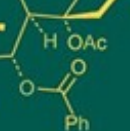
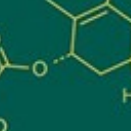
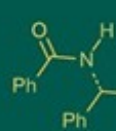
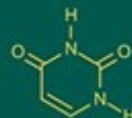


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Assessment of tree diversity indices and composition in urban green spaces of Rewa, Madhya Pradesh, India

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ABSTRACT

Urbanization causes substantial transformation of natural and semi-natural habitats and often results in the fragmentation, simplification and replacement of native vegetation. Urban green spaces therefore play an important role in maintaining plant diversity, ecological functions and ecosystem services within cities. The present study assessed the tree species diversity, abundance and structural composition of two urban green spaces, Site-I and Site-II, in Rewa city, Madhya Pradesh. The vegetation assessment revealed diverse and heterogeneous tree communities, with 61 species recorded at Site-I and a total tree density of 645 individuals ha⁻¹, while Site-II supported with 61 species with tree density of 625 individuals ha⁻¹. Considerable variation was observed among species in terms of density, basal area and Importance Value Index (IVI), indicating differences in their population abundance and structural contribution. At Site-I, *Azadirachta indica* and *Tectona grandis* were among the most abundant species, whereas *Mangifera indica*, *Ficus benghalensis*, *Tamarindus indica* and *Ficus religiosa* contributed substantially to basal area. *Ficus benghalensis* recorded the highest IVI (35.55), followed by *Mangifera indica* (18.50). At Site-II, *Tectona grandis* was the most abundant species with 35 trees, whereas *Ficus benghalensis*, despite having only five trees, exhibited the highest basal area (143.13 m² ha⁻¹), relative basal area (33.76) and IVI (35.20). Other structurally important species included *Ficus religiosa*, *Azadirachta indica*, *Dalbergia sissoo*, *Eucalyptus tereticornis* and *Acacia leucophloea*. The results demonstrate that urban green spaces of Rewa harbour considerable tree diversity and heterogeneous vegetation structure, where both species abundance and individual tree size contribute to ecological importance. The presence of numerous low-density species further indicates the potential of these urban green spaces for maintaining plant diversity and supporting urban biodiversity conservation.

Keywords: Urban green spaces, Tree diversity, Species richness, Phytosociology, Basal area, Importance Value Index, Rewa, Madhya Pradesh

1. Introduction

Urbanization is one of the most important drivers of contemporary landscape transformation. Natural and semi-natural habitats are progressively converted into residential areas, roads, commercial infrastructure and other built-up land uses to accommodate increasing human populations and associated economic activities. This transformation modifies the physical, biological and social characteristics of urban landscapes and frequently results in the reduction, fragmentation and simplification of vegetation. Urban green spaces consequently represent important remnants and deliberately created components of vegetation within otherwise highly modified environments. Parks, gardens, institutional campuses, roadside plantations, avenue plantations, playgrounds, cemeteries, vacant green areas and other vegetated patches collectively constitute an important component of urban green infrastructure. Urban vegetation performs a wide range of ecological and social functions. Trees and other plants can regulate local microclimates, intercept atmospheric pollutants, store carbon, reduce surface runoff, provide shade, moderate urban temperatures and contribute to recreational and aesthetic values (Tzoulas *et al.*, 2007; Nowak *et al.*, 2002) [2, 1]. Urban green spaces also provide habitat and food resources for birds, insects and other wildlife and may act as ecological stepping stones within fragmented urban landscapes (Threlfall *et al.*, 2016; Walker *et al.*, 2009) [3, 4]. The importance of urban green infrastructure is particularly relevant in the context of climate change because green spaces can contribute to climate adaptation, biodiversity conservation and ecosystem-service provision in cities (Tzoulas *et al.*, 2007) [2].

Plant diversity within urban environments is influenced by both natural ecological processes and human preferences. Urban vegetation frequently contains a mixture of native, introduced, ornamental and cultivated species. Studies of urban green spaces have demonstrated considerable variation in woody species richness, density and composition among different types of urban habitats (Muthulingam *et al.*, 2012; Threlfall *et al.*, 2016) [5, 3]. Although exotic plants can contribute to urban greening and aesthetic values, some introduced species may become invasive or alter ecological interactions with native organisms. Consequently, urbaniza-

