

Vegetation Structure, Composition and Plant Community types in Tropical Dry Deciduous Forests of Jaipur, Rajasthan, India

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Abstract

The research was carried out in the Aravalli Forests of Nahargarh (NWLS) and Jamwa Ramgarh Wildlife Sanctuaries (JRWLS) of Jaipur, Rajasthan, India. The vegetation structure, composition, biodiversity and plant community types were assessed across the five forest stands viz Nahargarh biological park (S1), Nahargarh Sanctuary (S2) in NWLS and Ramgarh (S3), Raisar (S4), and Digota (S5) of JRWLS, respectively. A total of 164 quadrats of 20*20 m² were laid to assess the vegetation data including frequency, basal area, density, importance value index (IVI), biodiversity indices (Shannon-weiner, Simpson, Pielou and Margalef's) and plant community types. The tree basal area ranged between 18.56 -34.36 m²/ha while stand density was 923-1433 tree/ha. Our study indicated the dominance of family Fabaceae with 20 species and 11 genera with *Anogeissus pendula* showing the maximum frequency, density, mean basal area and IVI. Further, the agglomerative hierarchal clustering showed five types of plant communities with *Anogeissus-Adhatoda* as the most widely spread community in these forests. Among the two sanctuaries, species diversity was higher for JRWLS (2.83) than NWLS (2.80). The current study provides important baseline data for forthcoming research on monitoring and preserving these forest's biological diversity. The significance of present study will provide insight into the structure and variety of tree species in tropical dry deciduous forests.



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Introduction


Forest management, as an important environmental indicator, has a significant impact on plant species diversity.^{1,2,3} Forest structure and function dynamics are influenced by several biotic and abiotic

elements.⁴ The ecological qualities of locations, abundance, variety, species richness, regeneration and distribution state of species all have a significant impact on the nature of forest communities.⁵ The overall population structure represented by tree

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diameter and class distribution gives useful data about each given stand's reproductive capabilities.^{6,7} Furthermore, evaluating the variety of species indicators reflects the resilience and long-term viability of forest ecosystems.⁸ All of these elements are required for maintaining biodiversity and conservation. Therefore, properly assessing the ecological makeup of every forest area is critical for scientific oversight. The study gives data on species diversity, community structure, resource allocation in niches, and the rate at which species change in an ecosystem.⁹ Species diversity, community structure, resource allocation for niches, and species turnover rate in a forest ecosystem can all be learned via a thorough vegetation analysis. Trees, as a key component of vegetation, need careful monitoring and management in order to preserve habitat as well as species variety,^{10,11} which, in consequence, are crucial features of the dynamics of forests that influence succession processes.¹² The collection of tree varieties will thus be a helpful tool for providing knowledge of forest varieties and maximizing biodiversity protection.¹³ To examine floristic structure, diversity of species, structural analysis and community are essential for providing the required information on forest diversity and species richness, and different species of vegetation are helpful for forest administration and help to understand ecosystem activities and forest ecology.¹⁴⁻²⁰ Furthermore, understanding the structure and floristic composition of a forest is beneficial for describe biologically or efficient significant plants and their diversity, as well as safeguarding endangered and commercially important plant species.²¹ Forests play a crucial role in maintaining environmental balance and offer numerous benefits to people and other animals.²² Northern India's tropical dry forests are biologically rich, with a variety of floristic compositions. It also boasts a varied range of commercial and medicinal plant species on which the residents rely to satisfy their basic needs and sustain their livelihoods.^{23,24}

Drylands covers 45 % of our Earth's land area and inhabits 38% of total population of the world. These are classified as areas having an aridity index less than 0.65. Global climate change along with increased in Earth's temperature has potential threats on world's biodiversity. The spatial and

temporal changes climatic conditions in drylands leads to vegetation shift and loss of overall ecosystem services, intensify the land degradation.²⁵ Nevertheless, there is a lack of evidence on plant diversity patterns and community structure in dryland forests. The semi-arid tracts in India covers 37 % of its whole geographic region. Rajasthan being the largest state in India, covering 10.40% of the nation's geographic area. On the basis of climatic conditions, Rajasthan can be classified as viz western and eastern parts as arid and semi-arid, respectively.²⁶ The forest area covers 8% of the state's whole geographical area and belongs to Tropical Dry Deciduous and Thorn Forests.²⁷ Low and erratic rainfall events, extreme diurnal and annual temperature and reduced soil ramify the frequent occurrence of drought in these regions. Climate and topography have a considerable impact on the distribution of vegetation in these locations. Nevertheless, to our understanding, plant community types and vegetation structure have not been well revealed in India's semi-arid area.

The Aravalli Mountain range, which stretches in a south-westerly and north-western direction from Gujarat to Delhi via Rajasthan to Haryana, is the oldest fold mountain range. It is around 692 kilometres long. It safeguards the plain of Indo-Gangetic by serving as an impediment to the spread of drought over a 50,000 km² area.²⁸ However, to our knowledge, the plant community types and vegetation structure have not been well revealed in India's semi-arid geographical region. The ongoing urbanisation causes these forests to be destroyed and fragmented, and the invasion of exotic species has a negative impact on the local tree species.²⁹ The present investigation provides vital baseline data for protecting and managing the current flora and native tree species found in these forests. However, no research has been undertaken on the floristic composition and plant types of Jaipur's Semi-arid Forest. The purpose of the work is to assess the importance value index, basal area and density of tree species at Naharagarh and Jamwa forest divisions of Jaipur, Rajasthan. The study also measures the diversity indices i.e. evenness and species diversity of tree and shrubs in these forest divisions. Furthermore, the study also aims to make the vegetation classification of the selected forests.

Materials and Methods

Study Area

The study was conducted in the forests of Jaipur district, Rajasthan. The city is located in the northern-eastern end of the Aravalli range and lies between 26°25' to 27°51' N and 74°55' to 76°15' E. The entire geographical area of the district is 11,143 Km², with the total forest area of Jaipur is 554.86 Km² which is 4.98% out of the district's entire area.³⁰ Except for the monsoon season, the region has a semi-arid climate that is dry. For the study, two forests were selected viz Nahargarh Wildlife Sanctuary (NWLS) and Jamwa Ramgarh Wildlife Sanctuary (JRWLS). The NWLS is located in the Aravalli ranges at Amber hills of Jaipur. The region covers 50 km² and is located between 26°56'15.08" to 26°57'5.81" N and 75°48'55.70" to 75°46'54.65" E. The JRWLS is the southern expansion of Sariska Tiger Reserve's and is situated to the north-east of Jaipur. It lies between

76° 03'E–27° 02'N (Fig. 1). Champion and Seth²⁷ classified both forests as north tropical thorn forests and dry deciduous forest.

