# Comparative Study of Phytosociological Statusof Herbs and Shrubs in Nanta Forest Region, Rajasthan, India


## Abstract

The objective 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.A random sampling of the flora of the protected vegetation stand (control) and non-protected vegetation stand (experimental sites) was done using quadrates of 100sqm for shrubs and 1sqm for herbs and the data was quantitatively analyzed. Inthe shruband herbs layerplant species that have the highest IVI in protected sites are reported absent from non-protected sites.In the present study area, it has been observed that the stem density, basal area, and species richnessare lower in non-protected vegetation stands than in protected vegetation sites. In protected and non-protected vegetation, the family Fabaceae dominates the vegetation in terms of IVI.In the shrub layer share of fabaceous species increased whereas in the ground layer, it decreased. Family Fabaceae have the highest species richness; 19 and 27 species in shrub and herb layersrespectively in protected vegetation whereas in non-protected vegetation; 4 species each of Asteraceae and Poaceae.

The Dominance-diversity curve of shrub+saplingsas well as herbs+ seedlings in protected vegetation show a gradual decrease in abundance whereas non-protected vegetation exhibits a sharp decline in IVI values, indicating a natural tendency for a small number of dominating species with high relative values.Overall floral diversity is reduced and dominance increased. It can be concluded that disturbances can cause changes in species composition or sometimes total replacement of plant species.Disturbances can affect the overall phytosociological characteristics of vegetation.



**Keywords:** Nanta, Dominance, Disturbance, IVI


## 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**[1].**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.

India, with its 2.4% land area, is a megadiverse country contributing 7 to 8% of all recorded species, including 45000 plant species in the world **[2].** National Forest Commission of India reported that as many as one-third of all endemic species face the threat of extinction **[3].** 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 **[4].** Approximately 500,000 species are spread over the world of which 100,000-160,000 are still unexplored or may be threatened **[5].** 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.Unregulated grazing, shifting cultivation, land diversion for developmental and infrastructure projects, and unsuitable use of forest resources are the major causes of vegetation degradation.In the Kota district of Rajasthan, there is a total of 546.73 sqkm (10.48% of total GA) area covered under forest cover which is 3.27 sqkmless than the 2017 assessment**[6].**

Conservation of foreststserves to protect and preserve biodiversity, prevent the extinction of endangered species, and maintain ecological balance.Forest conservation aims to know the composition of tree species and age distribution in order to plan restoration accordingly. The composition of plant community and distribution of plant species in the region is the reflection of environmental gradients**.**Hence,assessment of forest composition and community structure is a very necessary tool for management and conservation planning**[7].** 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 **[8].**

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 **[9].** The extent of changes in forest cover is studied through

phytosociological characteristics, usually by density and basal cover, which are the important bases of study for different vegetation types**[10].**Vegetation analysis provides detailed information about the turnover rate of species, community organization, and niche resource distribution patterns in a forest **[11].** Phytosociological studies are required for conservation planning and long-term utilization **[12].**The current study offers a detailed comparative analysis of community structure and phytosociological status of the Nanta forest region, Kota district, Rajasthan.

