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Floristic Composition and Diversity of Native and Naturalised Species in the Biodiversity Heritage Site of GKVK Campus, UAS, Bangalore

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Abstract

The study on floristic composition and diversity of flora in the heritage site of UAS, GKVK, Bengaluru revealed that the study site contains a total of 149 plant species belonging to 55 families which include 75 tree, 13 shrub, 59 herb and 2 climber species. The Shannon-Wiener Index (*H'*) and Simpson's diversity index (1-D) was found to be 3.53 and 0.95, respectively which shows that the study site is a species diverse system. Majority of the trees (51.59%) were in the girth class range of 30 cm to 60 cm and shows a reverse J shaped growth curve which indicates that the forests of the study site has good regeneration. Majority (28.43%) of the trees were found in the height range of 12 m to 15 m. Abundance to frequency ratio analyzed in the heritage site shows that all the woody species were contiguously distributed. Importance value index (IVI) analyzed show's that *Eucalyptus tereticornis* Sm. (58.01) and *Acacia auriculiformis* A. Cunn. ex Benth (38.64) were the dominant tree species. *Lantana camara* L. (8.15) - and *Ziziphus oenopolia* (L.) Mill. (7.34) were the major shrub species. *Panicum maximum* Jacq. (26.254), *Chromolaena odorata* (L.) R.M. King & H. Rob.(18.28) and *Mimosa pudica* L. (15.94) were the dominant herb species found in the study site. The study revealed that the biodiversity heritage site of GKVK campus is rich in species composition.

Keywords : Biodiversity, Heritage site, Diversity indices, Species composition

Biodiversity embraces variety and variability of life on earth. India is one of the seventeen mega biodiversity countries with only 2.4 per cent of the land area, India accounts for 8.1 per cent of the recorded species of the world. In India, 18 geographical sites had been declared as biodiversity heritage sites by National Biodiversity Authority (NBA) and there are four biodiversity heritage sites in Karnataka and University of Agricultural Sciences, GKVK, Bengaluru is one among them. The Gandhi Krishi Vignana Kendra is considered as one of the greenest areas in Bengaluru city. The campus is habitat to rich diversity (Subramanya and Nuthan, 2014). Biological diversity of this campus constitutes a repository of various forms of flora and fauna which needs to be protected and nurtured.

Karnataka Biodiversity Board in its meeting dated 08/09/2009 has declared GKVK campus as a heritage site under the section 37 (i) of the Biological Diversity Act, 2002. A total of 167 hectares in 14 patches are designated as biodiversity heritage site which consists of 40ha of scrub forest, 28 ha of parks and 99 ha of plantations & orchards. The biodiversity of the entire campus includes 113 species of mammals, 10 species of reptiles, 165 species of birds and 530 plant species which includes 70 species of medicinal plants, 6 rare plant species, 4 are endemic (deciduous forests) (Fathima *et al*., 1974). The campus with its valuable biodiversity is performing as a repository of diverse flora and fauna which also includes 196 species of butterflies as notified by Government of India No. FEE 132 ENV 2009 dated 02/08/2010. GKVK campus hosts scrub forest and a botanical garden along with plantations. GKVK has very high density of sandalwood trees with ideal condition for natural regeneration (Lakshmi *et al.,* 2015).

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The floristic composition and biodiversity studies can provide baseline information for monitoring and sustainable management of the biodiversity. It is essential to quantify the floristic composition and diversity of the campus for the future management. The present investigation provides essential background for formulating sustainable conservation of biodiversity in the biodiversity heritage site of GKVK.

Material and Methods

The study was carried out in the biodiversity heritage site of Gandhi Krishi Vigyana Kendra (GKVK), UAS Bangalore, GKVK is situated at an altitude of 924 meters above mean sea level. The annual rainfall ranges from 528 mm to 1374.4 mm with the mean 915.5mm. The study site records a maximum annual temperature of 29.3°C and minimum annual temperature of 17.9°C. 167 hectares of the total area of the campus in 14 patches has been designated as biodiversity heritage site and these 14 patches are named as area A (16 hectares), B (8 hectares), C (16 hectares), D (28 hectares), E1 (7 hectares), E2 (14 hectares), E3 (6 hectares), E4 (16 hectares), E5 (8 hectares), E6 (13 hectares), E7 (14 hectares), E8 (12 hectares), E9 (3 hectares) and E10 (6 hectares) which are spread across the campus (Karnataka Biodiversity Board notification, 2009). Out of these 14 patches area A, B and area C are natural forests and rest of the 10 designated are as contain cultivated or artificially planted species. This study was carried out during the winter season.

