera* (Willd) Link	Lamiaceae	0.89	0.35	0.32	1.56				
108	*Lindernia parviflora* (Roxb.) Haines	Linderniaceae	0.12	0.29	0.04	0.45				
109	*Ludwigia perennis* L.	Onagraceae	0.18	0.12	0.11	0.40				
110	*Malvastrumcoromandelianum* (L.) Garcke	Malvaceae	0.30	0.23	0.21	0.74	1.72	1.39	1.36	4.47
111	*Martynia annua* L.	Martyniaceae	1.19	0.29	1.07	2.55				
112	*Melochiacorchorifolia* L.	Malvaceae	0.30	0.17	0.16	0.63				
113	*Merremiaemarginata*(Burm f.) Hall. fil.	Convolvulaceae	0.30	0.35	0.32	0.96				

114	*Merremia tridentate* (L.)	Convolvulaceae	0.30	0.29	0.27	0.85				
115	*Mitragyna parviflora*. (Roxb.)Korth.	Rubiaceae	1.19	0.21	0.19	1.59				
116	*Momordica dioica* Roxb.ex.Willd.	Cucurbitaceae	0.12	0.06	0.05	0.23				
117	*Murdannianudiflora* (L) Brenan	Commelinaceae	0.30	0.46	0.43	1.19				
118	*Occimumbassilicum* L.	Lamiaceae	0.30	0.40	0.37	1.08				
119	*Oxystelma esculentum* (L.f.) Sm.	Apocynaceae	0.42	0.46	0.43	1.31				
120	*Parthenium hysterophorus*L.	Asteraceae	0.30	0.12	0.15	0.57	3.44	2.32	2.27	8.03
121	*Passiflora foetida* L.	Passifloraceae	0.12	0.12	0.11	0.34				
122	*Pergulariadaemia* (Forsk) Chiov.	Asclepiadaceae	1.79	0.58	0.53	2.90				
123	*Peristrophepaniculata*(Forssk.) R.K. Brummitt	Acanthaceae	1.19	0.55	0.51	2.26				
124	*Phoenix sylvestris* (L.)Roxb.	Arecaceae	0.06	0.01	0.02	0.09				
125	*Phyllanthus maderaspantensis* L.	Phyllanthaceae	1.79	0.68	0.63	3.10	3.44	1.55	1.51	6.50
126	*Phyllanthus urinaria*L.	Phyllanthaceae	1.79	0.69	0.64	3.12				
127	*Phyllanthus virgatus*Forst.f.	Phyllanthaceae	1.19	0.46	0.43	2.08				
128	*Physalis minima* Linn.	Solanaceae	0.30	0.23	0.21	0.74				
129	*Pithecellobium dulce (*Roxb.) *Benth.*	Fabaceae	0.06	0.01	0.01	0.08				
130	*Plumbago zeylanica* L.	Plumbaginaceae	0.24	0.05	0.02	0.30				
131	*Polygonum barbatum* L.	Polygonaceae	0.60	0.58	0.53	1.71				
132	*Polygonum plebeium* R.Br.	Polygonaceae	0.60	0.35	0.32	1.26	4.30	2.71	2.65	9.65

133	*Pongamia pinnata*(L.)*Pierre*	Fabaceae	0.60	0.58	0.53	1.71				
134	*Portulaca oleracea* L.	Portulacaceae	0.30	0.24	0.22	0.76				
135	*Pulicariacrispa* (Cass.) B&H.f.	Asteraceae	0.60	0.47	0.63	1.70				
136	*Pupalialappacea* (L.) Juss.	Amaranthaceae	1.19	1.13	1.51	3.83				
137	*Rhynochosia minima* (L.) DC.	Fabaceae	2.38	2.31	3.61	8.30				
138	*Ruellie Grandiflora* (Forssk.) Blatter	Acanthaceae	0.89	0.35	0.46	1.70				
139	*Rumex dentatus* L.	Polygonaceae	0.60	0.23	0.26	1.09	3.44	2.32	2.27	8.03
140	*Rungia repens* (L.) Nees	Acanthaceae	1.19	1.15	1.07	3.41				
141	*Saccharum spontaneum* L.	Poaceae	1.19	0.58	0.49	2.26				
142	*Securinegaleucopyrus*(Willd.) Müll.Arg.	Phyllanthaceae	0.30	0.06	0.06	0.42				
143	*Sesbania sesban*(L.) Merr.	Fabaceae	0.30	0.06	0.05	0.41				
144	*Setaria pumila* (Poir.) Roem. & Schult.	Poaceae	1.19	2.29	1.80	5.27				
145	*Sida acuta* Burm. f.	Malvaceae	1.19	0.29	0.27	1.75				
146	*Sida cordifolia* Linn.	Malvaceae	0.60	0.45	0.42	1.46				
147	*Sida ovata*Forssk.	Malvaceae	0.60	0.35	0.32	1.26				
148	*Sida spinosa* L.	Malvaceae	0.48	0.17	0.16	0.81				
149	*Solanum nigrum* L.	Solanaceae	0.30	0.22	0.25	0.76				
150	*Solanum virginianum* L.	Solanaceae	0.60	0.46	0.43	1.48	3.44	2.94	6.46	12.84
151	*Sonchus oleraceus* L.	Asteraceae	0.30	0.12	0.11	0.52				