**Study area**

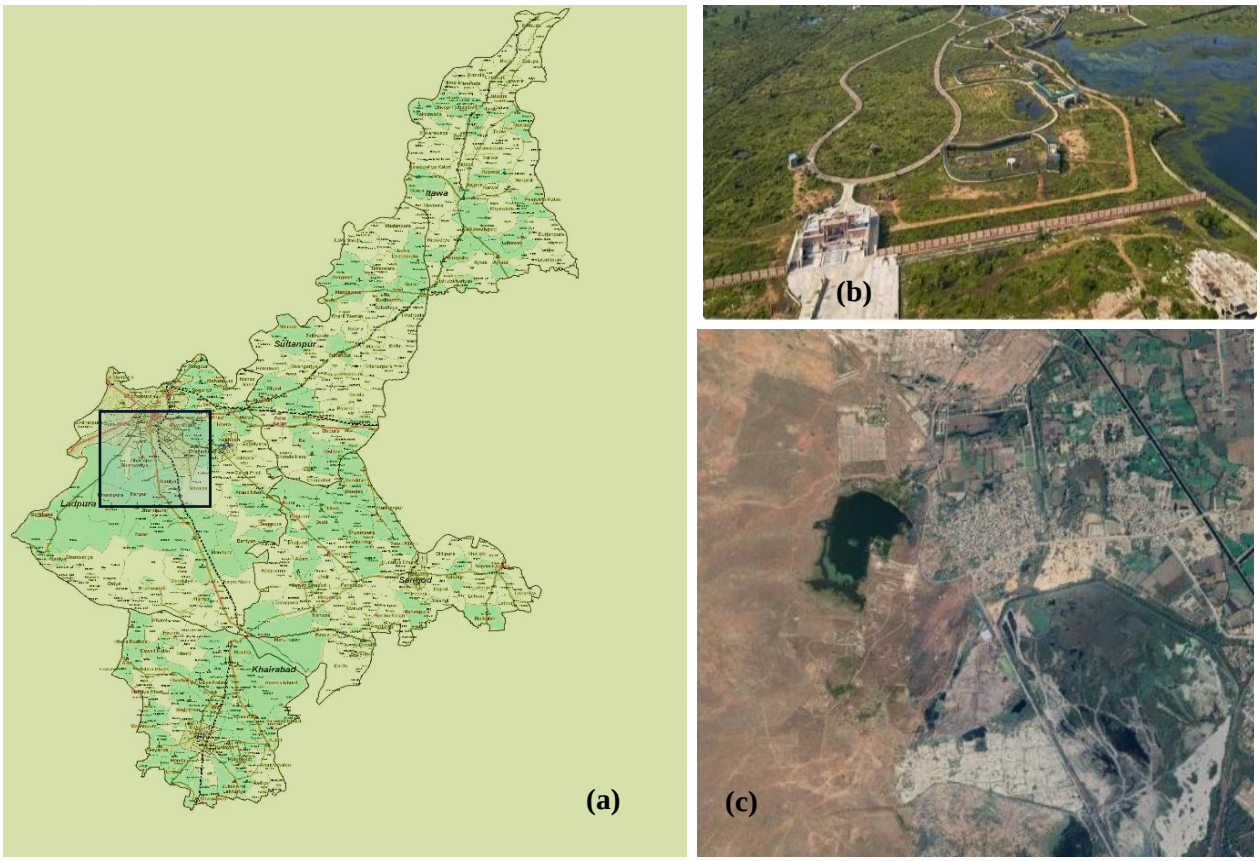


Figure 1: (a)Map of Kota District showing study area (in box). (b)Protected vegetation stand (drone view). (c) Satellite view of the study area.

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 underLadpura Tehsil of Kota district (Rajasthan). Nanta also has its historical significance as the famous “AbhedaMahal” 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, and two stands were

taken into account one is a protected vegetation stand (control site) and the other is a non-protected vegetation stand (experimental site).

In the study area it was recorded that in non-protected areas, there are disturbances in the form of grazing, collection of forest resources (leaves, fuel wood, gum, etc.), and movement of vehicles. In protected areas also there is some form of disturbance but it is negligible.

## Material and Method

**1. Vegetation sampling**: To determine the flora of the protected vegetation stand (control site) and non-protected stand (experimental site)random samplingwas 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 (100sqm), and 1x1m (1sqm) 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.A total of 90 quadrates for shrubs and 300 quadrates for herbs are laid in each of the sampling sites.

**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**[13]** and Magurran**[14].** Basal areas of the shrubs were expressed as $m^2$/ha 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 **[15].** Total density/ha for shrub, density/sqm for herb, basal area/ha for shrub, basal area/sqm for herb and species richness of shrub and herb were also tabulated.

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

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

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

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

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

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

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

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

**Results:**

In the protected vegetation sites the total density of shrubs and herbswere recordedas259.33 ind./haand 86.61 ind./$m^2$ respectively, whereas in the non-protected site,the density ofthe shrub and herbswere 141.33 ind./haand 12.88 ind./$m^2$respectively.The total basal areacalculated for shrub and herbs in the control site were 1.924 $m^2$/ha and 1.420 $cm^2/m^2$, whereas in the non-protected site,the total basal area calculated for shrub and herbs were 73.441 $m^2$/ha and 10.357$cm^2/m^2$respectively. 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 the status of vegetation forming the shrub layer and ground cover of the protected vegetationandnon-protected vegetation in terms of phytosociological parameters.

| **Parameters** | **Values** | |
|---|---|---|
| | **Protected vegetation stands** | **Non-protected vegetation stands** |
| Total density of shrub /ha | 259.33 | 141.33 |
| Total density of herbs /$m^2$ | 86.61 | 12.88 |
| Total basal area of shrubs ($m^2$/ha) | 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 *Mitragynaparviflora*. (Roxb.) Korth (21.05) has the highest IVI followed by*Anogeissuspendula*Edgew. (20.39) and *Hyptissuaveolens* (L.) Poit. (19.48)thus dominant in this areawhereas in the experimental site,*Ziziphusnummularia*(Burm.f.) Wight & Walk. -Arn.are dominanthavingthe highest IVI (66.28) followed by *Prosopisjuliflora* (Swartz) DC. (60.99) and *Acacia leucophloea*(Roxb.) Willd. (40.26)(Table 2).

In the herbaceous ground cover grass species *Apludamutica*L(IVI 18.70), and*Themedaquadrivalvis*(L.) Kuntze (IVI9.19) are dominant in protected vegetation whereas

in non-protected vegetation *Cynodondactylon*(L.) *Pers.*(IVI 22.60),*Eragrostispilosa*(L.) P. Beauv. (IVI 22.18) and *Chlorisvirgatus*SW. (IVI 18.88) are dominant (Table 3).

In protected vegetation only 9 shrub species account for >50% of the IVI and 36 shrub species contribute to <50% of IVI. 19 shrub species of the family Fabaceae account for 1/3$^{rd}$ 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 of IVI (142.23). 12 shrub species that are common to both sites share almost 1/3$^{rd}$ IVI (112.92) in protected vegetation.