Random quadrat sampling method was used to study the floristic composition and species diversity. Quadrats of 20 m^2 ware laid in different spots of the study area. In each quadrat all the individuals with girth ≥ 30cm were identified and measured for their girth at breast height and height. Individuals with GBH less than 30cm and height more than 1m are considered as saplings and these are enumerated in 5m^2 sub plot in one corner of the main plot. In the same sub plot, shrubs were also enumerated. For herbs and seedlings (height is less than 1m) four subplots of 1m^2 were laid out on all corners of the main plot and individuals were enumerated. A total of 137 quadrats were laid in the study site for recording the floral biodiversity. Identification of the species was done with the help of local floras and comparing the voucher specimen with the collection in the herbarium, Mahatma Gandhi Botanical Garden, UAS, GKVK, Bengaluru.

Floristic composition was analysed using importance value index (IVI) by evaluating the relative frequency, relative dominance and relative density (Curtis and McIntosh,1951). Species diversity was studied using the community indices such as Shannon-wiener diversity (Shannon and Weiner, 1963) and Simpson's diversity indices (Simpson, 1949).

Importance value index is the sum of the average measure of relative dominance, relative frequency and relative density. The field data was evaluated for number of species and quantitative analysis of frequency; density per hectare and basal area per hectare and their values were calculated and added to get Importance Value Index (Mueller-Dombois and Ellenberg, 1974). Importance Value Index, is a measure of how dominant a species is in a given ecosystem.

$$\text{Importance value index (IVI)} = \text{Relative dominance} + \text{Relative frequency} + \text{Relative density}$$

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

$$\text{Relative dominance} = \frac{\text{Total basal area of the species in all quadrats}}{\text{Total number of basal areas of all the species in all quadrats}} \times 100$$

$$\text{Relative Density} = \frac{\text{Number of quadrats in which species is studied}}{\text{Total number of quadrats studied}} \times 100$$

The Shannon-winter deiversity index (*H'*) is a widely used diversity index in ecological literatures. It measures the order/disorder in a particular system.

$$H' = -\sum_{i=1}^{N} P_i \ln P_i$$

Where, n_i = Number of individuals of the i^{th} species

N = Total number of individuals

Simpson's diversity indices (D) is the probability that two randomly chosen individuals belong to two different species. Measures founded on the Simpson index have a figure of desirable properties (Lande, 1996). In Simpson's diversity index, 0 represents infinite diversity and 1, no diversity. That is, The bigger the value of D, the lower the diversity. This is neither intuitive nor logical, so to get over this problem, D is often subtracted from 1 to give 1-D. with 1-D, the value of this index also ranges between 0 and 1, but now, the greater the value, the greater the sample diversity.

$$D = \sum \frac{n_i (n_i - 1)}{N (N - 1)}$$

Where, n_i = Number of individuals of the i^{th} species

N = Total number of individuals

Girth class wise distribution of tree species and height relationship was calculated and compared to evaluate the structural composition in the study area. Girth was measured at GBH and height was measured at canopy level. Woody species was grouped among nine girth classes, they are, 30 to <60, 60 to <90, 90 to <120, 120 to <150, 150 to <180, 180 to <210, 210 to <240, 240 to <270 and >270 cm. Height classes considered are <3, 3 to <6, 6 to <9, 9 to <12, 12 to <15, 15 to <18, 18 to <21, 21 to 24 (Koushik *et al.,* 2014).

Distribution of woody species was evaluated using the ratio of abundance to frequency (Whitford, 1949). If the value occurs below 0.025: regular, 0.025 - 0.05: random and if > 0.05 contiguous (Cottam and Curtis, 1956).

Results and Discussion

The floristic composition of the study site was composed of herbs, shrubs, climbers and tree species. A total of 149 plant species belonging to 55 families were found in the study site which includes 59 herbs, (Table 1), 75 tree species (Table 2) and 13 shrub & 2 climbers (Table 3). The number of species (149)