152	*Sphaeranthus indicus* L.	Asteraceae	0.60	0.58	0.53	1.71				
153	*Sporobolus coromandelianus* (Retz.) Kunth	Poaceae	0.60	2.29	2.12	5.00				
154	*Stylosanthesfruticosa* (Retz.)Alston	Fabaceae	0.36	0.17	0.10	0.63				
155	*Tamarindus indica*L.	Fabaceae	0.06	0.02	0.02	0.10				
156	*Terminalia bellirica (Gaertn.) Roxb.*	Combretaceae	0.06	0.01	0.01	0.08				
157	*Themeda quadrivalvis* (L.) Kuntze	Poaceae	0.30	4.62	4.28	9.19				
158	*Trichosanthescucumerina* L.	Cucurbitaceae	0.30	0.12	0.11	0.52				
159	*Tridax procumbens* L.	Asteraceae	2.38	1.14	1.06	4.58	4.81	3.10	3.02	10.93
160	*Typha elephantena*Roxb.	Typhaceae	0.12	0.23	0.21	0.56				
161	*Urginea indica* (Roxb.) Kunth	Liliaceae	0.30	0.22	0.29	0.81				
162	*Vernonia cinerea* (L.) Less.	Asteraceae	1.19	0.58	0.53	2.30	3.44	3.25	3.17	9.86
163	*Xantheumstrumarium* Linn.	Asteraceae	0.60	0.35	0.32	1.26				
164	*Ziziphus nummularia* (Burm.f.)Wightt&Arn.	Rhamnaceae	1.19	0.33	0.31	1.84	5.15	3.80	3.70	12.65