In protected vegetation, 15 herbaceous species having higher IVI account for >1/3$^{rd}$ of the IVI (108.97), whereas in non-protected vegetation only 5 herbaceous species (4 Poaceae& 1 Euphorbiaceae) account for nearly 1/3$^{rd}$ of the IVI. In protected vegetation, 19 herbaceous plants of the family Poaceae account for > 1/3$^{rd}$ of total IVI (106.23) whereas the family Fabaceae which hasthe largest number of plant species (27) accounts for a a total IVI of only 27.83.

Inthe shrub layer, *Mitragynaparviflora*. (Roxb.) Korth.,*Anogeissuspendula*Edgew, and *Hyptissuaveolens* (L.) Poit.which have the highest IVI in protected vegetation were reported absent from non-protected sites. In the herbaceous ground cover grass *Apludamutica*L. and *Themedaquadrivalvis*(L.) Kuntzehavethe highest value of IVI and was absent from non-protected vegetation sites.

In terms of density, *Hyptissuaveolens*(L.) Poit.(23.33 ind/ha) has the highest density followed by *Ziziphusnummularia*(Burm.f.) Wight &Arn. (16.67ind/ha)and *Balanitesaegytiaca* (L.) Delile (16.33ind/ha).In terms of basal area *Anogeissuspendula*Edgew.(0.226 $m^2$/ha) top the list followed by *Azadirachtaindica*A. Juss (0.201 $m^2$/ha) and *Mitragynaparviflora*. (Roxb.) Korth. (0.196 $m^2$/ha).In non-protected areas*Cynodondactylon*(L.) Pers.has the highest density and basal area followed by*Eragrostispilosa*(L.) P. Beauv. (1) (density 1.01 and 1.00; basal area 0.82 and 0.79 respectively) (Table 3).

In the protected vegetation sites the total density of shrubs and herbswere recordedas259.33 ind./haand 86.61 ind./$m^2$ respectively, whereas in the non-protected site, respective densities ofthe shrubs and herbswere 141.33 ind./haand 12.88 ind./$m^2$.The total basal areacalculated for shrub and herbs in the control site is 1.924 $m^2$/ha and 1.420 $cm^2/m^2$, whereas in the non-

protected site,the total basal area calculated for shrub and herbs are 73.441 $m^2$/ha and 10.357$cm^2$/$m^2$respectively.

The Dominance-diversity curve of shrubs and saplings, in non-protected vegetation sites exhibits a sharp decline in the corresponding IVI values, whereas shrub & herb 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 (Figure 2 & 3).Most of the herbaceous species in the ground cover have lower IVI values. Whereas the Dominance-diversity curve of shrubs+saplings and herbs+seedlings of non-protected site show a very steep fall signifying very few specieswith high values in relative terms(Figure 2 & 3).

Table 2:Phytosociological analysis; Relative Frequency (RF), Relative Density (RD), Relative Dominance (RDo), and Important Value Index (IVI)of shrub layerinthe protected stands and non-protected vegetation stands.

| | | **Protected Vegetation** | | | | | **Non-Protected vegetation** | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **S. N** | **Name of Species** | **Family** | **RF 1** | **RD1** | **RDo1** | **IVI 1** | **RF2** | **RD2** | **RDo2** | **IVI 2** |
| 1 | *Abelmoschusmoschatus*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 | *Albiziaprocera*(Roxb.)Benth. | Fabaceae | 1.00 | 0.64 | 2.02 | 3.66 | - | - | - | - |
| 7 | *Anogeissuspendula*Edgew. | Combretaceae | 2.99 | 5.76 | 11.64 | 20.39 | - | - | - | - |
| 8 | *Azadirachtaindica*A. Juss. | Meliaceae | 3.98 | 5.12 | 10.34 | 19.45 | 4.42 | 2.35 | 5.50 | 12.28 |
| 9 | *Balanitesaegytiaca* (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 | *Buteamonosperma*(Lam.) Taub. | Fabaceae | 2.99 | 2.56 | 8.08 | 13.63 | - | - | - | - |
| 12 | *Calotropisprocera*(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.) | Fabaceae | 0.40 | 0.26 | 0.52 | 1.17 | - | - | - | - |