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tion does not simply reduce vegetation cover; it can also produce substantial changes in species composition, abundance, dominance and community structure (Walker *et al.*, 2009) [4]. Urban parks and green spaces may therefore support heterogeneous assemblages of tree species resulting from historical land use, plantation programmes, natural regeneration and continued management (Nagendra *et al.*, 2011) [6]. The assessment of species richness and composition is therefore essential for understanding the ecological characteristics of urban green spaces. Biodiversity conservation within cities has become increasingly important because urban expansion can cause habitat loss and fragmentation and may alter the ecological conditions required by native species. Urban green spaces can retain elements of the original vegetation as well as provide opportunities for the establishment of additional plant species. Research in Indian cities has demonstrated substantial variation in tree diversity and species composition among urban green spaces, reflecting differences in habitat conditions, management history and human influence (Pandey *et al.*, 2018; Mishra *et al.*, 2021) [8, 7]. However, the ecological value of a green space depends not only on its area but also on vegetation structure, species composition, tree size, habitat complexity and management practices. The structural characteristics of urban vegetation are particularly important because trees constitute one of the major components of urban green infrastructure. Large and mature trees may provide disproportionately important ecological functions because of their greater canopy area, biomass, carbon storage and habitat availability (Stagoll *et al.*, 2012) [9]. At the same time, smaller trees, shrubs and ground vegetation contribute to vertical structural complexity and increase the range of resources available to urban organisms (Threlfall *et al.*, 2016) [3]. Thus, assessment of tree density, frequency, basal area and relative ecological importance provides useful information for understanding the structure and composition of urban vegetation. Phytosociological measures such as relative density, relative frequency, relative basal area and Importance Value Index (IVI) are particularly useful for identifying species that contribute most strongly to community structure.

Urban green spaces also have important implications for human well-being. They provide opportunities for recreation, relaxation and social interaction while contributing to environmental quality. A systematic review of urban green infrastructure research identified multiple ecosystem services associated with urban green spaces, including regulating, provisioning and cultural services, with health and social well-being being important dimensions of their contribution to urban populations (Tzoulas *et al.*, 2007) [2]. Similarly, research on urban vegetation indicates that trees are among the most frequently investigated vegetation components because of their diverse ecosystem-service functions, including carbon storage, microclimate regulation and environmental improvement (Nowak *et al.*, 2002) [1]. Studies from Indian cities have further emphasized the ecological and conservation significance of urban tree vegetation. For example, investigations in Bangalore documented substantial variation in street-tree density, diversity and composition (Nagendra *et al.*, 2010) [10], while studies of urban parks demonstrated changes in tree diversity, distribution and composition associated with urban development and management history (Nagendra *et al.*, 2011) [6]. These findings indicate that systematic assessment of urban vegetation is important not only for biodiversity documentation but also for understanding the ecological functions of urban green spaces. The issue is particularly relevant for Indian cities, where rapid urban growth has transformed land use and created increasing pressure on natural and semi-natural ecosystems. Indian urban areas face multiple environmental challenges, including air pollution, increasing temperatures, alteration of drainage patterns, loss of vegetation and habitat fragmentation. Studies conducted in different Indian urban centres have documented considerable diversity of trees and other plant species within urban green spaces, highlighting their role in maintaining urban biodiversity (Pandey *et al.*, 2018; Mishra *et al.*, 2021) [8, 7]. Research in Prayagraj, for instance, has documented diverse plant assemblages within urban green spaces and

emphasized the importance of these areas for conserving plant diversity in an increasingly urbanized environment (Mishra *et al.*, 2021) [7]. Similarly, assessments of tree species composition, biomass and carbon stocks in urban green spaces have demonstrated that urban trees can make substantial contributions to carbon storage and ecological functioning (Mishra *et al.*, 2022) [11]. Thus, urban green-space planning has become an important component of biodiversity conservation, climate adaptation and sustainable urban development.

Rewa is an important urban centre in northeastern Madhya Pradesh and forms part of the Vindhyan landscape. The district is characterized by diverse terrain and vegetation, while the city itself contains a mosaic of residential, institutional, recreational and roadside green spaces. Although the city contains numerous parks, institutional green areas, roadside plantations and other vegetated spaces, systematic information on their plant species composition and phytosociological characteristics is relatively limited. Such information is necessary to identify dominant and ecologically important species, recognize species-rich sites and understand the contribution of individual species to urban vegetation structure. Assessment of urban plant diversity can also provide a baseline for future monitoring. Species inventories can help identify native species that should be retained, species that are suitable for future urban plantation programmes, and species that contribute substantially to canopy development and structural complexity. The municipal administration of Rewa is actively involved in the development and maintenance of green spaces and horticultural areas, further highlighting the relevance of scientific information on urban vegetation composition for management planning. Therefore, the present study was undertaken to assess the plant species diversity and composition of selected urban green spaces of Rewa city, Madhya Pradesh. The study particularly aimed to document tree species richness and abundance and to evaluate important phytosociological attributes such as density, frequency, basal area, relative density, relative frequency, relative basal area and Importance Value Index (IVI). The resulting information is expected to provide a baseline for understanding urban vegetation structure and for developing strategies for biodiversity conservation and sustainable management of green spaces in Rewa.

2. Materials and methods

2.1 Study area

The present study was conducted in Rewa city, Madhya Pradesh, India, an important urban centre located in the northeastern part of the state. Geographically, Rewa lies within the Vindhyan landscape and is situated at approximately 24°32' N latitude and 81°15' E longitude, with an elevation of about 316 m above mean sea level. The city serves as the administrative headquarters of Rewa district and forms part of the Vindhyan Plateau region. Rewa district is located in the Baghelkhand region of Madhya Pradesh and is characterized by diverse physiographic features, including plains, hills, ravines and river valleys. The region experiences a subtropical climate, with hot summers and relatively cool winters. From an agroclimatic perspective, Rewa falls within the Kymore Plateau and Satpura Hills agroclimatic zone of Madhya Pradesh. The varied environmental conditions and urban landscape of the city provide a suitable setting for studying plant species diversity, composition and vegetation structure in urban green spaces.