The study area received an average rainfall of 74.8 mm and average maximum and minimum humidity of 87% to 24.42% during the study periods, the average maximum and minimum temperature were 32.41° C and 20.96°C, respectively (Fig. 2) (IMD, 2022). Most of the region is covered with rocks from the Delhi and Aravalli systems, including quartzite, conglomerates, grits, limestone, phyllite, granites, and schist. The sanctuary is mainly covered by red sandy soils. Red soil is often low in nitrogen, phosphorus, and humus content, as well as being alkaline. The forest is spread over different geological and soil formations and hilly forests across the area, Aravalli's terrain and thus differs in composition.³¹

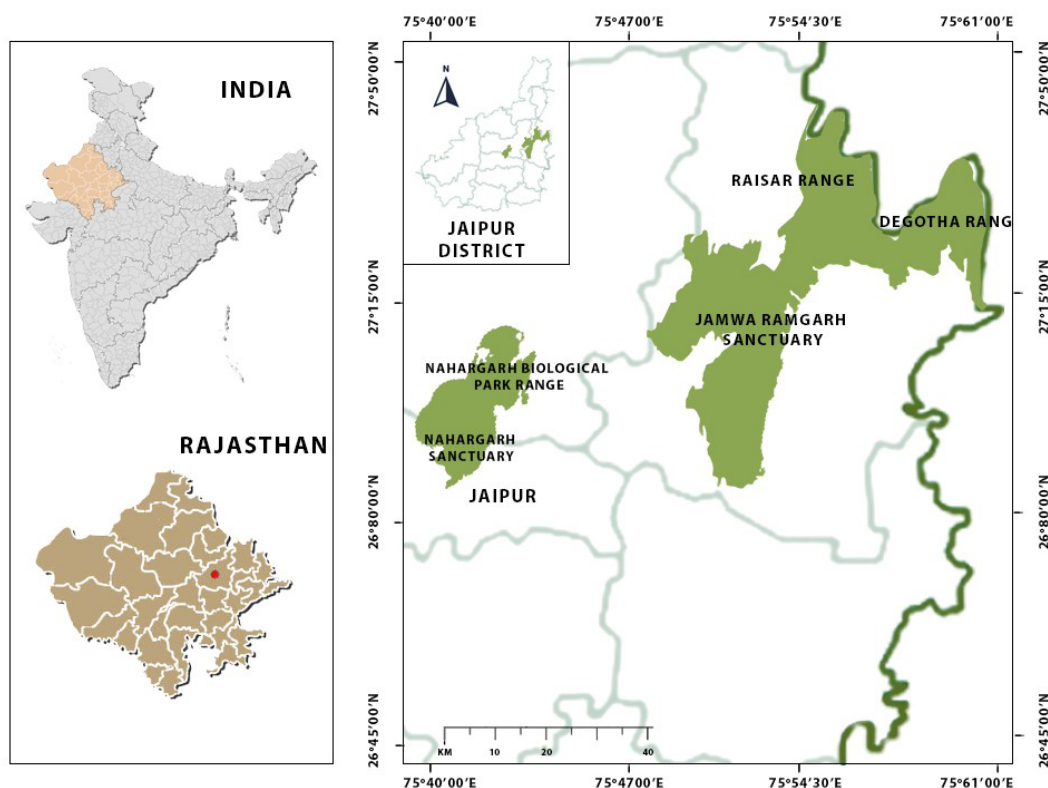


Fig. 1: Key map of the study area in Jaipur, Rajasthan.

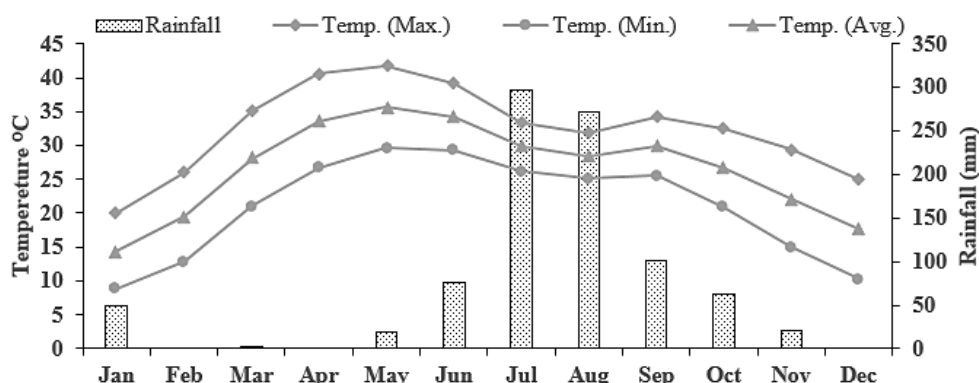


Fig. 2: Climatic parameters rainfall (mm) and temperature (C) during study period 2022.

We have selected five forest stands for the study, two in NWLS viz Nahargarh Biological Park, Nahargah Sanctuary, and three sites in JRWLS viz Ramgarh, Raisar, Digota, respectively. The stands were chosen

based on forest's accessibility. All the stands are classified as reserve forests, which have the highest level of protection. The chosen stand's specifics are provided in (Table 1).

Table 1: Characteristics of the selected forest stands.

Parameter	Nahargarh WLS		Jamwa Ramgarh WLS		
	S1	S2	S3	S4	S5
Forest Location	Sisiyawas	Vidhyadhar Nagar	Jamwa Ramgarh	Raisar	Digota, Sankotda
Altitude (m)	465	514	488	504	652
Latitude (N)	27°1'0	26°58'54.18	27°1'9.60	27°9'5.60	27°5'17.29
Longitude (E)	75°50'56	76°49'4.26	76°0'6.46	76°7'8.05	76°9'39.67
Fores Status	Reserved	Reserved	Reserved	Reserved	Reserved
Soil moisture (%)	9.79±0.14	9.20±0.48	9.50±0.32	9.10±0.29	10±0.41
Soil pH	6.71±0.07	7.17±0.35	7.11±0.37	7.62±0.19	7.20±0.38

Values are in means (±) standard deviation

Sampling and Data Analysis

For the vegetative analysis of these locations, the phytosociological studies were carried out during the rainy seasons, while for the trees and shrubs, they were done only once, between July to October 2022 among the selected sites in both the forest sanctuaries. To determine the vegetation's most representative composition, a random sample of the vegetation was used for analysis. We use the nested quadrat technique to conduct the vegetation survey. For the study, 68 and 96 quadrats, each of 20×20 m were laid on-site to observe the plants and shrubs, in NWLS and JRWLS respectively, the circumference

at breast height for each tree quadrat (cbh; i.e. 164 quadrats, each of 20×20 m) were placed there for the aim of examining trees and sub-quadrats 5×5 m size for shrubs, in Nahargarh WLS and Jamwa Ramgarh WLS respectively, every quadrat's circumference measured at breast height (cbh; i.e. at 1.37 m above from the base) of every tree (>10 cm cbh) was measured, and those with cbh <10 cm were records as saplings.³² These species Importance Value Index (IVI) were used to determine the dominance of the plant species. Through the examination of the relative frequency, frequency, relative density, density, relative dominance, abundance, and IVI,

vegetation composition was assessed using the formula given by Mishra.³³

Diversity Indices

The indices viz. shannon-wiener,³⁴ simpson,³⁵ margalef,³⁶ and pielou³⁷ were calculated to analyse the diversity, concentration of dominance, species richness, and evenness respectively.

Statistical Analysis

The vegetation was classified by agglomerative hierarchical cluster analysis using free version of XLSTAT (version 2023). The ward's group linkage method and similarity ratio were used to classify plots into comparable groups based on species abundance data.^{38,39} One-way analysis was used to analyse the significant differences in tree and shrub density and basal area among the different forest stands and also between the sanctuaries using XLSTAT.