Table 1

Herbaceous species composition of the heritage site of GKVK

Name of the Species	Family
Acanthospermum australe (Loefl.) Kuntze.	Asteraceae
Achyranthes aspera L.	Amaranthaceae
Ageratum conyzoides L.	Asteraceae
Alternanther abrasiliana (L.) Kuntze.	Amaranthaceae
Alternanthe rasessilis (L.) R.Br. ex DC.	Amaranthaceae
Aristida setacea Retz.	Poaceae
Bidens pilosa L.	Asteraceae
Blepharisma deraspatensis (L.) B.Heyne ex Roth.	Acanthaceae
Calypto carpusvialis Less.	Asteraceae
Cardiospermum halicacabum L.	Sapindaceae
Cassia hirsuta L.	Fabaceae
Cassia tora (L.) Roxb.	Fabaceae
Celastruspaniculatus Willd.	Celastraceae
Centothecalappacea (L.) Desv.	Poaceae
Centrosemapubescens Benth	Fabaceae
Chenopodiumvulvaria L.	Amaranthaceae
Chlorisbarbata Sw.	Poaceae
Chromolaenaodorata (L.) R.M.King & H.Rob.	Asteraceae
Commelinabenghalensis L.	Commelinaceae
Crassocephalumcrepidioides (Benth.) S.Moore.	Asteraceae
Crotalaria juncea L.	Fabaceae
Curcuma longa L.	Zingiberaceae
Cynodondactylon (L.) Pers.	Poaceae
Cyperusrotundus L.	Cyperaceae
Dactylisglomerata L.	Poaceae
Desmodiumpaniculatum (L.) DC.	Fabaceae
Digitariaciliaris (Retz.) Koeler	Poaceae
Hygrophilaerecta (Burm.f.) Hochr.	Acanthaceae
Eragrostis sp. L.	Poaceae
Erigeron bonariensis L.	Asteraceae
Euphorbia heterophylla L.	Euphorbiaceae
Heteropogoncontortus (L.) P.Beauv. ex Roem. &Schult.	Poaceae
Ichnocarpusfrutescens (L.) W.T.Aiton.	Apocynaceae
Indigoferahirsuta L.	Fabaceae
Ipomoea staphylina Roem. &Schult.	Convolvulaceae
Malvastrumcoromandelianum (L.) Garcke.	Malvaceae
Mimosa pudica L.	Fabaceae
Panicum maximum Jacq.	Poaceae
Panicumvirgatum Roxb. ex Steud.	Poaceae
Partheniumhysterophorus L.	Asteraceae
Paspalumdilatatum Poir.	Poaceae

Name of the Species	Family
Passiflorafoetida L.	Passifloraceae
Pennisetumpolystachion (L.) Schult.	Poaceae
Pennisetumsetaceum (Forssk.) Chiov.	Poaceae
Cenchrusstramineus (Peter) Morrone.	Poaceae
Peperomiamagnoliifolia (Jacq.) A.Dietr.	Piperaceae
Plumbagozeylanica L.	Plumbaginaceae
Portulacaoleracea L.	Portulacaceae
Richardiascabra L.	Rubiaceae
Sidacordata (Burm.f.) Borss.Waalk.	Malvaceae
Sidacordifolia L.	Malvaceae
Solanum nigrum L.	Solanaceae
Sorghum halepense (L.) Pers.	Poaceae
Sphagneticolatrilobata (L.) Pruski.	Asteraceae
Stylosanthesfruticosa (Retz.) Alston.	Fabaceae
Synedrellanodiflora (L.) Gaertn.	Asteraceae
Urenalobata L.	Malvaceae
Urochloalachnantha (Hochst.) A.M.Torres & C.M.Morton.	Poaceae
Vernoniacinerea (L.) Less.	Asteraceae

found in the present study was observed to be lower than the number of species reported by Fathima *et al*., 1974 where they recorded a total of 530 plant species in the entire GKVK campus. This may be because of the conversion of the lands of GKVK for the purpose of research and agriculture. This may also be due to the change in land use from natural forest to Agro-ecosystem, reduction of woody species and subsequent replacement by shrubs and weedy herbs. Floristic composition and diversity of the campus has been changed compared to early 1970's. Amulya (2012) observed that there was a change in vegetation cover in GKVK between 1970 to 2011 because of major forest destruction (about 48.14% of the total forest area) which occurred between 2001 to 2011. However, the number of species recorded in the present study was higher than the number of species recorded (135 species belonging to 45 families) by Tarakeswara *et al.,* 2018 in the deciduous forests of eastern Ghats of India which shows us that the species richness of the study site is higher than some deciduous forests of Eastern Ghats.