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| | H.S.Irwin&Barneby | | | | | | | | | |
| 16 | *Celosia argentea* L. | Amaranthaceae | 1.99 | 3.84 | 0.48 | 6.32 | - | - | - | - |
| 17 | *Dalbergiasissoo*Roxb. exDC. | Fabaceae | 1.00 | 0.64 | 0.32 | 1.96 | - | - | - | - |
| 18 | *Daturainnoxia*Mill. | Solanaceae | 1.20 | 0.90 | 0.45 | 2.54 | 6.64 | 4.69 | 1.76 | 13.09 |
| 19 | *Dichrostachyscinerea*(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 | *Ficusracemosa*L. | Moraceae | 1.99 | 1.28 | 0.65 | 3.92 | - | - | - | - |
| 23 | *Grewiatenax* (Forssk.) Fiori | Malvaceae | 1.00 | 0.64 | 0.73 | 2.36 | - | - | - | - |
| 24 | *Holopteleaintegrifolia (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 | *Indigoferaoblongifolia*Forssk. | Fabaceae | 1.99 | 3.84 | 1.09 | 6.92 | - | - | - | - |
| 27 | *Indigopheratinctoria* L. | Fabaceae | 0.80 | 1.92 | 0.97 | 3.69 | - | - | - | - |
| 28 | *Jatrophacurcus* L. | Euphorbiaceae | 1.00 | 0.64 | 0.18 | 1.82 | - | - | - | - |
| 29 | *Jatrophagossypifolia* L. | Euphorbiaceae | 1.99 | 3.84 | 1.09 | 6.92 | - | - | - | - |
| 30 | *Kirganeliareticulata*(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 | *Leucaenaleucocephala*(Lam.) de Wit. | Fabaceae | 4.98 | 3.20 | 1.62 | 9.80 | - | - | - | - |
| 33 | *Martyniaannua* L. | Martyniaceae | 1.99 | 1.92 | 2.18 | 6.09 | - | - | - | - |

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|---|---|---|---|---|---|---|---|---|---|---|
| 34 | *Mitragynaparviflora*. (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 | *Pithecellobiumdulce (*Roxb.) *Benth.* | Fabaceae | 0.40 | 0.26 | 0.13 | 0.78 | - | - | - | - |
| 38 | *Pongamiapinnata*(L.)Pierre | Fabaceae | 1.99 | 1.66 | 2.57 | 6.23 | - | - | - | - |
| 39 | *Prosopisjuliflora*(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 | *Sesbaniasesban*(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 | *Typhaelephantena*Roxb. | Typhaceae | 0.60 | 1.28 | 2.59 | 4.46 | - | - | - | - |
| 44 | *Ziziphusmauritiana Lam.* | Rhamnaceae | 0.40 | 0.26 | 0.13 | 0.78 | - | - | - | - |
| 45 | *Ziziphusnummularia*(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 (RF), Relative Density (RD), Relative Dominance (RDo), and Important Value Index (IVI)of the herbaceous layerin the protected stands and non-protected vegetation stands.

| | | **Protected Vegetation** | | | | | **Non-Protected vegetation** | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **S. N** | **Name of Species** | **Family** | **RF 1** | **RD1** | **RDo1** | **IVI 1** | **RF2** | **RD2** | **RDo2** | **IVI 2** |
| 1 | *Abelmoschusmoschatus*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 | *Aervalanata*(L.)Juss. | Amaranthaceae | 0.71 | 0.23 | 0.21 | 1.16 | - | - | - | - |
| 10 | *Aeschynomeneindica* 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 | *Albiziaprocera(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 | *Alternantherasessilis*(L.) R. Br. | Amaranthaceae | 1.79 | 0.69 | 0.64 | 3.12 | 2.58 | 3.25 | 3.17 | 9.01 |
| 16 | *Alysicarpusvaginalis* (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 | *Andrographispaniculata* (Burm.f) Nees | Acanthaceae | 1.79 | 0.58 | 0.90 | 3.27 | - | - | - | - |

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|---|---|---|---|---|---|---|---|---|---|---|
| 21 | *Anogeissuspendula*(Edgew) | Combretaceae | 0.60 | 0.29 | 0.27 | 1.15 | - | - | - | - |
| 22 | *Apludamutica* L. | Poaceae | 1.19 | 7.50 | 10.00 | 18.70 | - | - | - | - |
| 23 | *Argemonemexicana* 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 | *Aristidaadscensionis L.* | Poaceae | 0.60 | 2.86 | 2.15 | 5.61 | - | - | - | - |
| 26 | *Azadirachtaindica*A.Juss. | Meliaceae | 0.60 | 0.23 | 0.31 | 1.13 | - | - | - | - |
| 27 | *Balanitesaegytiaca* (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 | *Blumealaciniata* (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 | *Borreriapusilla* (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 | *Buteamonosperma*(Lam.) Taub. | Fabaceae | 0.30 | 0.06 | 0.05 | 0.41 | - | - | - | - |
| 37 | *Caesuliaaxillaris*Roxb. | Asteraceae | 0.36 | 0.58 | 0.53 | 1.47 | - | - | - | - |
| 38 | *Calotropisprocera* (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 | - | - | - | - |

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|---|---|---|---|---|---|---|---|---|---|---|
| 40 | *Capparissepiaria* L. | Capparaceae | 0.12 | 0.22 | 0.25 | 0.58 | - | - | - | - |
| 41 | *Cardiospermumhalicacabum* 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 | *Chlorisvirgatus* SW. | Poaceae | 0.54 | 2.27 | 2.11 | 4.92 | - | - | - | - |
| 49 | *Chrozophorarottleri*(Geis) A.Juss.ex Spreng. | Euphorbiaceae | | | | | 5.15 | 7.67 | 6.06 | 18.88 |
| 50 | *Chrozophorarottlerin*(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 | *Cocciniagrandis* (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 | *Conyzabonariensis* L. | Asteraceae | 0.30 | 0.35 | 0.32 | 0.96 | - | - | - | - |
| 57 | *Corchorusolitorius* L. | Malvaceae | 0.60 | 0.45 | 0.50 | 1.55 | - | - | - | - |