Results

Floristic Composition

Out of 164 plots, 92 different plant species were found belonging to 66 genera and 39 families. Out of which 60 species represented from angiosperms, of these, 65.22% species were trees, 24 species (26.09%) were shrubs, and 8 species (8.7%) were climbers. Fabaceae was the most diverse of the plant families, with 20 species and 11 genera. This was followed by with species and genera as Malvaceae (10 species; 6 genera), Capparaceae (4 species; 3 genera), Boraginaceae, Euphorbiaceae, Menispermaceae each representing 3 species and 2 genera, Ebenaceae, Moraceae each representing 3 species and 1 genus, respectively. The other families are either represented by 2 or 1 genera. Among the genus, *Acacia* was the most diversely found genera with 6 species, whereas *Grewia* was the most frequently found shrub in the forest genera with 5 species. (Appendix A)

Vegetation Density and Basal Area

In the field of study, the total basal area (TBA) and tree density ranges from 18.56 to 34.36 m²/ha and 923 to 1433 tree/ha, respectively. A significantly higher density of trees was found at JRWLS (1319.53 tree/ha than NWLS (994.15 tree/ha) with $p < 0.0001$, respectively. Among the forest stands, the maximum tree density was estimated at S3 (1433

tree/ha), followed by S4 (1171 tree/ha), S5 (1014 tree/ha), S2 (1086 tree/ha), and S1 (923 tree/ha), respectively. Tree density was significantly different among the five stands ($p < 0.0001$).

Among the tree species, *Anogeissus pendula* have the with highest density in all the stands except in S4 i.e. with maximum density at S3 (884 tree/ha) followed by S2 (626 tree/ha), S1 (437 tree/ha) and S5 (388 tree/ha), respectively. However, at S4 the species *Prosopis juliflora* showed maximum density with 217 tree/ha. The other tree species of increased density (tree/ha) were *Acacia senegal*, *Acacia tortilis*, *Holoptelea integrifolia*, *P.juliflora*, *Boswellia serrata*, respectively.

The basal area in all the studied sites ranged from 18.56 m²/ha (S2) to 34.36 m²/ha (S3), with the mean basal area (MBA) as 27.13 ± 6.43 m²/ha, respectively. A higher value of MBA was for JRWLS (32.89 ± 2.53 m²/ha) than NWLS (21.08 ± 2.99 m²/ha). Among the forest stands, highest TBA was found for S3 (34.36 m²/ha), followed by S5 (31.08 m²/ha), S4 (29.39 m²/ha), S1 (22.27 m²/ha), and S2 (18.56 m²/ha), respectively. The TBA was significantly different among the five stands and between the two sanctuaries i.e. NWLS and JRWLS, respectively ($p < 0.0001$).

Similarly, the TBA was also largest for *A. pendula* in both the forest stands viz i.e. S1 (14.66 m²/ha) and S2 (6.28 m²/ha) of NWLS and S5 (5.96 m²/ha) of JRWLS. However, in the forest stands S3 and S4 of JRWLS it was *B serrata* recorded with highest TBA i.e. 13.31 m²/ha, 8.78 m²/ha, respectively. Further there were few species recorded with high TBA were *Butea monosperma* (3.66 m²/ha), *Ailanthus excelsa* (3.17 m²/ha), *Acacia senegal* (2.84 m²/ha), *Lannea coromandelica* (2.34 m²/ha), *Holoptelea integrifolia* (1.55 m²/ha), *Acacia tortilis* (0.23 m²/ha), *Prosopis cineraria* (0.41 m²/ha), respectively. Among the sanctuaries, *B serrata* had highest TBA (11.71 m²/ha) at JRWLS, while *A pendula* (11.61 m²/ha) at NWLS. For the shrubs, the density ranges from 598 to 1845 tree/ha with higher values at JRWLS (1349.74 tree/ha) than NWLS (783.47 tree/ha). The density of shrubs was found significantly different across the forest stands five stands and among the sanctuaries ($p < 0.002$). At NWLS, *Grewia tenax* was the most frequently found species both at stand S1 (235 tree/

ha) and S2 (209 tree/ha). The other important shrubs found in NWLS were *Adhatoda zeylanica*, *Grewia flavescens* and *Capparis sepiaria* with 58.33%; 72.92 tree/ha. At JRWLS stands, the maximum shrub density was for *Adhatoda zeylanica* i.e. 376 tree/ha at S3, 575 tree/ha at S4, and 416 tree/ha at S5, respectively. The other commonly found shrubs were *Euphorbia caducifolia*, *Capparis sepiaria*, *Hibiscus micranthus*, and *Securinega leucopyrus*.

Frequency and IVI

In the study area, *A pendula* was found to be the most frequently found species all the forest stands also

with highest IVI value i.e. S1 (90%; 127.2), S2 (83%; 105.56), S3 (93.65%; 96.18), S5 (85.71%, 68.54), respectively. At S4, the maximum frequency and IVI was for *P juliflora* (63.16%; 33.15) (Appendix A).

Among the shrubs at NWLS, *G tenax* was the most frequently found species both at stand S1 (69.77%) and S2 (84%). At JRWLS stands, *Grewia flavescens* had the highest frequency i.e. 55.56% (S3), 68.42% (S4), and *G tenax* with 64.29% at S5 (Table 2).

Table 2: Frequency and density of shrubs in Nahargarh (NWLS) and Jamwa Ramgarh (JRWLS) Sanctuary of Aravalli Forest ranges in Jaipur.

Parameter	NWLS		JRWLS		
	S1	S2	S3	S4	S5
Frequency (%)	427.91	332	331.75	389.47	428.57
Density (individual/ha)	901.74	574	1275	1844.74	1128.57

Table 3: Biodiversity Indices in Nahargarh (NWLS) and Jamwa Ramgarh (JRWLS) Sanctuary of Aravalli Forest ranges in Jaipur

Indices	NWLS		JRWLS		
	S1	S2	S3	S4	S5
Species Diversity					
Shannon Index (H')					
Trees	2.01	1.89	1.64	2.41	2.57
Shrubs	2.07	1.81	2.12	2.09	1.92
Simpson Index (CD)					
Trees	0.26	0.35	0.4	0.12	0.17
Shrubs	0.2	0.24	0.17	0.17	0.21
Species evenness (SE)					
Pielou Index					
Trees	0.61	0.53	0.45	0.78	0.7
Shrubs	0.7	0.64	0.72	0.74	0.71
Species richness (d)					
Margalef Index					
Trees	3.53	4.86	4.52	3.09	6.15
Shrubs	2.45	2.52	2.23	2.21	2.17

Diversity Indices

The Shannon index (H') ranges between 1.64 to 2.57 for tree layer, with highest values at stand S5

(2.57) i.e. Raisar, followed by S4 (2.41), S1 (2.01), S2 (1.89) and S3 (1.64). Regarding the tree species, the Simpson index (CD) has a range of 0.12 to 0.40,

being maximum at stand S3 (Ramgarh), Margalef index from 3.09 to 6.15 with maximum richness value at S5 (Digota) and Pielou index ranges from 0.45 to 0.78 with maximum evenness at S4 (Raisar) (Table 3).