2.2 Selection of study sites

Ten representative sampling sites were selected from two major urban green spaces of Rewa city, namely Laxmanbagh and the Awadhesh Pratap Singh University (APS University) Campus, for the assessment of plant species diversity and vegetation composition. The study sites were identified through preliminary field reconnaissance and systematic field visits to ensure adequate representation of the existing vegetation. The selected sites encompassed spatially distinct green patches within the two study areas and exhibited variation in vegetation characteristics, species composition and stand structure. These

sites were surveyed to document the floristic diversity, abundance and phytosociological characteristics of the existing tree vegetation.

2.3 Vegetation sampling and species identification

A random sampling approach was adopted to assess the tree vegetation within the selected urban green spaces. Vegetation sampling was carried out using quadrats measuring 20 m × 20 m, each covering an area of 400 m². A total of 132 quadrats were laid across the study sites to capture variations in tree species composition, abundance and distribution. Within each quadrat, all tree individuals were recorded and identified, and their diameter at breast height (DBH) was measured at 1.37 m above ground level. Trees with a DBH greater than 10 cm were included in the main tree vegetation assessment, while individuals with a DBH less than 10 cm were recorded separately as young or smaller tree individuals, wherever applicable.

Plant species encountered during the field investigations were identified on the basis of their morphological characteristics using standard

taxonomic literature, regional floras and relevant botanical references. Field identification was supplemented by consultation of authenticated botanical resources whenever necessary. The nomenclature of all recorded species was subsequently standardized to ensure consistency in the analysis. The identified species were evaluated in terms of their occurrence, abundance and contribution to the overall vegetation structure. Particular emphasis was placed on determining species that contributed substantially to tree density, frequency, basal area and overall ecological importance within the selected urban green spaces.

2.4 Phytosociological analysis

The vegetation data were analyzed using standard phytosociological procedures following the approach of Curtis and McIntosh (1950). The following parameters were calculated.

Density

Density was calculated as:

$$\text{Density} = \frac{\text{Total number of individuals of a species}}{\text{Total area sampled}}$$

The values were converted to individuals per hectare.

Frequency

Frequency was expressed as the percentage of sampling units in which a species occurred:

$$\text{Frequency (\%)} = \frac{\text{Number of quadrats in which species occurs}}{\text{Total number of quadrats}} \times 100$$

Basal Area

Basal area was estimated from the diameter at breast height:

$$BA = \frac{\pi D^2}{4}$$

where D represents DBH.

The basal area values were standardized to a per-hectare basis.

Relative Density

$$\text{Relative Density} = \frac{\text{Density of a species}}{\text{Total density of all species}} \times 100$$

Relative Frequency

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

Relative Basal Area

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

Importance Value Index

The ecological importance of individual species was assessed using the Importance Value Index:

$$\text{IVI} = \text{Relative Density} + \text{Relative Frequency} + \text{Relative Basal Area}$$

Species with higher IVI values were considered to have greater structural importance within the sampled vegetation.

3. Results

Vegetation assessment at Site-I

The vegetation assessment at Site-I revealed a diverse tree community comprising 61 recorded tree species. The total tree density was 645 individuals ha⁻¹, indicating a relatively well-represented woody vegetation structure. The recorded species exhibited considerable variation in frequency, abundance, basal area and relative ecological importance, reflecting differences in their distribution and dominance within the site. Among the recorded species, *Azadirachta indica* showed the highest density (35 individuals), followed by *Tectona*

grandis (35 individuals), while *Acacia leucophloea*, *Acacia nilotica* ssp. *indica*, *Adina cordifolia*, *Aegle marmelos*, *Ailanthus excelsa*, *Dalbergia sissoo*, *Eucalyptus tereticornis* and several other species also occurred with relatively high densities of 25 individuals. The density of most other species was considerably lower, generally ranging between 5 and 20 individuals.

In terms of basal area, *Mangifera indica* exhibited the highest basal area (314.4 m² ha⁻¹), followed by *Ficus benghalensis* (144.19 m² ha⁻¹) and *Tamarindus indica* (113.09 m² ha⁻¹). *Ficus religiosa* (95.56 m² ha⁻¹), *Tectona grandis* (56.55 m² ha⁻¹) and *Dalbergia sissoo* (53.99 m² ha⁻¹) also contributed substantially to the basal area of the stand. These species therefore represented an important component of the structural dominance of the vegetation. The relative frequency, relative density and relative basal area varied markedly among

species. *Azadirachta indica* recorded a relatively high relative frequency (5.43), relative density (8.90) and relative basal area (0.64), resulting in an IVI of 14.97. *Mangifera indica* showed an exceptionally high relative basal area (8.90) and an IVI of 18.50, whereas *Ficus benghalensis* recorded a relative basal area of 34.09 and the highest reported IVI of 35.55. *Ficus religiosa* also showed considerable structural importance, with an IVI of 14.22.