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|---|---|---|---|---|---|---|---|---|---|---|
| 58 | *Corchorustrilocularis* L. | Malvaceae | 0.30 | 0.35 | 0.32 | 0.96 | - | - | - | - |
| 59 | *Croton bonplandianus*Baill. | Euphorbiaceae | 0.60 | 0.23 | 0.26 | 1.09 | - | - | - | - |
| 60 | *Cucumiscallosus* (Rott.) Cogn. | Cucurbitaceae | 0.60 | 0.21 | 0.19 | 1.00 | - | - | - | - |
| 61 | *Cucumismaderaspatanus* 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 | *Cynodondactylon (L.) Pers.* | Poaceae | 1.19 | 0.46 | 0.35 | 2.00 | 6.53 | 8.13 | 7.94 | 22.60 |
| 64 | *Cyperusalulatus*Kern. | Cyperaceae | 0.89 | 2.31 | 2.14 | 5.34 | - | - | - | - |
| 65 | *Cyperusiria* L. | Cyperaceae | 0.83 | 2.30 | 2.13 | 5.26 | - | - | - | - |
| 66 | *Cyperusrotundus* L. | Cyperaceae | 1.19 | 1.14 | 1.06 | 3.39 | - | - | - | - |
| 67 | *Dactylocteniumaristatum* Link | Poaceae | 0.54 | 3.23 | 2.42 | 6.19 | - | - | - | - |
| 68 | *Dalbergiasissoo*Roxb. ex DC. | Fabaceae | 0.30 | 0.06 | 0.06 | 0.42 | - | - | - | - |
| 69 | *Daturainnoxia*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 | *Dichrostachyscinerea*(L.) Wight &Arn. | Fabaceae | 0.60 | 0.27 | 0.25 | 1.11 | - | - | - | - |
| 72 | *Digeramuricata* (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 |

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|---|---|---|---|---|---|---|---|---|---|---|
| 77 | *Eclipta alba* (L.)Hassk. | Asteraceae | 0.30 | 0.12 | 0.11 | 0.52 | - | - | - | - |
| 78 | *Elytrariaacaulis* (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 | *Eragrostispilosa* (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 | *Ficusracemosa*L. | Moraceae | 0.30 | 0.06 | 0.05 | 0.41 | - | - | - | - |
| 86 | *Ficus religiosa L.* | Moraceae | 0.18 | 0.03 | 0.03 | 0.25 | - | - | - | - |
| 87 | *Gomphrenacelosoides* Mart. | Amaranthaceae | 0.30 | 0.22 | 0.29 | 0.81 | - | - | - | - |
| 88 | *Grewiatenax* (Forssk.) Fiori | Malvaceae | 0.12 | 0.02 | 0.03 | 0.17 | - | - | - | - |
| 89 | *Hedyotishispida* Retz. | Rubiaceae | 0.12 | 0.12 | 0.11 | 0.34 | - | - | - | - |
| 90 | *Holopteleaintegrifolia (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 | *Imperatacylindrica* (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 | *Indigoferalinnaei* Ali | Fabaceae | 0.60 | 0.46 | 0.43 | 1.48 | - | - | - | - |
| 95 | *Indigoferaoblongifolia*Forsk. | Fabaceae | 0.60 | 0.35 | 0.32 | 1.26 | - | - | - | - |

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|---|---|---|---|---|---|---|---|---|---|---|
| 96 | *Indigopheratinctoria* L. | Fabaceae | 0.42 | 0.35 | 0.32 | 1.08 | - | - | - | - |
| 97 | *Ipomeapes-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 | *Jatrophagossypifolia* 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 | *Kirganeliareticulata*(Poir) *Baill.* | Phyllanthaceae | 0.12 | 0.03 | 0.03 | 0.19 | - | - | - | - |
| 102 | *Kyllingabulbosa*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 | *Launaeaprocumbens*(Roxb.) | Asteraceae | 0.89 | 0.23 | 0.26 | 1.38 | 6.01 | 2.94 | 2.87 | 11.83 |
| 106 | *Leucaenaleucocephala*(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 | *Linderniaparviflora* (Roxb.) Haines | Linderniaceae | 0.12 | 0.29 | 0.04 | 0.45 | - | - | - | - |
| 109 | *Ludwigiaperennis* 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 | *Martyniaannua* 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 | - | - | - | - |