For the shrubs, the Shannon diversity was highest (2.12) at S3 (Ramgarh) and lowest (1.81) in S2 (Nahargarh Sanctuary), respectively. Among the

other indices, the species richness (2.52) and dominance (0.24) were maximum in stand S2 (Nahargarh Sanctuary), species evenness (0.74) in S4 (Raisar) (Table 3). Among the two sanctuaries, species diversity (H') and richness were higher for JRWLS (2.83; 8.45) than NWLS (2.80; 7.31). Whereas, the concentration of dominance (CD) and species evenness of NWLS (0.12; 0.68) were high than JRWLS (0.11; 0.65), respectively.

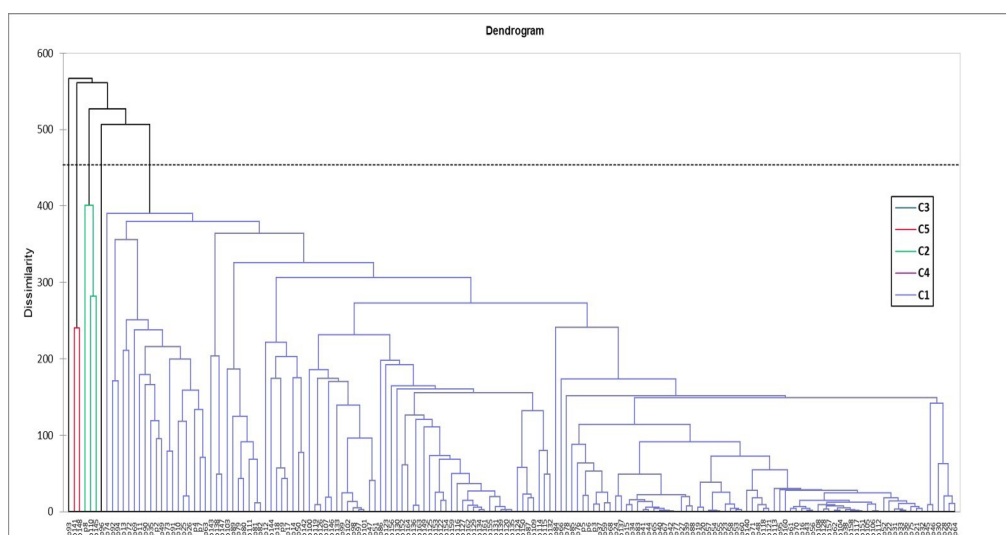


Fig. 3: Plant community analysis in Nahargarh (NWLS) and Jamwa Ramgarh (JRWLS) Sanctuary of Aravalli Forest ranges in Jaipur.

Plant community Analysis

Five plant community clusters were found using the results of agglomerative hierarchical cluster analysis (Fig. 3). The communities were arranged based on the dominating plant species that had the greatest mean abundance cover for the specific community. Community type 1 (*A pendula-Adhatoda zeylanica*) is the major vegetation community comprising largest forest area with 164 sampling plots and highest plant species (87) and is widely distributed all over both the sanctuaries i.e. JRWLS and NWLS. *Adhatoda zeylanica* and *A pendula* were the most dominant shrub and tree species identified in that community. The other associated tree species were *Flacourtia indica*, *Naringi crenulata*, *Euphorbia caducifolia*, *Grewia flavescens*, *Grewia tenax*, *Ziziphus nummularia* and *Barleria prionitis*. The diversity indices determined for this community were shannon diversity, species richness, margalef

index, simpson concentration dominance for this community was 2.98, 87, 9.35, and 0.11, respectively. Community type 2 (*Acacia Senegal-Grewia flavescens*) comprises 3 sampling plots with main associated tree species such as *Acacia tortilis*, *Balanites aegyptiaca*, *Maytenus emarginata*, *P juliflora*. The diversity indices showed 2.93, 27, 4.63, 0.06 as shannon diversity, species richness, margalef index, and simpson dominance values for this community. This community is mostly dispersed in NWLS. Community type 3 (*Wrightia tinctoria*) covering one sampling plot of the total samples forest area. The associated tree species of this community are *Butea monosperma*, *Mallotus philippensis*. The shannon diversity, species richness, margalef index, simpson dominance for this community was 2.07, 14, 2.94, and 0.17, respectively. The community was observed in JRWLS. Community type 4 (*Adhatoda zeylanica*) with one sampling plot in JRWLS.

Community type 5 (*Holoptelea integrifolia-Grewia damine*) covers 2 sampling plots. The associated tree species in this community are such as *Ceiba pentandra*, *Grewia flavescens* and *Gloriosa superba*. The diversity was highest for this community with shannon diversity, species richness, margalef index, simpson dominance for this community was 3.52, 55, 8.58, and 0.038, respectively. The location of the community was found to be in NWLS.

Discussion

Tropical dry forests are less complicated structurally and floristically than wet forests, with just half or fewer of the plant species present in moist forests.⁴⁰ Regarding this, the current investigations indicated that the species composition and variety of the dry forest are comparable to many other dry forests. These studies were carried out in the tropical dry deciduous forests of the NWLS and the JRWLS near Jaipur.

Forest Stand Structure

In the studied forests, a prominence of family Fabaceae has been reported with 20 species and 11 genera. The dominance of leguminous species has also been reported from previous studies on dry forest of Vindhayan highlands of India,⁴¹ Ecuador.⁴² The low soil moisture and nutrient constraint environment in these forests promotes the establishment and survival of nitrogen fixation species.^{41,43,44} Further, the successful establishment of Fabaceae reflects the environmental conditions governing the pollination and dispersal of these species.^{39,45}

IVI determines the sociological interaction of dominating species in a community in a forest. *A pendula* was found to be the most prominent species with highest frequency, density, and IVI in all the forest stands (S1, S2, S3, and S5) of both the sanctuaries. Previous studies on similar forests have also reported the dominance of this species in the forests of Sariska National Park.^{46,47} However, at Raisar (S4) of JRWLS the dominance species of *P juliflora* was observed with highest frequency, density, and IVI. Being an exotic species, a check is required for its distribution as it might be a potential risk to the locally growing species.⁴⁸

Tree Density and Basal Area

Basal area of trees it is an essential property for quantifying vegetation composition and site attribute.⁴⁹ The tree species included in the current study range in basal area from 18.56 to 34.36 m²/ha, with a mean of (27.13 m²/ha). It was within the range reported by previous studies on dry forests (20.79 m²/ha);⁵⁰ (26.52 m²/ha),⁵¹ and is greater than the figures stated for Madhya Pradesh's tropical dry forests (25 m²/ha),⁵² tropical thorn forests of North India (3.69–11.99 m²/ha)⁵³ and Peninsula India (15.38 m²/ha).⁵⁴ However, the basal area was lower as reported for sub-tropical forests of Udaypur district, Nepal (29.52 m²/ha),⁵⁵ and dry deciduous forests of Raipur (48.29–50.35 m²/ha)⁵⁶ (Table 4). Basal area of a tree is influenced by level of disturbances, species composition and successional strategies of the forest stands.⁵⁷ A higher MBA at stand S3 (Ramgarh) of JRWLS could be due to presence of mature individuals of trees species *B serrata*, *A. pendula*, *Lannea coromandelica* which are well adapted in forests.