Dominance and Diversity

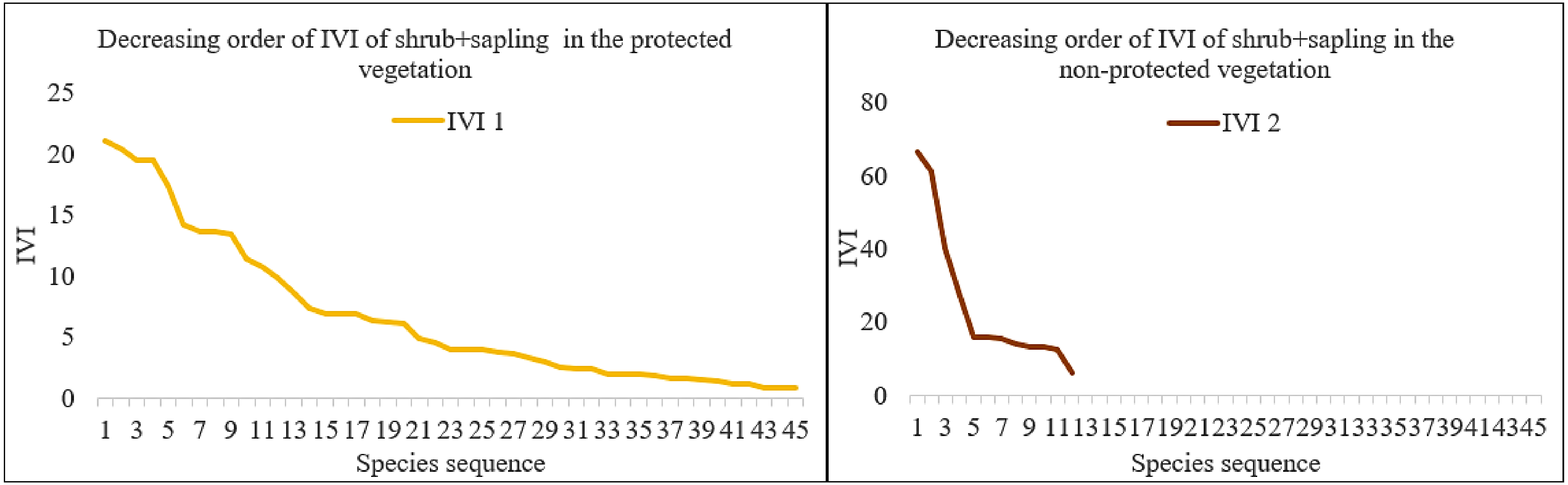

Figure 2: Dominance-diversity curve of shrubs+saplings in protected and non-protected vegetation stands. In the plotted graph species sequence on X axis and IVI on Y axis.

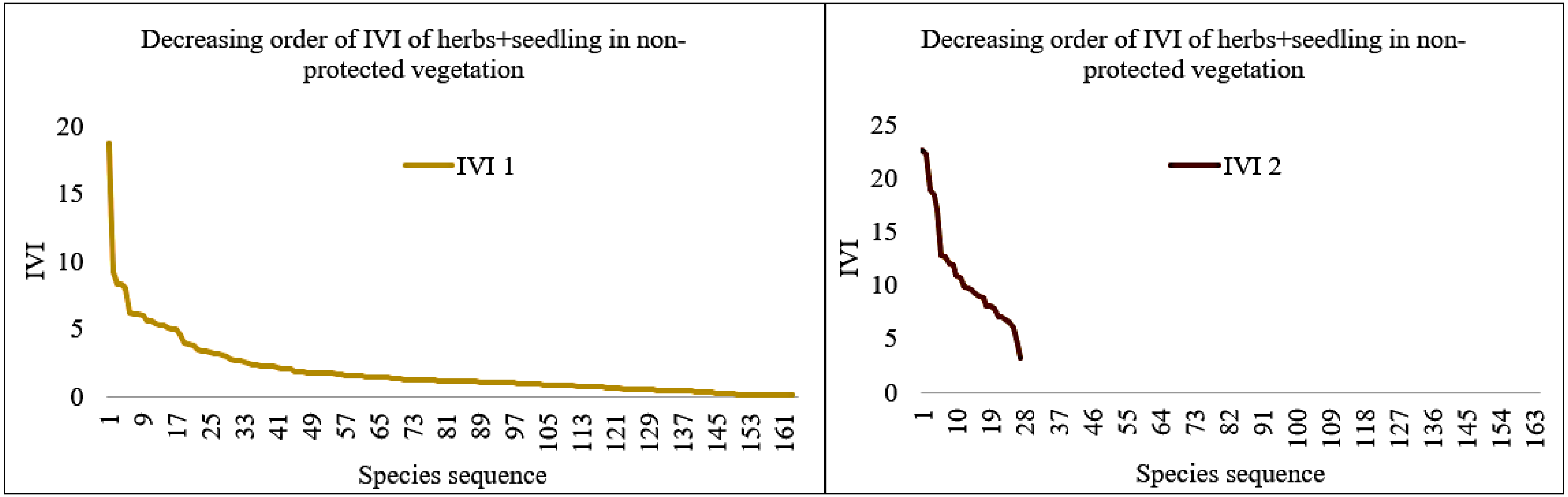

Figure 3: Dominance-diversity curve of herbs+seedlings inprotected and non-protected vegetation stands. In the plotted graph species sequence on X axis and IVI on Y axis

Discussion

In the present study area, it has been observed that the stem density and basal area are lower in non-protected vegetation stand than in protected vegetation site.In many studies the similar results were observed by many researchers due to various human disturbances in non-protected vegetation site **(Bhuyan*et al.*, 2003; Kumar & Shahabuddin, 2005).**In shrub layer of control site *Hyptissuaveolens*(L.) Poit.has highest density but the basal area of *Anogeissus pendula* Edgew is higher than*Hyptissuaveolens*(L.) Poit.It shows that species with higher basal areas do not necessarily have higher densities, demonstrating the size differences among species(**Shibru & Balcha, 2004).**