Several species occurred at low density and consequently contributed relatively little to stand-level dominance. Species such as *Annona squamosa*, *Anogeissus latifolia*, *Anthocephalus chinensis*, *Artocarpus heterophyllus*, *Bridelia retusa*, *Buchanania lanzan*, *Butea monosperma*, *Carissa carandas*, *Cordia dichotoma*, *Dicrostachys cinerea*, *Holarrhena antidysenterica*, *Jatropha curcas*, *Livistona chinensis*, *Saraca asoka*, *Terminalia bellirica* and *Thevetia peruviana*

were represented by approximately five individuals in the dataset and had comparatively low IVI values. The results indicate that the vegetation at Site-I was characterized by high species richness and uneven species dominance, with a few species—particularly *Ficus benghalensis*, *Mangifera indica*, *Tamarindus indica*, *Ficus religiosa*, *Tectona grandis* and *Dalbergia sissoo*—making substantial contributions to the structural characteristics of the stand. These differences may be due to the attribute of climate variability (Ogie-Odia *et al*, 2010). This finding could be attributed as a result of anthropogenic activities or due to the fact that the family of Fabaceae is the most common family found in the tropics and can be found in all the habitats within the regime as cited by Hadiza (2015). This finding is also far from what Muazu, (2010)

Table 4.1. Diversity analysis of tree species presents in Laxmanbagh (site 1)

S N	Tree species (Site-I)	FR	AB	DEN	B.A msq/qdrt	B.A msq/ha	RF	RD	RBA	IVI
1	<i>Acacia catechu</i>	10	1.0	0.1	0.05	2.65	1.55	1.37	0.31	3.23
2	<i>Acacia ferruginea</i>	5	1.0	0.05	0.03	0.64	0.78	0.68	0.15	1.61
3	<i>Acacia leucophloea</i>	25	1.6	0.25	0.06	12.31	3.88	5.48	0.36	9.72
4	<i>Acacia nilotica ssp. indica</i>	25	0.2	0.25	0.03	0.87	3.88	0.68	0.20	4.77
5	<i>Adina cordifolia</i>	25	0.2	0.25	0.20	4.91	3.88	0.68	1.16	5.72
6	<i>Aegle marmelos</i>	25	0.2	0.25	0.03	0.87	3.88	0.68	0.20	4.77
7	<i>Ailanthus excelsa</i>	25	0.2	0.25	0.13	3.14	3.88	0.68	0.74	5.30
8	<i>Albizia procera</i>	10	1.0	0.1	0.23	11.45	1.55	1.37	1.35	4.27
9	<i>Annona squamosa</i>	5	1.0	0.05	0.01	0.28	0.78	0.68	0.07	1.53
10	<i>Anogeissus latifolia</i>	5	1.0	0.05	0.13	3.30	0.78	0.68	0.78	2.24
11	<i>Anthocephalus chinensis</i>	5	1.0	0.05	0.08	2.01	0.78	0.68	0.48	1.94
12	<i>Artocarpus heterophyllus</i>	5	1.0	0.05	0.06	1.54	0.78	0.68	0.36	1.82
13	<i>Azadirachta indica</i>	35	1.9	0.35	0.11	34.94	5.43	8.90	0.64	14.97
14	<i>Bambusa bambos</i>	10	1.0	0.1	0.00	0.19	1.55	1.37	0.02	2.94
15	<i>Bridelia retusa</i>	5	1.0	0.05	0.08	2.01	0.78	0.68	0.48	1.94
16	<i>Buchanania lanzan</i>	5	1.0	0.05	0.08	1.89	0.78	0.68	0.45	1.91
17	<i>Butea monosperma</i>	5	1.0	0.05	0.08	1.89	0.78	0.68	0.45	1.91
18	<i>Callistemon viminalis</i>	5	1.0	0.05	0.05	1.33	0.78	0.68	0.31	1.77
19	<i>Carissa carandas</i>	5	1.0	0.05	0.00	0.07	0.78	0.68	0.02	1.48
20	<i>Cassia fistula</i>	10	1.0	0.1	0.15	7.60	1.55	1.37	0.90	3.82
21	<i>Cassia siamea</i>	5	1.0	0.05	0.06	1.54	0.78	0.68	0.36	1.82
22	<i>Citrus Spp.</i>	15	1.0	0.15	0.01	0.85	2.33	2.05	0.07	4.45
23	<i>Cordia dichotoma</i>	5	1.0	0.05	0.06	1.54	0.78	0.68	0.36	1.82
24	<i>Dalbergia sissoo</i>	25	2.2	0.25	0.20	53.99	3.88	7.53	1.16	12.57
25	<i>Delonix regia</i>	15	1.3	0.15	0.17	17.35	2.33	2.74	1.03	6.09
26	<i>Dicrostachys cinerea</i>	5	1.0	0.05	0.01	0.24	0.78	0.68	0.06	1.52
27	<i>Diospyros melanoxylon</i>	5	1.0	0.05	0.11	2.84	0.78	0.68	0.67	2.13
28	<i>Emblia officinalis</i>	10	1.0	0.1	0.04	1.90	1.55	1.37	0.22	3.14
29	<i>Eucalyptus tereticornis</i>	25	1.0	0.25	0.37	46.74	3.88	3.42	2.21	9.51
30	<i>Feronia elephantum</i>	10	1.0	0.1	0.35	17.63	1.55	1.37	2.08	5.00
31	<i>Ficus benghalensis</i>	5	1.0	0.05	5.77	144.19	0.78	0.68	34.09	35.55
32	<i>Ficus glomerata</i>	5	1.0	0.05	0.20	5.11	0.78	0.68	1.21	2.67
33	<i>Ficus infectoria</i>	5	1.0	0.05	0.22	5.52	0.78	0.68	1.30	2.76
34	<i>Ficus religiosa</i>	10	1.0	0.1	1.91	95.56	1.55	1.37	11.30	14.22
35	<i>Holarrhena antidysenterica</i>	5	1.0	0.05	0.04	0.95	0.78	0.68	0.22	1.68
36	<i>Holoptelea integrifolia</i>	5	1.0	0.05	0.25	6.16	0.78	0.68	1.46	2.92
37	<i>Jatropha curcas</i>	5	1.0	0.05	0.01	0.28	0.78	0.68	0.07	1.53
38	<i>Lagerstroemia parviflora</i>	5	1.0	0.05	0.13	3.30	0.78	0.68	0.78	2.24
39	<i>Leucaena leucocephala</i>	20	1.0	0.2	0.06	5.73	3.10	2.74	0.34	6.18
40	<i>Livistona chinensis</i>	5	1.0	0.05	0.04	0.95	0.78	0.68	0.22	1.68
41	<i>Madhuca indica</i>	5	1.0	0.05	0.48	11.95	0.78	0.68	2.82	4.28