Shannon-Wiener Index of the study site was found to be 3.53. Shannon-Wiener Index values of 3.36, 2.07 and 2.87 was observed for herbs, shrubs and tree

TABLE 2
Tree species composition

Name of the Species	Family
Acacia auriculiformis A.Cunn. ex Benth.	Fabaceae
Ailanthus excelsa Roxb.	Simaroubaceae
Ailanthus malabarica DC.	Simaroubaceae
Albiziaamara (Roxb.) Boivin.	Fabaceae
Albizialebbeck (L.) Benth.	Fabaceae
Albiziaodoratissima (L.f.) Benth.	Fabaceae
Amooralawii (Wight) Bedd.	Meliaceae
Anacardiumoccidentale L.	Anacardiaceae
Andirainermis (W.Wright) DC.	Fabaceae
Annonamuricata L.	Annonaceae
Arengaobtusifolia Mart.	Arecaceae
Artocarpusheterophyllus Lam.	Moraceae
Azadirachtaindica A. Juss.	Meliaceae
Bauhinia purpurea L.	Fabaceae
Bauhinia variegata L.	Fabaceae
Broussonetiapapyrifera (L.) L'Hér. ex Vent.	Moraceae
Buteamonosperma (Lam.) Kuntze.	Fabaceae
Cassia fistula L.	Fabaceae
Cassia siamea Lam.	Fabaceae
Delonixregia (Bojer ex Hook.) Raf.	Fabaceae
Dilleniaindica L.	Dilleniaceae
Diospyrosmelanoxylon Roxb.	Ebenaceae
Diospyrosmontana B. Heyne ex A. DC.	Ebenaceae
Diospyros sp. L.	Ebenaceae
Dracaena reflexa Lam.	Asparagaceae
Enterolobiumcontortisiliquum (Vell.) Morong.	Fabaceae
Eucalyptus citriodora Hook.	Myrtaceae
Eucalyptus tereticornis Sm.	Myrtaceae
Ficusbenghalensis L.	Moraceae
Ficusbenjamina L.	Moraceae
Ficuskrishnae C.DC.	Moraceae
Ficusmollis Willd.	Moraceae
Ficustsjahela Burm.f	Moraceae
Ficusvirens Aiton.	Moraceae
Gliricidiasepium (Jacq.) Kunth.	Fabaceae
Gmelinaarborea Roxb. ex Sm.	Lamiaceae
Grevillearobusta A.Cunn. ex R.Br.	Proteaceae
Jacaranda mimosifolia D.Don.	Bignoniaceae
Lagerstroemia lanceolata Wight &Arn.	Lythraceae
Leucaenaleucocephala (Lam.) de Wit.	Fabaceae
Mangiferaindica L.	Anacardiaceae
Tapinanthusbangwensis (Engl.&K.Krause) Danser.	Loranthaceae
Manilkarazapota (L.) P.Royen.	Sapotaceae
Meliadubia Cav.	Meliaceae

Name of the Species	Family
Michelia × longifolia Blume.	-
Micheliachampaca L.	Magnoliaceae
Mimusopselengi Bojer.	Sapotaceae
Monoonfragrans (Dalzell) B.Xue& R.M.K.Saunders.	Annonaceae
Peltophorumpterocarpum (DC.) Backer ex K.Heyne.	Fabaceae
Perseaamericana Mill.	Lauraceae
Phyllanthusemblica L.	Phyllanthaceae
Phyllanthuspolyphyllus Willd.	Phyllanthaceae
Polyalthialongifolia (Sonn.) Benth. & Hook.f. ex Thwaites.	Annonaceae
Pongamiapinnata (L.) Pierre.	Fabaceae
Pritchardiapacifica Seem. & H.Wendl.	Arecaceae
Psidiumcattleyanum Sabine.	Myrtaceae
Psidiumguajava L.	Myrtaceae
Pterocarpusmarsupium Roxb.	Fabaceae
Pterygotaalata Thwaites.	Malvaceae
Santalum album L.	Santalaceae
Sapinduslaurifolius Balb. ex DC.	Sapindaceae
Schleicheraoleosa (Lour.) Oken.	Sapindaceae
Securinegaleucopyrus (Willd.) Müll.Arg.	Phyllanthaceae
Simaroubaglauca DC.	Simaroubaceae
Sterculiaurens Roxb.	Malvaceae
Swieteniamahagoni (L.) Jacq.	Meliaceae
Syzygiumcumini (L.) Skeels.	Myrtaceae
Syzygiumjambos (L.) Alston.	Myrtaceae
Syzygiumoperculatum (Roxb.) Nied.	Myrtaceae
Tamarindusindica L.	Fabaceae
Tectonagrandis L.f.	Lamiaceae
Terminaliaarjuna (Roxb. ex DC.) Wight &Arn.	Combretaceae
Terminaliabellirica (Gaertn.) Roxb.	Combretaceae
Terminaliatomentosa Wight &Arn.	Combretaceae
Xanthophyllumovatifolium Chodat.	Polygalaceae