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|---|---|---|---|---|---|---|---|---|---|---|
| 115 | *Mitragynaparviflora*. (Roxb.)Korth. | Rubiaceae | 1.19 | 0.21 | 0.19 | 1.59 | - | - | - | - |
| 116 | *Momordicadioica*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 | *Oxystelmaesculentum*(L.f.) Sm. | Apocynaceae | 0.42 | 0.46 | 0.43 | 1.31 | - | - | - | - |
| 120 | *Partheniumhysterophorus*L. | Asteraceae | 0.30 | 0.12 | 0.15 | 0.57 | 3.44 | 2.32 | 2.27 | 8.03 |
| 121 | *Passiflorafoetida* 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 | *Phyllanthusmaderaspantensis* L. | Phyllanthaceae | 1.79 | 0.68 | 0.63 | 3.10 | 3.44 | 1.55 | 1.51 | 6.50 |
| 126 | *Phyllanthusurinaria*L. | Phyllanthaceae | 1.79 | 0.69 | 0.64 | 3.12 | - | - | - | - |
| 127 | *Phyllanthusvirgatus*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 | *Pithecellobiumdulce (*Roxb.) *Benth.* | Fabaceae | 0.06 | 0.01 | 0.01 | 0.08 | - | - | - | - |
| 130 | *Plumbagozeylanica* L. | Plumbaginaceae | 0.24 | 0.05 | 0.02 | 0.30 | - | - | - | - |
| 131 | *Polygonumbarbatum* L. | Polygonaceae | 0.60 | 0.58 | 0.53 | 1.71 | - | - | - | - |
| 132 | *Polygonumplebeium* R.Br. | Polygonaceae | 0.60 | 0.35 | 0.32 | 1.26 | 4.30 | 2.71 | 2.65 | 9.65 |
| 133 | *Pongamiapinnata*(L.) *Pierre* | Fabaceae | 0.60 | 0.58 | 0.53 | 1.71 | - | - | - | - |

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|---|---|---|---|---|---|---|---|---|---|---|
| 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 | *RuellieGrandiflora*(Forssk.) Blatter | Acanthaceae | 0.89 | 0.35 | 0.46 | 1.70 | - | - | - | - |
| 139 | *Rumexdentatus* L. | Polygonaceae | 0.60 | 0.23 | 0.26 | 1.09 | 3.44 | 2.32 | 2.27 | 8.03 |
| 140 | *Rungiarepens* (L.) Nees | Acanthaceae | 1.19 | 1.15 | 1.07 | 3.41 | - | - | - | - |
| 141 | *Saccharumspontaneum* 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 | *Sesbaniasesban*(L.) Merr. | Fabaceae | 0.30 | 0.06 | 0.05 | 0.41 | - | - | - | - |
| 144 | *Setariapumila* (Poir.) Roem. & Schult. | Poaceae | 1.19 | 2.29 | 1.80 | 5.27 | - | - | - | - |
| 145 | *Sidaacuta* Burm. f. | Malvaceae | 1.19 | 0.29 | 0.27 | 1.75 | - | - | - | - |
| 146 | *Sidacordifolia* Linn. | Malvaceae | 0.60 | 0.45 | 0.42 | 1.46 | - | - | - | - |
| 147 | *Sidaovata*Forssk. | Malvaceae | 0.60 | 0.35 | 0.32 | 1.26 | - | - | - | - |
| 148 | *Sidaspinosa* 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 | *Sphaeranthusindicus* L. | Asteraceae | 0.60 | 0.58 | 0.53 | 1.71 | - | - | - | - |

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|---|---|---|---|---|---|---|---|---|---|---|
| 153 | *Sporoboluscoromandelianus* (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 | *Terminaliabellirica (Gaertn.) Roxb.* | Combretaceae | 0.06 | 0.01 | 0.01 | 0.08 | - | - | - | - |
| 157 | *Themedaquadrivalvis* (L.) Kuntze | Poaceae | 0.30 | 4.62 | 4.28 | 9.19 | - | - | - | - |
| 158 | *Trichosanthescucumerina* L. | Cucurbitaceae | 0.30 | 0.12 | 0.11 | 0.52 | - | - | - | - |
| 159 | *Tridaxprocumbens* L. | Asteraceae | 2.38 | 1.14 | 1.06 | 4.58 | 4.81 | 3.10 | 3.02 | 10.93 |
| 160 | *Typhaelephantena*Roxb. | Typhaceae | 0.12 | 0.23 | 0.21 | 0.56 | - | - | - | - |
| 161 | *Urgineaindica* (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 | *Ziziphusnummularia* (Burm.f.)Wightt&Arn. | Rhamnaceae | 1.19 | 0.33 | 0.31 | 1.84 | 5.15 | 3.80 | 3.70 | 12.65 |