(continued on next page)

S N	Tree species (Site-I)	FR	AB	DEN	B.A msq/qdrt	B.A msq/ha	RF	RD	RBA	IVI
42	<i>Mangifera indica</i>	25	2.6	0.25	0.97	314.4	3.88	8.90	5.72	18.50
43	<i>Mimusops elengi</i>	5	1.0	0.05	0.09	2.14	0.78	0.68	0.51	1.97
44	<i>Moringa oleifera</i>	5	1.0	0.05	0.19	4.71	0.78	0.68	1.11	2.57
45	<i>Nyctanthes arborescens</i>	5	1.0	0.05	0.06	1.43	0.78	0.68	0.34	1.80
46	<i>Peltophorum pterocarpum</i>	5	1.0	0.05	0.24	5.94	0.78	0.68	1.40	2.86
47	<i>Phoenix sylvestris</i>	15	1.3	0.15	0.06	6.16	2.33	2.74	0.36	5.43
48	<i>Pithecellobium dulce</i>	10	1.0	0.1	0.14	6.93	1.55	1.37	0.82	3.74
49	<i>Polyalthia longifolia</i>	5	1.0	0.05	0.11	2.84	0.78	0.68	0.67	2.13
50	<i>Pongamia pinnata</i>	25	1.6	0.25	0.13	26.40	3.88	5.48	0.78	10.14
51	<i>Psidium guajava</i>	10	1.0	0.1	0.03	1.27	1.55	1.37	0.15	3.07
52	<i>Pterocarpus marsupium</i>	5	1.0	0.05	0.17	4.34	0.78	0.68	1.03	2.49
53	<i>Saraca asoka</i>	5	1.0	0.05	0.04	0.95	0.78	0.68	0.22	1.68
54	<i>Shorea robusta</i>	5	1.0	0.05	0.30	7.55	0.78	0.68	1.78	3.24
55	<i>Syzygium cumini</i>	5	1.0	0.05	0.28	7.07	0.78	0.68	1.67	3.13
56	<i>Tamarindus indica</i>	15	1.3	0.15	1.13	113.09	2.33	2.74	6.68	11.75
57	<i>Tectona grandis</i>	35	1.1	0.35	0.28	56.55	5.43	5.48	1.67	12.58
58	<i>Terminalia arjuna</i>	5	1.0	0.05	0.50	12.57	0.78	0.68	2.97	4.43
59	<i>Terminalia bellirica</i>	5	1.0	0.05	0.08	2.01	0.78	0.68	0.48	1.94
60	<i>Thevetia peruviana</i>	5	1.0	0.05	0.01	0.13	0.78	0.68	0.03	1.49
61	<i>Ziziphus mauritiana</i>	5	4.0	0.05	0.03	2.54	0.78	2.74	0.15	3.67
	Total	645		6.45	16.92	1097	100	100	100	300

Vegetation assessment at Site-2

The vegetation analysis at Site-2 recorded a total of 625 trees ha⁻¹, representing a diverse assemblage of tree species. The overall abundance was 77.7, while the total basal area was 6.25 m² per quadrat and 16.9 m² ha⁻¹, indicating substantial variation in the structural contribution of individual species. Among the recorded species, *Tectona grandis* exhibited the highest density (35 trees), followed by *Acacia catechu*, *Acacia leucophloea* and *Leucaena leucocephala*, each with 25 trees. *Azadirachta indica*, *Dalbergia sissoo*, *Eucalyptus tereticornis*, *Mangifera indica*, *Pongamia pinnata*, *Thevetia peruviana* and *Ziziphus mauritiana* also showed relatively high densities of 20 trees each.