species, respectively (Table 4). These values show that the study site is a species diverse system. The higher diversity indices reveal high plant diversity and abundance in the study site. The Shannon-Wiener Index found in the present study falls within the range of 0.67 to 4.86 reported in tropical forests of Indian sub-continent (Joshi & Shalini, 2018; Kumar *et al.,* 2010 and Panda *et al.,* 2013). Area D (2.90), C (2.78) and A (2.38) were found to be having the highest species diversity (Table 4). Area D (2.66) showed the highest herb diversity, area E5 (1.70) had the highest shrub diversity and area C (3.59) had the highest tree diversity (Table 5) in the study site.

TABLE 3

Shrub species and Climber species composition

Name of the Species	Family
Shrub species	
Bambusa vulgaris Nees.	Poaceae
Caesalpiniapulcherrima (L.) Sw.	Fabaceae
Calliandracalothyrsus Meisn	Fabaceae
Canthiumparviflorum Lam.	Rubiaceae
Durantaerecta L.	Verbenaceae
Ixora coccinea L.	Rubiaceae
Jasminumcuspidatum Rottler	Oleaceae
Lantana camara L.	Verbenaceae
Malpighia glabra L.	Malpighiaceae
Phoenix sylvestris (L.) Roxb.	Arecaceae
Scutiamyrtina (Burm.f.) Kurz.	Rhamnaceae
Ventilagobombaiensis Dalzell.	Rhamnaceae
Ziziphusoenopolia (L.) Mill.	Rhamnaceae
Climber Species	
Diplocyclospalmatus (L.) C.Jeffrey.	Cucurbitaceae
Plecospermumspinosum (Willd.) Trécul.	Moraceae

Simpson's index results show's that the study site exhibits high diversity with Simpson's diversity index (1-D) value of 0.95. Area D (0.92), Area C (0.88) and Area A (0.88), respectively shows the highest Simpson's diversity among the different areas of the heritage site (Table 1). Area D (0.91) had the highest herb diversity, area E5 (0.80) had the highest shrub diversity and area C (0.97) had the highest tree diversity (Table 5) compared to other areas of heritage site. Simpson's index results in the study site is similar to the Simpson index reported by Bajpai *et al.* (2017) in the moist deciduous forest of eastern Terai, India. Area C (H' = 2.78, 1-D = 0.88) which is a natural forest containing wild species shows the highest diversity compared to cultivated patches where planting has been taken up. Among the cultivated sites area E3 (H' = 2.35, 1-D = 0.88) exhibits the highest diversity (Table 4).

Eucalyptus tereticornis Sm. (IVI = 58.01) and *Acacia auriculiformis* A. Cunn. ex Benth (IVI=38.64) were the dominant tree species (Table 6). Highest contribution in IVI by dominant tree species was because of their greater basal area and high relative dominance. This reflects the ecological success of these species in the study area. Even though

TABLE 4

Shannon-Wiener and Simpson's Index for the different areas of the study site

Area of heritage site	Shannon-Wiener Index (*H'*)	Simpson's Index(1-D)
A	2.38	0.88
B	1.55	0.63
C	2.78	0.88
D	2.90	0.92
E1	1.27	0.63
E2	2.22	0.84
E3	2.35	0.88
E4	2.20	0.84
E5	2.26	0.87
E6	2.26	0.82
E7	1.88	0.62
E8	1.75	0.70
E9	1.58	0.77
E10	1.83	0.79
Entire study site	3.53	0.95

Santalum album L. shows high IVI value, its relative dominance was found to be very low because majority of the *Santalum album* L. present in the study site are still in the sapling stage. High Relative density and Relative frequency of *Santalum album* L. shows that it has good regeneration in the study site. Importance Value Index is essential to understand the plant community composition and the competitive ability of species in an ecosystem. On the basis of IVI values this forest community can be considered as *Eucalyptus tereticornis* Sm. and *Acacia auriculiformis* A. Cunn. ex Benth forest community. Panda *et al.,* 2013 reported that in Eastern Ghats, *Shorea robusta* C. F. Gaertn., *Lannea coromandelica* (Houtt.) Merr., *Madhuca indica* J. F. Gmel. and *Diospyros melanoxylon* Wild. were the dominant tree species which has a different forest community compared to heritage site of GKVK. Herbaceous species *Panicum maximum* Jacq. (IVI = 26.25), *Chromolaena odorata* (L.) R. M. King & H. Rob. (IVI=18.28) and *Mimosa pudica* L. (IVI=15.94) were the dominant herb