## Dominance and Diversity

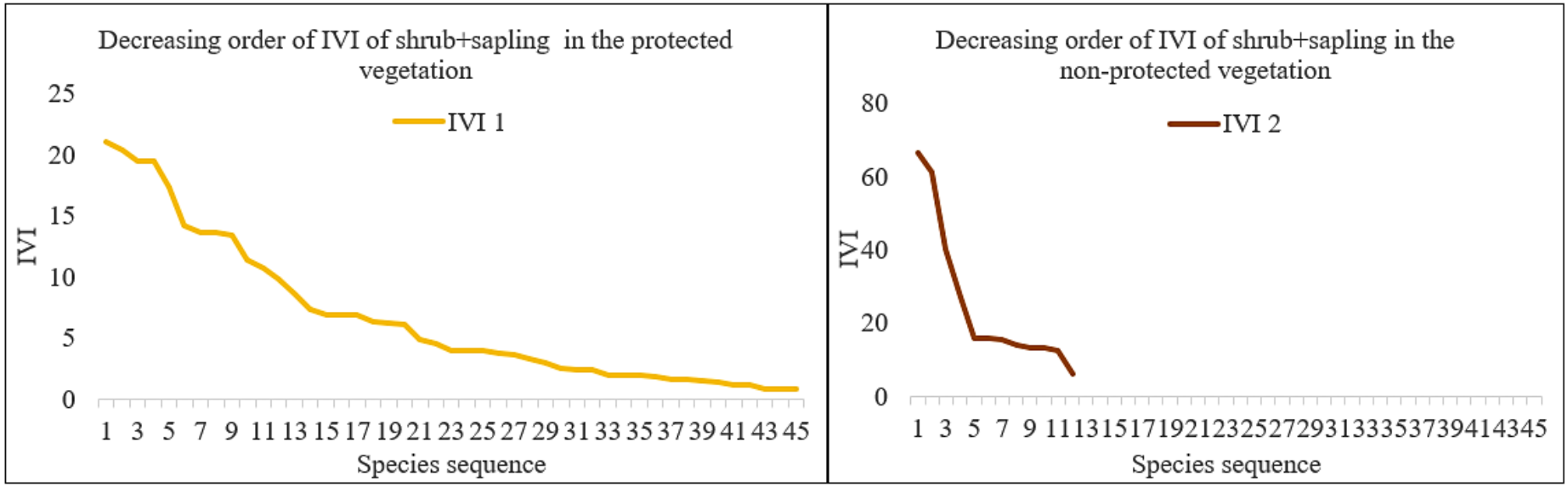


**Figure 2:** Dominance-diversity curve of shrubs+saplings in protected and non-protected vegetation stands. In the plotted graph species sequence on X axis and IVI on Y axis.

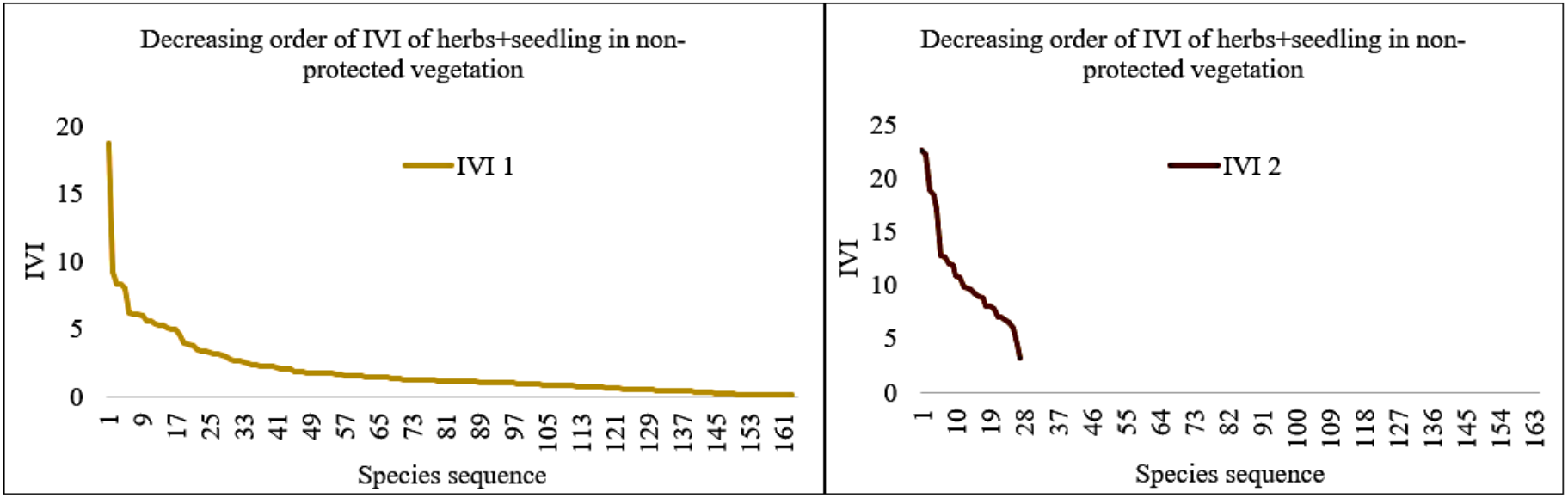


**Figure 3:** Dominance-diversity curve of herbs+seedlings inprotected and non-protected vegetation stands. In the plotted graph species sequence on X axis and IVI on Y axis

## Discussion

In the present study area, it has been observed that the stem density and basal area are lower in non-protected vegetation stands than in protected vegetation sites.In many studies,similar results were observed by many researchers due to various human disturbances in non-protected vegetation sites**[16, 17].** In the shrub layer of the control site,the basal area of saplings of *Anogeissuspendula*Edgew is higher than*Hyptissuaveolens*(L.) Poit. but the density of *Hyptissuaveolens*(L.) Poit. is higher, because this species is an invasive species with massive seed production and is considered as a weed globally **[18].** It also shows that species with higher basal areas do not necessarily have higher densities, demonstrating the size differences among species**[19].**