The tree density estimated for the study area ranges from 923 to 1433 tree/ha with a total of 1134.8 tree/ha and is comparable with tropical dry deciduous forest of Rajasthan (702–1671 tree/ha);⁵⁸ (650–1520 tree/ha);⁵⁶ (917–1716 tree/ha),⁴⁶ Western Ghats of South India (351–1173 tree/ha).⁵⁹ However, it was higher than range reported in previous studies for tropical dry deciduous forests of India i.e. 517 tree/ha in Tamil Nadu (517 tree/ha),⁶⁰ Madhya Pradesh (519–859 tree/ha),⁵² Budelkhand (5.88–7.15 tree/ha),⁶¹ West Bengal (547–979 tree/ha),⁵⁰ tropical thorn forest (159.03 tree/ha),⁵⁴ semi-arid forest of Delhi and Argentina (633–684 tree/ha),⁵¹ (533 tree/ha),⁶² deciduous dry forest of Central Brazil (513–733 tree/ha),⁶³ sub-tropical forest of Udaypur district, Nepal (1.40 to 431.58 trees/ha).⁵⁵

A higher density could be attributed to low level of disturbances as these forests are protected areas where anthropogenic activities are regulated. Conversely, tree density of present study area is lower than what has been reported from Mexican tropical deciduous forest (1386 tree/ha).⁶⁴

Table 4: Comparison of current studies (density and basal area) with other tropical dry deciduous forest stands.

Region and forest type	Density (tree/ha)	Basal Area (m ² /ha)	Reference
Tropical dry deciduous forest, Mexico		31.3	65
Tropical dry forests in Vietnam's Central Highlands Region	431.05-562.40	5.74-23.7	45
Deciduous Dry Forest Central Brazil	513-733	19.3-28.3	63
Chaco semi-arid forest Argentina	533.33	14.59	62
Mexican tropical deciduous forest	1386	15.9	64
Sub-tropical forest of Udaypur District of Nepal	1.40-431.58	29.52	55
Tropical dry deciduous forest, India	702-1671	15.43-71.76	58
Semi-Arid Forest Delhi, India	633-684	19.87-33.16	51
Moist deciduous forest, Kollam Kerala	877	26.88	66
Tropical dry deciduous forest, West Bengal, India	549.52-979.65	8.86-33.22	50
Tropical dry deciduous forest, Bundelkhand India	5.88-7.15	41.37-59.78	61
Tropical thorn forest Northern India	290-850	3.69-11.99	53
Tropical dry deciduous forest Western India	458-728	5.96-19.31	67
Tropical dry forest of Northern India		13.54-18.53	41
Tropical thorn forest, Peninsular India	159.03	15.38	54
Tropical dry deciduous forest Madhya Pradesh, India	519-859	20.5-29.5	52
Tropical deciduous forests of Northcentral Eastern Ghats, India	395-573	13.05-28.42	68
Tropical forests in Eastern Ghats of Andhra Pradesh, India	435-767	25.82	69
Dry deciduous forest Raipur, India	650-1520	48.29-50.35	56
Semi-Evergreen Forest of North-East, India	90-125		70
Tropical dry deciduous forest of Malyagiri hill ranges, Eastern Ghats, India	443	13.73	71
Tropical dry forests of Eastern Ghats, India	479	15.20	72
Tropical dry deciduous forest Tamil Nadu, India	517	16.72	60
Tropical dry deciduous forest India	917.2-1716.7	3-32.73	46
Pench Tiger Reserve, Maharashtra, India	433.75	13.7	73
Tropical dry deciduous forests of Tiruvannamalai, Tamil Nadu, India	450.5-727	18.85-27.2	74
Western Ghats, South India	352-1173	28.05-81.38	59
Tropical deciduous forests of Eastern Ghats, India	268.33-655.47	6.65-22.28	75
Dry tropical forest in Balamdi Watershed of Chhattisgarh Plain	237.50-231.25	4.99-5.14	76
Singara Range, Western Ghats, India	524	25.32	77
Tropical dry deciduous forest of Eastern Ghats, Andhra Pradesh, India	674-796	8.55-26.89	78
Tropical dry deciduous forest of Rajasthan, India	923-1433	18.56-34.36	Present Study

Shrubs Density and Frequency

Grewia was the most frequently found shrub in the forest genera with 5 species. The S4 (Raisar)

stand has a higher shrub density than the other disturbed forest stands. In the current study, the S4 (Raisar) stand showed strong regeneration,

and anthropogenic disturbances like fuelwood collecting, lopping, cutting, and grazing were found to be minimal. The lowest density was recorded in S2 (Nahargarh Sanctuary), indicating inadequate regeneration in this stand. This poor regeneration of shrubs could be attributed to low levels of fertility which effect the seed germination or fruiting significantly decreasing the sapling population.⁸ Several biotic and abiotic factors including drought, soil water availability, light, level of disturbances, ground cover, and herbivory also shown to affect the successful development and establishment of shrubs seedlings.⁷⁹⁻⁸²

Diversity Indices

Species diversity is determined by species adaptability and increases in tandem with community stability. In the current forests viz NWLS and JRWLS, the Shannon-Weiner (H') index varied from 1.65 to 2.57, which is between the 0.67–4.86 reported range seen in the Indian sub-continent tropical forests (1.85–2.05);⁷⁵ (0.67–0.79);⁶⁷ (2.20–2.65).⁵⁹ These numbers suggest that the tropical deciduous forest of currently is an ecosystem rich in species. The variation in species diversity among the different forest stands could be explained by various physiographic, edaphic and biotic factors affecting the distribution of species both at landscapes and forest sites.^{39,83} Species diversity when compared with other tropical dry forests of India is lower than deciduous forest of Northcentral Eastern Ghats, (3.80);⁶⁸ Eastern Ghats, Andhra Pradesh, (4.97);⁷⁸ Bundelkhand (3.60);⁶¹ Tamil Nadu (2.83).⁶⁰ However, the diversity indices were higher than previous studies from tropical dry deciduous forests Tiruvannamalai, Tamil Nadu (1.95);⁷⁴ Maharashtra (2.92);⁷³ Western India (0.73);⁶⁷ Northern India (3.32)⁴¹ and tropical thorn forest Peninsular (1.76).⁵⁴

Further, the equal representation of the species in a community can be understood by species evenness. The high values of species evenness, diversity, and lower dominance from Raisar and Digota stands of JRWLS, indicates preferential environmental conditions for the existence of the community.

An overall high species diversity of both trees and shrubs at JRWLS as compared to NWLS could be attributed to favourable environmental gradients to which biotic communities interact.³⁸ The variation in

diversity indices among the forest stands could be due to level and type of disturbances, physiographic factors such as altitude, slope, soil type and other environmental elements that were not taken into account for the present study. The current phytosociological examination offers researchers and policymakers with data on forest inventory and its significance for future conservation initiatives of tropical dry deciduous forests in these regions. The study also observed the remarkable occurrence of two IUCN listed critically endangered species of Indian Thar Desert viz *Commiphora wightii* and *Tecomella undulata* in the research area.