The structural dominance of the vegetation was not necessarily associated with the highest density. *Ficus benghalensis* recorded a relatively low density of 5 trees, but possessed a very high basal area of 143.13 m² ha⁻¹, resulting in the highest relative basal area (33.76) and the highest IVI (35.20) among the species recorded. This indicates that large-diameter individuals of *F. benghalensis* made a disproportionately large contribution to the overall stand structure. Similarly, *Ficus religiosa*, despite having only 5 trees, recorded a basal area of 47.17 m² ha⁻¹ and a relative basal area of 11.13, resulting in an IVI of 12.50. *Tectona grandis*, on the other hand, combined high density (35 trees) with a basal area of 62.34 m² ha⁻¹, relative density of 5.13 and relative basal area of 1.84, giving an IVI of 12.50. Thus, *T. grandis* represented an important species from the perspective of population density, whereas *F. benghalensis* was structurally dominant because of its large basal area.

Eucalyptus tereticornis also contributed substantially to the stand structure, with a density of 20 trees, basal area of 46.56 m² ha⁻¹ and IVI of 8.51. *Dalbergia sissoo* recorded a density of 20 trees, basal area of 37.16 m² ha⁻¹ and IVI of 8.94, while *Azadirachta indica* recorded a density of 20 trees, basal area of 32.25 m² ha⁻¹ and IVI of 11.53. These species therefore represented important components of the tree community in terms of both density and structural contribution. Species such as *Acacia catechu* and *Acacia leucophloea* had relatively high densities of 25 trees, with IVI values of 11.36 and 11.50, respectively. *Leucaena leucocephala* also had a density of 25 trees and an IVI of 7.54. Their relatively high densities indicate good representation within the sampled vegetation, although their structural dominance was lower than that of the major large-tree species. *Tamarindus indica* recorded a density of only 5 trees, but its relatively

large basal area (10.18 m² ha⁻¹) resulted in an IVI of 3.84. Likewise, *Terminalia arjuna* recorded 10 trees, a basal area of 19.24 m² ha⁻¹ and an IVI of 5.15, demonstrating that species with comparatively moderate densities can make appreciable contributions to stand structure through larger individual tree size.

A considerable number of species occurred at comparatively low densities of 5 trees, including *Acacia ferruginea*, *Acacia nilotica* ssp. *indica*, *Adina cordifolia*, *Aegle marmelos*, *Ailanthus excelsa*, *Anogeissus latifolia*, *Bauhinia purpurea*, *Bridelia retusa*, *Buchanania lanzan*, *Butea monosperma*, *Callistemon viminalis*, *Carissa carandas*, *Cassia fistula*, *Cassia siamea*, *Ficus benghalensis*, *Ficus glomerata*, *Ficus religiosa*, *Holarrhena antidysenterica*, *Holoptelea integrifolia*, *Jatropha curcas*, *Lagerstroemia parviflora*, *Livistona chinensis*, *Madhuca indica*, *Melia azadirach*, *Millingtonia hortensis*, *Mimusops elengi*, *Moringa oleifera*, *Nyctanthes arborescens*, *Peltophorum pterocarpum*, *Pithecellobium dulce*, *Polyalthia longifolia*, *Pterocarpus marsupium*, *Putranjiva roxburghii*, *Santalum album*, *Saraca asoka*, *Terminalia bellirica* and *Woodfordia fruticosa*. Most of these species showed relatively low IVI values, reflecting their limited contribution to overall stand dominance. Site-I exhibited a heterogeneous tree community characterized by a combination of high-density species and structurally dominant large trees. The results demonstrate that species abundance alone did not determine ecological importance; rather, basal area played a major role in determining IVI. In particular, *Ficus benghalensis* emerged as the most structurally important species, whereas *Tectona grandis* was the most abundant species. The coexistence of numerous low-density species with a smaller number of dominant species indicates a mixed and unevenly structured vegetation community at Site-2. This could be attributed to the fact that the species relationship and their pattern of richness are abundance in the study area as cited by (Young & Swiacki, 2006). This finding is similar to the findings of (Ihenyem et al, 2010)

4. Conclusion

The study revealed that the urban green spaces of Rewa support a diverse and structurally heterogeneous tree community, with substantial variation in species density, basal area and ecological importance between the two assessed sites. While *Tectona grandis* was among the most abundant species, *Ficus benghalensis* emerged as the most structurally dominant species at both sites because of the large size of its individuals and high basal-area contribution. The occurrence of

several low-density species alongside dominant and abundant trees indicates considerable floristic heterogeneity within the urban vegetation. These findings highlight the ecological importance of existing urban green spaces and emphasize the need for their systematic con-

servation, protection of mature trees and maintenance of diverse species composition to enhance urban biodiversity and ecosystem services in Rewa.