Important value index is useful to compare the ecological importance of the species and determine their priority for conservation **(Bogale *et al.*, 2017).**In control sitespecies like *Mitragyna parviflora*. (Roxb.) Korth, *Anogeissus pendula* Edgew., *Hyptissuaveolens* (L.) Poit, *Azadirachta indica* A.Juss., possesses maximum IVI, and thus are dominating this area. In protected vegetation only 9 shrub species accounts for >50% of the IVI and 36 shrub species contribute to <50% of IVI. 19 shrub species of family Fabaceae account for 1/3rd of the IVI in protected vegetation. In the experimental site *Ziziphus nummularia*(Burm.f.) Wight &Arnand *Prosopis juliflora* (Swartz) DCare dominating the area.In non-protected vegetation only 12 shrub species contribute to the total IVI whereas out of 12 species, fabaceous shrubs share the largest part of IVI (142.23). 12 shrub species that are common to both the sites share almost 1/3rd IVI (112.92) in protected vegetation.

Among shrub Species *Ziziphus nummularia* (Burm.f.) Wight & Walk.Arn,*Prosopis juliflora* (Swartz) DC. and *Acacia leucophloea* (Roxb.) Willd.) can survive in poor climatic condition. Dominance of *Acacia* species being strong competitors in their environment **(Tilman, 1982**) shows dominance in the study area. Due to their high resiliency to drought and grazing (**Ahmed, 1986; Hien, 1995)** it holds apreferentialplace in afforestation in context of land degradation. The species *Ziziphus nummularia* (Burm.f.) Wight &Arnis highly draught tolerant and can survive in harsh conditions**(Sivalingam *et al*., 2021).** The species*Prosopis juliflora* (Swartz) DC. is an exotic species and indicates that exotic species can grow faster than other species and spread over the land that is barren and non-protected **(Parandiyal*et al*., 2000).** It not only thrives but improves the environment around it **(Mahmood *et al*., 2016; Saraswathi & Chandrasekaran 2016; Vallejo *et al*., 2012).**

Among grasses, two species *Apluda mutica* L and *Themeda quadrivalvis* (L.) Kuntze are the most dominating species having maximum IVI in this site that formed the major ground cover, which shows their ecological importance. In non-protective stand dominant species in the herbaceous layer belong to the family Poaceae.Several studieshave found a predominance of annuals, mostly grasses on disturbed site soils**(Londe& Silva 2014;Giannini *et al.*, 2017)**. Because annuals are more adaptive, they have a short life span and high reproductive capacity, allowing grasses to rapidly colonize the open spaces created by disturbances.

In protected vegetation, 15 herbaceous species having higher IVI account for >1/3rd of the IVI (108.97), whereas in non-protected vegetation only 5 herbaceous species (4 Poaceae& 1 Euphorbiaceae) accounts for nearly 1/3rd of the IVI. Only 4 herbaceous species account for largest share of IVI (80.35) in non-protected vegetation. Family Poaceae helps in soil stabilization, erosion prevention, and the formation of channels for water infiltration.When grasses die and degrade, they add organic matter to the soil, increasing its fertility**(*Singer et al.*, 2009).**In protected vegetation, 19 herbaceous plants of family Poaceae account for > 1/3rd of total IVI (106.23) whereas family Fabaceae which have largest number of plant species (27) account for total IVI of only 27.83.

In both the stands of the shrub layer Family Fabaceae recorded maximum basal area,it covered 45% of the total basal area in the protective vegetation stand and 60% of the total basal area in the non-protective stand.Fabaceae is one of the families that have a superior capacity to withstand the harsh conditions presented in degraded land and is able to grow in low-nutrient soil**(Rai *et al.*, 2016).**Earlier studies in this region also indicated dominance and abundance of Fabaceae **(Jaiswal & Dadhich, 2010; Malav & Jaiswal, 2023)**

The Dominance-diversity curve of shrubs and saplings, in protective vegetation siteexhibits a sharp decline in the corresponding IVI values, indicating a natural tendency for a small number of dominating species with higher relative values. Shrub species in protected vegetation are showing gradual decrease in abundance whereas in non-protected stand only few species have maximum IVI indicating that only few species are abundant. This proves that Protected site present a more diverse species assemblage than non-protected site in terms of species richness and equitability in which individuals are distributed among species. In herbaceous layer only few species are abundant, monopolizing a considerable proportion of dominance while most of the species share lower range of dominance. Most of the herbaceous species in the ground cover have lower IVI values.Whereas the Dominance-diversity curve of shrubs +saplings and herbs+seedlingsof non-protective site show a very steep fall signifying very few specieswith highvalues in relative terms.The dominance diversity curve indicates the random distribution of shrubs and herbs in protected area in comparison to non-protected area **(Moktan & Das, 2011).**