Important value index (IVI)not only presents the overall picture of the ecological importance of a species in a community **[20]** butis useful to compare the ecological importance of the species and determine their priority for conservation **[21].** According to Noraimy*et al*., the species having the highest IVI is considered dominant in the community **[22].** In protected and non-protected vegetation, fabaceous plant species show dominance. In both the stands of the shrub layer Family Fabaceae recorded maximum basal area, it covered 45% of the total basal area in the protected vegetation stand and 60% of the total basal area in the non-protected 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**[23].** Earlier studies in this region also indicated the dominance and abundance of Fabaceae **[24, 25].**

The result indicates that high IVI was attributed to few species in both sites. These species are well adapted to the existing level of disturbances in the study area. Variation in IVI shows the different ecological importance of each species in the study sites.

Among shrub Species *Ziziphusnummularia*(Burm.f.) Wight & Walk.Arn,*Prosopisjuliflora* (Swartz) DC. and *Acacia leucophloea*(Roxb.) Willd.) can survive in poor climatic conditions. Dominance of *Acacia* species being strong competitors in their environment **[26]** shows dominance in the study area. Due to their high resiliency to drought and grazing **[27, 28]**it holds apreferentialplace in afforestation in context of land degradation. The species *Ziziphusnummularia*(Burm.f.) Wight &Arnis highly draught tolerant and can survive in harsh conditions**[29].** The species*Prosopisjuliflora* (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 **[30].** It not only thrives but improves the environment around it **[31, 32, 33].**

Among herbs, species of Poaceae are the most dominating species having maximum IVI in protected vegetation, which shows their ecological importance. In non-protectedstands dominant species in the herbaceous layer belong to the family Poaceae but the species composition has changed. 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**[34].**

Several studieshave found a predominance of annuals, mostly grasses on disturbed site soils**[35, 36].** 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.The results show that species that contribute to the largest share of IVI are changed in two sampling sites. Variation in dominance in two sites may be due to physical and biological disturbances which is a major source of variation in community structure **[37, 38].**

A sharp decline in the Dominance-diversity curve of shrubs and herbs in non-protected vegetationindicates a natural tendency for a small number of dominating species with higher relative values whereas vegetation of protected sites presents a more diverse species assemblage than non-protected site in terms of species richness and equitability in which individuals are distributed among species. In the herbaceous layer,only a few species are abundant, monopolizing a considerable proportion of dominance while most of the species share a lower range of dominance. The dominance diversity curve indicates the random distribution of shrubs and herbs in protected areas in comparison to non-protected areas**[39].**

Natural as well as man-made disturbances are integral drivers of forest dynamics that are visible in changes in species composition and diversity which determine the flow of ecosystem services and its productivity **[40, 41, 42].** Lower density and species richness in non-protected vegetation show the presence of disturbances in the study area. Disturbance gradients may cause changes in the structural attributes of forests **[43]**and plant diversity and other associated vegetation attributes are negatively affected by increasing frequency and intensity of disturbances**[44, 45].**Anthropogenic disturbance has also been linked to a decrease in stem density of plants in a number of other tropical forest areas**[46].**Many species are absent or present in insufficient numbers at the experimental site due to anthropogenic

influences**[47]** the condition which has the potential to result in the gradual extinction of many forest species**.**According to research undertaken in various parts of the world, the biological diversity of plants and other features of forest vegetation such as density, basal area, and species diversity decrease as the degree of disturbance increases**[48, 49].**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 **[50].**

The most interesting fact is that in non-protected vegetation *Chrozophorarottleri* (Geis) A. Juss.exSpreng. which is not reported in protected vegetation contributes to 6.23% share of total IVI. It is an invasive species native to tropical Africa **[51].**Disturbance acts in plant communities in another way, however, by promoting invasions by non-native and weedy plant species **[52, 53, 54]**whichcan reduce or displace native species, both plant and animal, and may even alter ecosystem function **[55, 56].** Microenvironmental variables change with the seasons, and can also influence the growth stage of plant communities, i.e., seedlings, saplings, and young trees, which support any forest's population structure **[57].**

**Conclusion**

In the present study area, it has been observed that the stem density, basal area, and species richnessare lower in non-protected vegetation stands than in protected vegetation stands. According to the "intermediate disturbance hypothesis,"the highest species occur when the disturbancefrequency is at an intermediate level, but in the present study area, the disturbance frequency is high.The difference in vegetation in both 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 stands.The unexplored Nanta forest area and various wild species 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.

In both the shrub and herb layer there is a total absence of plant species that were dominant in protected vegetation.The stem density, basal area and species richness are lower in non-protected vegetation stand than in protected vegetation site. Results of the present investigation proves that disturbances can cause change in species composition or sometimes

total replacement of plant species, diversity is reduced and dominance increased, thus affecting overall phytosociological characteristic of vegetation.

***Authors' contributions***

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

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