Table 4.2. Diversity analysis of tree species in APS University Campus (site 2)

S N	Tree species (Site-2)	FR	AB	DEN	B.A msq/qdrt	B.A msq/ha	RF	RD	RBA	IVI
1	<i>Acacia catechu</i>	25	2.2	0.25	0.05	14.60	4.00	7.05	0.31	11.36
2	<i>Acacia ferruginea</i>	5	1.0	0.05	0.03	0.71	0.80	0.64	0.17	1.61
3	<i>Acacia leucophloea</i>	25	2.2	0.25	0.08	20.75	4.00	7.05	0.45	11.50
4	<i>Acacia nilotica ssp. indica</i>	5	1.0	0.05	0.07	1.77	0.80	0.64	0.42	1.86
5	<i>Adina cordifolia</i>	5	1.0	0.05	0.20	4.91	0.80	0.64	1.16	2.60
6	<i>Aegle marmelos</i>	5	1.0	0.05	0.03	0.87	0.80	0.64	0.20	1.65
7	<i>Ailanthus excelsa</i>	5	1.0	0.05	0.13	3.14	0.80	0.64	0.74	2.18
8	<i>Albizia lebbek</i>	10	1.0	0.1	0.23	11.45	1.60	1.28	1.35	4.23
9	<i>Albizia procera</i>	10	1.0	0.1	0.34	17.10	1.60	1.28	2.02	4.90
10	<i>Annona squamosa</i>	10	1.0	0.1	0.01	0.57	1.60	1.28	0.07	2.95
11	<i>Anogeissus latifolia</i>	5	1.0	0.05	0.13	3.30	0.80	0.64	0.78	2.22
12	<i>Anthocephalus chinensis</i>	10	1.0	0.1	0.08	4.02	1.60	1.28	0.47	3.36
13	<i>Artocarpus heterophyllus</i>	10	1.0	0.1	0.06	3.08	1.60	1.28	0.36	3.25
14	<i>Azadirachta indica</i>	20	3.0	0.2	0.11	32.25	3.20	7.69	0.63	11.53
15	<i>Bombax ceiba</i>	10	1.0	0.1	1.31	65.35	1.60	1.28	7.71	10.59
16	<i>Bauhinia purpurea</i>	5	1.0	0.05	0.03	0.87	0.80	0.64	0.20	1.65
17	<i>Bauhinia racemosa</i>	15	1.0	0.15	0.02	1.51	2.40	1.92	0.12	4.44
18	<i>Bridelia retusa</i>	5	1.0	0.05	0.08	2.01	0.80	0.64	0.47	1.92
19	<i>Buchanania lanzan</i>	5	1.0	0.05	0.09	2.27	0.80	0.64	0.54	1.98
20	<i>Butea monosperma</i>	5	1.0	0.05	0.06	1.43	0.80	0.64	0.34	1.78
21	<i>Callistemon viminalis</i>	5	1.0	0.05	0.05	1.33	0.80	0.64	0.31	1.75
22	<i>Carissa carandas</i>	5	1.0	0.05	0.00	0.07	0.80	0.64	0.02	1.46
23	<i>Cassia fistula</i>	5	1.0	0.05	0.15	3.80	0.80	0.64	0.90	2.34
24	<i>Cassia siamea</i>	5	1.0	0.05	0.06	1.54	0.80	0.64	0.36	1.80
25	<i>Citrus Spp.</i>	10	1.0	0.1	0.03	1.73	1.60	1.28	0.20	3.09
26	<i>Cordia dichotoma</i>	5	1.0	0.05	0.06	1.54	0.80	0.64	0.36	1.80
27	<i>Dalbergia latifolia</i>	5	1.0	0.05	0.20	4.91	0.80	0.64	1.16	2.60
28	<i>Dalbergia sissoo</i>	20	1.8	0.2	0.21	37.16	3.20	4.49	1.25	8.94
29	<i>Delonix regia</i>	15	1.0	0.15	0.31	23.38	2.40	1.92	1.84	6.16
30	<i>Dicrostachys cinerea</i>	5	1.0	0.05	0.01	0.28	0.80	0.64	0.07	1.51
31	<i>Diospyros melanoxylon</i>	5	1.0	0.05	0.11	2.84	0.80	0.64	0.67	2.11
32	<i>Emblica officinalis</i>	5	1.0	0.05	0.04	0.95	0.80	0.64	0.22	1.67
33	<i>Eucalyptus tereticornis</i>	20	1.0	0.2	0.47	46.56	3.20	2.56	2.75	8.51
34	<i>Feronia elephantum</i>	5	1.0	0.05	0.31	7.79	0.80	0.64	1.84	3.28
35	<i>Ficus benghalensis</i>	5	1.0	0.05	5.73	143.13	0.80	0.64	33.76	35.2
36	<i>Ficus glomerata</i>	5	1.0	0.05	0.20	5.11	0.80	0.64	1.20	2.65
37	<i>Ficus infectoria</i>	10	1.0	0.1	0.21	10.62	1.60	1.28	1.25	4.13
38	<i>Ficus religiosa</i>	5	1.0	0.05	1.89	47.17	0.80	0.64	11.13	12.5
39	<i>Holarrhena antidysenterica</i>	5	1.0	0.05	0.04	0.95	0.80	0.64	0.22	1.67
40	<i>Holoptelea integrifolia</i>	5	1.0	0.05	0.25	6.16	0.80	0.64	1.45	2.89
41	<i>Jatropha curcas</i>	5	1.0	0.05	0.01	0.28	0.80	0.64	0.07	1.51
42	<i>Lagerstroemia parviflora</i>	5	1.0	0.05	0.13	3.30	0.80	0.64	0.78	2.22
43	<i>Leucaena leucocephala</i>	25	1.0	0.25	0.06	7.16	4.00	3.21	0.34	7.54
44	<i>Livistona chinensis</i>	5	1.0	0.05	0.04	0.95	0.80	0.64	0.22	1.67
45	<i>Madhuca indica</i>	5	1.0	0.05	0.11	2.84	0.80	0.64	0.67	2.11
46	<i>Mangifera indica</i>	20	1.0	0.2	0.18	18.09	3.20	2.56	1.07	6.83
47	<i>Melia azadirach</i>	5	1.0	0.05	0.08	1.89	0.80	0.64	0.45	1.89
48	<i>Millingtonia hortensis</i>	5	1.0	0.05	0.19	4.71	0.80	0.64	1.11	2.55
49	<i>Mimusops elengi</i>	5	1.0	0.05	0.08	2.01	0.80	0.64	0.47	1.92
50	<i>Moringa oleifera</i>	5	1.0	0.05	0.06	1.43	0.80	0.64	0.34	1.78