Plant Community Types

The five types of plant communities are occupying the forests of NWLS and JRWLS of Jaipur. There is a little fluctuation in species diversity, evenness, and dominance among these communities. Overall, the community type 1 dominated with *A pendula-Adhatoda zeylanica* is the most widespread community of the study area. However, the other communities viz community 2, and 3 also showed higher diversity. This could also be due to few sampling plots occupied by these communities. Also, the variation in diversity among the communities could be further explained by biotic and abiotic factor along with anthropogenic influences.³⁹

Conclusion

The current study analyses the composition, biodiversity and community types of vegetation in NWLS and JRWLS forests of Jaipur. A total of 92 species and 39 families were documented with the dominance of family Fabaceae with 20 species and 11 genera. Among the shrubs *Adhatoda zeylanica* found to be the most dominating species. The study reported higher the density, basal area and IVI in JRWLS forest as compared NWLS. Among the trees *A pendula* was found to be the most dominating species in both the sanctuaries. The hierarchal clustering classified five community types indicating the maximum distribution of *A pendula-Adhatoda zeylanica* community in these forests. Further, the biodiversity indices suggested an overall higher diversity in JRWLS forest as compared NWLS, respectively.

The variation in vegetation composition and species diversity are determined mainly by various

environmental and biotic factors at a specific site. The data on phytosociological factors, distribution patterns, and tree species variety in a forest are valuable to forest managers, researchers, and scientists in developing efficient forest conservation management plans. Since the study was focused on species composition and biodiversity levels among the two forest sanctuaries (NWLS, JRWLS). However, for framing future management strategies in dry forests a further investigation on distribution of plant community types on the basis of climate variables and physiographic level, soil properties is required.

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Conflict of Interest

The authors declare that there are no conflicts of interest.

Data Availability Statement

The manuscript incorporates all datasets produced or examined throughout this research study are available on request from the corresponding author.

Ethics Statement

It has not been studied on humans or animals.

Authors' Contribution

- **Naveen Kumar:** Contributed by formulating the concept, composing the paper, compiling data, creating graphs and writing the first drafts.
- **Sonali Tiwari:** Review and validation of the article, Priyanka Jatav: Review and validation of the article.
- **Dr. Archana Meena:** Recommended a critical evaluation of the paper and concluded the approval of the version to be submitted to the journal.

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Appendix A.

Density, frequency, basal area and importance value index (IVI) of the tree species across the selected sites, in Nahargarh and Jamwa Ramgarh Wildlife Sanctuaries.

Nahargarh Biological Park (S1)

Species	Family	F (%)	Density tree/ha	IVI	Basal Area m ² /ha
<i>Acacia catechu</i> (L.) Willd. Oliv.	Fabaceae	2.33	1.16	0.63	0.02
<i>Acacia leucophloea</i> (Roxb.) Willd.	Fabaceae	32.56	29.65	11.34	0.57
<i>Acacia nilotica</i> (L.) Del,	Fabaceae	4.65	1.74	1.07	0.02
<i>Acacia senegal</i> Sensu O.B.Mill	Fabaceae	55.81	112.79	26.91	1.14
<i>Acacia tortilis</i> (Forssk.) Hayne	Fabaceae	53.49	59.3	24.06	1.89
<i>Anogeissus pendula</i> Edgew.	Combretaceae	90.7	436.63	127.2	14.33
<i>Bauhinia racemosa</i> Lam.	Fabaceae	13.95	6.98	4.63	0.33
<i>Balanites aegyptiaca</i> (L.) Delile.	Zygophyllaceae	20.93	31.98	7.37	0.07
<i>Boswellia serrata</i> Roxb. ex Cocleb	Burseraceae	4.65	1.74	1.04	0.01
<i>Butea monosperma</i> (Lam.) Taub.	Fabaceae	9.3	4.07	3.02	0.22
<i>Cocculus pendulus</i> (J.R.Forst. & G.Forst.) Diels	Menispermaceae	13.95	6.4	3.16	0.02
<i>Commiphora wightii</i> (Arn.) Bhandari	Burseraceae	11.63	6.4	2.76	0.02

<i>Crateva religiosa</i> G. Forst.	Capparaceae	2.33	6.4	1.14	0.01
<i>Dichrostachys cinerea</i> Wight et Arn.	Fabaceae	46.51	60.47	14.98	0.10
<i>Ehretia laevis</i> Roxb.	Boraginaceae	9.3	2.91	1.92	0.01
<i>Holoptelea integrifolia</i> (Roxb.) Planch.	Ulmaceae	13.95	6.4	4.48	0.31
<i>Lannea coromandelica</i> (Houtt.) Merr.	Anacardiaceae	20.93	13.37	5.75	0.16
<i>Maytenus emarginata</i> (Willd.) Ding Hou	Celastraceae	55.81	45.93	16.35	0.40
<i>Mitragyna parvifolia</i> (Roxb.) Korth.	Rubiaceae	4.65	5.23	1.8	0.10
<i>Moringa oleifera</i> Lam.	Moringaceae	2.33	1.16	1.07	0.12
<i>Pongamia pinnata</i> (L.) Pierre	Fabaceae	2.33	0.58	0.49	0.01
<i>Prosopis ceneraria</i> (L.) Druce.	Fabaceae	37.21	20.93	16.01	1.64
<i>Prosopis juliflora</i> (Swartz.) DC.	Fabaceae	51.16	47.09	16.28	0.54
<i>Salvadora persica</i> L.	Salvadoraceae	2.33	0.58	0.47	0.01
<i>Sterculia urens</i> Roxb.	Sterculiaceae	2.33	3.49	1.43	0.14
<i>Wrightia tinctoria</i> (Roxb.) R. Br.	Apocynaceae	6.98	4.65	2.01	0.07
<i>Ziziphus mauritiana</i> Lam.	Rhamnaceae	11.63	4.65	2.64	0.03

Nahargarh Sanctuary (S2)

Species	Family	F (%)	Density tree/ha	IVI	Basal Area m ² /ha
<i>Acacia jacquemontii</i> Benth.	Fabaceae	4	1	0.84	0.02
<i>Acacia leucophloea</i> (Roxb.) Willd.	Fabaceae	4	1	1.23	0.09
<i>Acacia nilotica</i> (L.) Del,	Fabaceae	8	3	2.44	0.16
<i>Acacia senegal</i> Sensus O.B.Mill.	Fabaceae	52	69	21.15	1.17
<i>Acacia tortilis</i> (Forssk.) Hayne	Fabaceae	12	10	5.68	0.51
<i>Albizia lebbeck</i> (L.) Benth.	Fabaceae	4	2	1.83	0.18
<i>Anogeissus pendula</i> Edgew.	Combretaceae	80	626	105.56	6.28
<i>Azadirachta indica</i> A. Juss.	Meliaceae	16	6	7.30	0.75
<i>Bauhinia racemosa</i> Lam.	Fabaceae	28	13	9.22	0.64
<i>Balanitis aegyptiaca</i> (L.) Delille.	Zygophyllaceae	4	1	0.78	0.01
<i>Boswellia serrata</i> Roxb. ex Cocleb	Burseraceae	8	6	3.62	0.32
<i>Butea monosperma</i> (Lam.) Taub.	Fabaceae	8	2	2.80	0.24
<i>Clerodendrum phlomidis</i> L. f.	Lamiaceae	8	13	2.52	0.01
<i>Cocculus hirsutus</i>	Menispermaceae	12	7	2.77	0.04
<i>Commiphora wightii</i> (Arn.) Bhandari	Burseraceae	36	30	10.03	0.28
<i>Cordia sinensis</i> Lam.	Boraginaceae	4	1	1.17	0.08
<i>Crateva religiosa</i> G. Forst.	Capparaceae	16	35	7.21	0.26
<i>Dalbergia paniculata</i> Roxb	Fabaceae	12	5	2.70	0.06
<i>Dalbergia sissoo</i> DC.	Fabaceae	4	2	0.99	0.03
<i>Dichrostachys cineraria</i> Wight et Arn.	Fabaceae	48	22	9.73	0.02
<i>Diospyros melanoxylon</i> Roxb.	Ebenaceae	4	4	1.73	0.13
<i>Ehretia laevis</i> Roxb.	Boraginaceae	24	13	5.44	0.08
<i>Euphorbia nerifolia</i> L.	Euphorbiaceae	4	2	0.87	0.01
<i>Flacourtia indica</i> (Burm.f.) Merr.	Salicaceae	12	5	2.64	0.05
<i>Grewia damine</i> Gaertn.	Malvaceae	24	38	9.26	0.35
<i>Holoptelea integrifolia</i> (Roxb.) Planch.	Ulmaceae	52	58	28.22	2.61
<i>Lannea coromandelica</i> (Houtt.) Merr.	Anacardiaceae	44	29	17.49	1.4