Lower density and species richness in non-protected vegetation show disturbance of some kind. Natural as well as natural disturbances are integral drivers of forest dynamics that are visible in change in species composition and diversity which determine flow of ecosystem services and its productivity **(Tilman*et al*., 1997; Bagchi & Ritchie 2010; Bagchi *et al*., 2012).**Anthropogenic disturbance has also been linked to a decrease in stem density of plants in a number of other tropical forest areas **(Kumar & Shahabuddin, 2005).**Many species are absent or present in insufficient numbers at the experimental site due to anthropogenic influences**(Sanou *et al.,* 2021).**The variation in species may be due to changes in elevation topography, forest microclimate, soil type, and rainfall patterns and levels and types of human-caused disturbances such as grazing, wood cutting,etc **(Raha *et al*., 2023).**

Most interesting fact is that in non-protected vegetation *Chrozophora rottleri* (Geis) A. Juss.ex Spreng. which is not reported in protected vegetation contribute to 6.23% share of total IVI. Disturbance acts in plant communities in another way, however, by promoting invasions by non-native and weedy plant species **(Ewel 1986; Hobbs 1989; Rejmanek, 1989)** whichcan reduce or displace native species, both plant and animal, and may even alter ecosystem function **(Vitousek, 1986; Schofield, 1989).**Microenvironmental variables change with the seasons, can also influence the growth stage of plant communities, i.e., seedlings, saplings, and young trees, which support any forest's population structure **(Alamgir & Al-Amin, 2007).**

Conclusion

In the present study area, it has been observed that the stem density, basal area and species richnessare lower in non-protected vegetation stand than in protected vegetation stand. According to "intermediate disturbance hypothesis"highest species occur when disturbancesfrequency is at intermediate level, but in present study area the disturbance frequency is high.The difference in vegetation in both the stands is due to various anthropogenic factors present here. Increased anthropogenic activity and its detrimental effects on biodiversity are confirmed by the markedly decreased biodiversity in non-protected vegetation stand.Nanta forest area is unexplored and various wild speciesare present heremust be conserved as a genetic reservoir.The present scenario demands urgent attention to conserve the plant diversity of this region to avoid the risk of extinction of the plant species.

Inthe shrub layer, *Mitragyna parviflora*. (Roxb.) Korth.,*Anogeissus pendula* Edgew, and *Hyptissuaveolens* (L.) Poit.Which have highest IVI were reported absent from non-protected sites where *Ziziphus nummularia*(Burm.f.) Wight &Arn., Prosopis*juliflora* (Swartz) DC. (60.99) and *Acacia leucophloea*(Roxb.)Willd. Have highest IVI.In the herbaceous ground cover grass *Apludamutica*L. and *Themeda quadrivalvis* (L.) Kuntzehavethe highest value of IVI were absent from non-protected vegetation sites where *Cynodondactylon*(L.) *Pers.*And *Eragrostispilosa*(L.) P. Beauv. Have highest IVI.The stem density, basal area and species richness are lower in non-protected vegetation stand than in protected vegetation site.

Only 9 shrub species accounts for >50% of the IVI; 36 shrub species contribute to <50% of IVI in the protected vegetation and 19 shrub species of family Fabaceae account for nearly 1/3rd of the IVI. In non-protected vegetation total IVI is shared by 12 shrub species whereas out of which, fabaceous shrubs share the largest part (47.17%) of IVI. 12 common shrub species share almost 1/3rdof the total IVI (112.92) in protected vegetation.

In protected vegetation, 15 herbaceous species account for >1/3rd of the IVI (108.97), whereas only 5 herbaceous species (4 Poaceae& 1 Euphorbiaceae) account for nearly 1/3rd of the IVI in non-protected vegetation. Only 4 herbaceous species account for the largest share of IVI (80.35) in non-protected vegetation. Family Poaceae (19 species) account for > 1/3rd of total IVI (106.23) whereas family Fabaceae account for a total IVI of only 27.83 even after having has the largest number of species (27). *Chrozophorarottleri* (Geis) A.Juss.ex Spreng.was not reported in protected vegetation but in protected herbaceous vegetation contributes to 6.23% share of total IVI. Results of the present investigation proves that disturbances can cause change in species composition or sometimes total replacement of plant species. Overall diversity is reduced and dominance increased.

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