(continued on next page)

S N	Tree species (Site-2)	FR	AB	DEN	B.A msq/qdrt	B.A msq/ha	RF	RD	RBA	IVI
51	<i>Nyctanthes arborescens</i>	5	1.0	0.05	0.02	0.44	0.80	0.64	0.10	1.55
52	<i>Peltophorum pterocarpum</i>	5	1.0	0.05	0.24	5.94	0.80	0.64	1.40	2.84
53	<i>Phoenix sylvestris</i>	10	1.0	0.1	0.06	3.08	1.60	1.28	0.36	3.25
54	<i>Pithecellobium dulce</i>	5	1.0	0.05	0.14	3.46	0.80	0.64	0.82	2.26
55	<i>Polyalthia longifolia</i>	5	1.0	0.05	0.11	2.84	0.80	0.64	0.67	2.11
56	<i>Pongamia pinnata</i>	20	1.5	0.2	0.13	19.80	3.20	3.85	0.78	7.82
57	<i>Psidium guajava</i>	5	2.0	0.05	0.03	1.27	0.80	1.28	0.15	2.23
58	<i>Pterocarpus marsupium</i>	5	1.0	0.05	0.17	4.34	0.80	0.64	1.02	2.46
59	<i>Putranjiva roxburghii</i>	5	1.0	0.05	0.08	1.89	0.80	0.64	0.45	1.89
60	<i>Samanea saman</i>	10	1.0	0.1	0.03	1.27	1.60	1.28	0.15	3.03
61	<i>Santalum album</i>	5	1.0	0.05	0.04	1.04	0.80	0.64	0.24	1.69
62	<i>Saraca asoka</i>	5	1.0	0.05	0.06	1.43	0.80	0.64	0.34	1.78
63	<i>Syzygium cumini</i>	10	1.0	0.1	0.28	14.14	1.60	1.28	1.67	4.55
64	<i>Tamarindus indica</i>	5	1.0	0.05	0.41	10.18	0.80	0.64	2.40	3.84
65	<i>Tectona grandis</i>	35	1.1	0.35	0.31	62.34	5.60	5.13	1.84	12.5
66	<i>Terminalia arjuna</i>	10	1.0	0.1	0.38	19.24	1.60	1.28	2.27	5.15
67	<i>Terminalia bellirica</i>	5	1.0	0.05	0.01	0.33	0.80	0.64	0.08	1.52
68	<i>Thevetia peruviana</i>	20	1.3	0.2	0.01	0.80	3.20	3.21	0.04	6.44
69	<i>Woodfordia fruticosa</i>	5	1.0	0.05	0.02	0.38	0.80	0.64	0.09	1.53
70	<i>Ziziphus mauritiana</i>	20	1.8	0.2	0.02	3.97	3.20	4.49	0.13	7.82
	Total	625	77.7	6.25	16.9	739.8	100	100	100	300

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