<i>Maytenus emarginata</i> (Willd.) Ding Hou	Celastraceae	28	32	12.04	0.83
<i>Mitragyna parvifolia</i> (Roxb.) Korth.	Rubiaceae	8	3	3.23	0.3
<i>Naringi crenulate</i> (Roxb.) Nicolson	Rutaceae	4	3	0.97	0.01
<i>Prosopis cineraria</i> (L.) Druce.	Fabaceae	4	1	1.34	0.11
<i>Sterculia urens</i> Roxb.	Sterculiaceae	4	1	0.78	0.01
<i>Tecomella undulata</i> (Sm.) Seem.	Bignoniaceae	8	3	7.44	1.05
<i>Wrightia tinctoria</i> (Roxb.) R. Br.	Apocynaceae	40	37	12.21	0.44
<i>Ziziphus mauritiana</i> Lam.	Rhamnaceae	4	2	0.99	0.03

Jamwa Ramgarh (S3)

Species	Family	F (%)	Density tree/ha	IVI	Basal Area m ² /ha
<i>Acacia leucophloea</i> (Roxb.) Wild.	Fabaceae	7.94	3.57	1.83	0.06
<i>Acacia nilotica</i> (L.) Del.	Fabaceae	3.17	0.79	0.68	0.02
<i>Acacia senegal</i> Sensus O.B.Mill.	Fabaceae	28.57	51.59	10.69	0.68
<i>Acacia tortilis</i> (Forssk.) Hayne	Fabaceae	12.70	11.51	4.1	0.35
<i>Aegle marmelus</i> (L.) Corr.	Rutaceae	1.59	2.38	0.47	0.01
<i>Albizia lebbeck</i> (L.) Bent	Fabaceae	1.59	0.4	0.36	0.02
<i>Anogeissus pendula</i> (L.) Wild.	Combretaceae	93.65	884.13	96.18	6.10
<i>Azadirachta indica</i> Juss.	Meliaceae	1.59	0.4	0.32	0.01
<i>Bauhinia racemosa</i> Lam.	Fabaceae	4.76	1.19	1.07	0.05
<i>Boswellia serrata</i> Roxb. ex Coleb	Burseraceae	68.25	124.21	59.59	13.31
<i>Butea monosperma</i> (Lam.) Taub.	Fabaceae	47.62	53.57	21.29	3.11
<i>Cassia fistula</i> L.	Fabaceae	34.92	38.49	11.56	0.91
<i>Ceiba pentandra</i> (L.) Gaertn.	Malvaceae	1.59	1.19	0.39	0.01
<i>Commiphora wightii</i> (Arn.) Bhandari	Burseraceae	3.17	9.92	1.28	0.01
<i>Cordia dichotoma</i> G. Forst.	Boraginaceae	3.17	1.59	0.89	0.07
<i>Crateva religiosa</i> G. Forst.	Capparaceae	1.59	0.79	0.36	0.01
<i>Dalbergia sissoo</i> DC.	Fabaceae	1.59	0.4	0.32	0.01
<i>Dichrostachys cinerea</i> Wight et Arn.	Fabaceae	31.75	44.05	8.96	0.08
<i>Diospyros melanoxylon</i> Roxb.	Ebenaceae	3.17	0.79	0.7	0.02
<i>Ehretia laevis</i> Roxb.	Boraginaceae	3.17	1.19	0.654	0.002
<i>Eucalyptus camaldulensis</i> Dehnh.	Myrtaceae	1.59	0.4	0.48	0.06
<i>Ficus benghalensis</i> L.	Moraceae	3.17	1.19	3.61	1.02
<i>Ficus racemosa</i> L.	Moraceae	11.11	5.16	6.83	1.54
<i>Ficus religiosa</i> L.	Moraceae	1.59	0.4	0.49	0.06
<i>Grewia asiatica</i> L.	Malvaceae	1.59	0.4	0.34	0.01
<i>Holoptelea integrifolia</i> (Roxb.) Planch.	Ulmaceae	36.51	23.02	12.85	1.62
<i>Lannea coromandelica</i> (Houtt.) Merr.	Anacardiaceae	44.44	37.3	19.26	3.00
<i>Maytenus emarginata</i> (Wild.) Ding Hou	Celastraceae	7.94	7.94	2.32	0.12
<i>Mitragyna parvifolia</i> (Roxb.) Korth.	Rubiaceae	1.59	1.19	0.45	0.03
<i>Moringa oleifera</i> Lam.	Moringaceae	1.59	0.4	0.34	0.01
<i>Phoenix sylvestris</i> (L.) Roxb.	Fabaceae	1.59	0.79	0.44	0.04
<i>Prosopis cineraria</i> (L.) Druce.	Fabaceae	11.11	4.76	2.96	0.22
<i>Prosopis juliflora</i> (Swartz.) DC.	Fabaceae	23.81	44.44	7.44	0.03
<i>Salvadora persica</i> L.	Salvadoraceae	3.17	0.79	0.94	0.11
<i>Sterculia urens</i> Roxb.	Sterculiaceae	20.63	13.49	7.96	1.15

<i>Syzygium heyneanum</i> (Duthie) Well. Ex Gamble	Myrtaceae	1.59	0.4	0.45	0.05
<i>Wrightia tinctoria</i> (Roxb.) R. Br.	Apocynaceae	30.16	57.94	10.78	0.47
<i>Ziziphus mauritiana</i> Lam.	Rhamnaceae	1.59	0.4	0.32	0.004

Raisar (S4)

Species	Family	F (%)	Density tree/ha	IVI	Basal Area m ² /ha
<i>Acacia leucophloea</i> (Roxb.) Wild.	Fabaceae	31.58	52.63	14.08	1
<i>Acacia nilotica</i> (L.) Del.	Fabaceae	5.26	1.32	1.63	0.15
<i>Acacia senegal</i> Sensus O.B.Mill.	Fabaceae	52.63	153.95	33.13	2.84
<i>Ailanthus excelsa</i> Roxb.	Simaroubaceae	15.79	34.21	16.8	3.17
<i>Anogeissus pendula</i> (L.) Wild.	Combretaceae	36.84	198.68	26.25	0.61
<i>Balanites aegyptiaca</i> (L.) Delile.	Zygophyllaceae	5.26	7.89	1.74	0.01
<i>Bauhinia racemosa</i> Lam.	Fabaceae	5.26	2.63	1.34	0.03
<i>Boswellia serrata</i> Roxb. ex Coleb	Burseraceae	36.84	119.74	47.3	8.78
<i>Butea monosperma</i> (Lam.) Taub.	Fabaceae	36.84	71.05	27.75	4.25
<i>Cassia fistula</i> L.	Fabaceae	15.79	9.21	4.55	0.20
<i>Dalbergia sissoo</i> DC.	Fabaceae	5.26	2.63	3.4	0.63
<i>Dichrostachys cineraria</i> Wight et Arn.	Fabaceae	47.37	139.47	21.28	0.03
<i>Diospyros melanoxylon</i> Roxb.	Ebenaceae	5.26	5.26	1.7	0.07
<i>Flacourtia indica</i> Roxb.	Salicaceae	10.53	56.58	7.11	0.07
<i>Holoptelea integrifolia</i> (Roxb.) Planch.	Ulmaceae	26.32	26.32	14.12	1.97
<i>Lannea coromandelica</i> (Houtt.) Merr.	Anacardiaceae	31.58	18.42	12.82	1.49
<i>Maytenus emarginata</i> (Wild.) Ding Hou	Celastraceae	10.53	3.95	2.67	0.08
<i>Phoenix sylvestris</i> (L.) Roxb.	Arecaceae	5.26	3.95	1.55	0.05
<i>Prosopis ceneraria</i> (L.) Druce.	Fabaceae	31.58	17.11	12.17	1.33
<i>Prosopis juliflora</i> (Swartz.) DC.	Fabaceae	63.16	217.11	33.15	0.66
<i>Sterculia urens</i> Roxb.	Sterculiaceae	26.32	25	14.04	1.99
<i>Wrightia tinctoria</i> (Roxb.) R. Br.	Apocynaceae	5.26	3.95	1.41	0.01

Digota (S5)

Species	Family	F (%)	Density tree/ha	IVI	Basal Area m ² /ha
<i>Acacia catechu</i> (L.) Willd. Oliv.	Fabaceae	28.57	21.43	6.31	0.16
<i>Acacia leucophloea</i> (Roxb.) Wild.	Fabaceae	42.86	35.71	11.1	0.64
<i>Acacia nilotica</i> (L.) Del.	Fabaceae	7.14	3.57	3.05	0.55
<i>Acacia senegal</i> Sensus O.B. Mill.	Fabaceae	21.43	16.07	4.97	0.20
<i>Albizia lebbek</i> (L.) Benth.	Fabaceae	7.14	1.79	1.12	0.01
<i>Anogeissus pendula</i> (L.) Wild.	Combretaceae	85.71	387.50	68.54	5.96
<i>Anogeissus latifolia</i> (Roxb. Ex DC.) Wall. Ex Guill. & Perr.	Combretaceae	14.29	8.93	3.74	0.32
<i>Balanites aegyptiaca</i> (L.) Delile.	Zygophyllaceae	14.29	17.86	3.94	0.11

<i>Bauhinia racemose</i> Lam.	Fabaceae	14.29	7.14	2.6	0.02
<i>Boswellia serrata</i> Roxb. ex Coleb	Burseraceae	42.86	44.64	24.28	4.46
<i>Butea monosperma</i> (Lam.) Taub.	Fabaceae	28.57	80.36	28.68	5.30
<i>Cassia fistula</i> L.	Fabaceae	14.29	5.36	2.76	0.13
<i>Clerodendrum phlomidis</i> L. f.	Lamiaceae	7.14	8.93	2.32	0.16
<i>Dichrostachys cinerea</i> Wight et Arn.	Fabaceae	42.86	16.07	7.26	0.05
<i>Diospyros cordifolia</i> Roxb.	Ebenaceae	14.29	14.29	3.47	0.07
<i>Diospyros melanoxylo</i> Roxb.	Ebenaceae	14.29	14.29	4.39	0.36
<i>Diospyros montana</i> Roxb.	Ebenaceae	7.14	1.79	1.5	0.13
<i>Ehretia levis</i> Roxb.	Boraginaceae	14.29	3.57	2.29	0.04
<i>Euphorbia neriiifolia</i> L.	Euphorbiaceae	7.14	5.36	1.62	0.05
<i>Ficus racemosa</i> L.	Moraceae	14.29	3.57	13.73	3.59
<i>Flacourtia indica</i> (Burm.f.) Merr.	Salicaceae	7.14	1.79	1.16	0.02
<i>Grewia asiatica</i> L.	Malvaceae	14.29	12.50	3.12	0.01
<i>Helictares ixora</i> L.	Malvaceae	7.14	3.57	1.29	0.01
<i>Holoptelea integrifolia</i> (Roxb.) Planch.	Ulmaceae	21.43	12.50	6.06	0.64
<i>Hymenodictyon orixense</i> (Roxb.) Mabb.	Rubiaceae	7.14	3.57	1.33	0.02
<i>Lannea coromandelica</i> (Houtt.) Merr.	Anacardiaceae	57.14	23.21	11.54	0.59
<i>Mallotus philippensis</i> (Lam.) Mull. Arg.	Euphorbiaceae	7.14	12.50	3.31	0.36
<i>Maytenus emarginata</i> (Wild.) Ding Hou	Celastraceae	21.43	5.36	7.01	1.16
<i>Miliusa tomentosa</i> (Roxb.) J. Sinclair	Annonaceae	14.29	12.50	4.16	0.34
<i>Mitragyna parvifolia</i> (Roxb.) Korth.	Rubiaceae	28.57	16.07	15.31	3.13
<i>Moringa concanensis</i> Nimmo	Moringaceae	7.14	1.79	1.5	0.13
<i>Moringa oleifera</i> Lam.	Moringaceae	14.29	16.07	8.94	1.25
<i>Naringi crenulata</i> (Roxb.) Nicolson	Rutaceae	14.29	28.57	5.23	0.18
<i>Phoenix sylvestris</i> (L.) Roxb.	Arecaceae	7.14	3.57	1.96	0.21
<i>Prosopis ceneraria</i> (L.) Druce.	Fabaceae	7.14	1.79	1.21	0.04
<i>Prosopis juliflora</i> (Swartz.) DC.	Fabaceae	42.86	57.14	11.38	0.07
<i>Salvadora oleoides</i> Decne.	Salvadoraceae	7.14	1.79	1.11	0.004
<i>Sterculia urens</i> Roxb.	Sterculiaceae	7.14	3.57	1.9	0.20
<i>Wrightia tinctoria</i> (Roxb.) R. Br.	Apocynaceae	42.86	96.43	16.36	0.41
<i>Ziziphus mauritiana</i> Lam.	Rhamnaceae	7.14	1.79	1.16	0.02

Values F = Frequency; IVI = Importance Value Index