TABLE 5

Diversity indices for herbs, shrubs and tree species in different areas of the study site

Site Name	Diversity indices of Shrubs		Diversity indices of Herbs		Diversity indices of Trees	
	Shannon-Wiener Index	Simpson index	Shannon-Wiener Index	Simpson index	Shannon-Wiener Index	Simpson index
A	1.91	0.78	1.55	0.75	1.79	0.74
B	0.69	0.39	1.34	0.73	1.49	0.72
C	2.39	0.88	1.08	0.65	3.59	0.97
D	2.66	0.91	1.69	0.77	2.34	0.87
E1	1.33	0.69	-	-	-	-
E2	1.45	0.74	-	-	1.2	0.62
E3	1.83	0.82	-	-	1.61	0.78
E4	2.53	0.9	1.52	0.74	1.44	0.68
E5	2.5	0.9	1.7	0.8	1.68	0.78
E6	1.37	0.62	1.28	0.69	2.26	0.86
E7	1.4	0.67	1.37	0.7	2.62	0.92
E8	1.77	0.76	-	-	0.27	0.12
E9	1.96	0.76	-	-	-	-
E10	1.97	0.8	-	-	0.66	0.36
Entire study site	3.36	0.95	2.07	0.84	2.87	0.89

TABLE 6

Importance value index of major woody species

Name of the species	Relative Dominance	Relative Density	Relative Frequency	Importance Value index
Eucalyptus tereticornis Sm.	25.29	22.36	10.35	58.01
Acacia auriculi-formis A. Cunn. ex Benth.	17.75	13.07	7.81	38.64
Santalum album L.	1.00	12.05	9.77	22.82
Bambusa vulgaris Nees.	16.3	2.2	2.34	20.85
Mangifera indica L.	5.32	4.2	6.05	15.58
Jacaranda mimosifolia D. Don.	2.89	6.51	4.49	13.89
Tamarindus indica L.	5.2	2.68	4.49	12.37
Lantana camara L.	0.07	2.26	5.82	8.15
Ziziphus oenopolia (L.) Mill.	0.11	2.2	5.03	7.34
Pongamia pinnata (L.) Pierre.	1.28	1.78	3.02	6.08

species in the study site (Table 7). *Lantana camara* L. (IVI = 8.15) -and *Ziziphus oenopolia* (L.) Mill. (IVI = 7.34) were the major shrub species (Table 6). The 10 major woody species occupies 67.91 per cent of the IVI. Similar results were also recorded by Krishnamurthy *et al.* (2010) in the dry deciduous forests of Bhadra wildlife sanctuary where dominant species occupied 62 per cent of the Importance Value.

Girth class wise distribution of woody species in the heritage site shows that 51.59 per cent of the trees were in the girth class range of 30 cm to 60 cm (Table 8) and shows a reverse J. shaped growth curve

TABLE 7

Importance value index of major herbaceous species

Name of the species	Relative Density	Relative Frequency	Importance Value index
Panicum maximum Jacq.	13.18	13.08	26.25
Chromolaena odorata (L.) R.M. King & H. Rob.	9.16	9.13	18.28
Mimosa pudica L.	7.94	8	15.94
Panicum virgatum Roxb. ex. Steud.	7.94	7.71	15.66
Alternanthera sessilis (L.) R.Br. ex DC.	5.05	5.08	10.13
Parthenium hysterophorus L.	4.49	4.52	9.00
Cynodon dactylon (L.) Pers.	4.11	4.14	8.25
Cyperus rotundus L.	3.93	3.95	7.88
Pennisetum polystachion (L.) Schult.	3.08	3.1	6.19
Richardia scabra L.	3.13	3.01	6.14

TABLE 8

Girth class and height class distribution of woody species in the heritage site

Girth Class (cm)	Frequency in number	Percentage	Height Class (m)	Frequency in number	Percentage
30-60	632	51.59	1-3	222	12.16
60-90	444	36.24	3-6	439	24.05
90-120	80	6.53	6-9	126	6.90
120-150	38	3.10	9-12	255	13.97
150-180	18	1.46	12-15	519	28.43
180-210	7	0.57	15-18	181	9.91
210-240	4	0.32	18-21	80	4.38
240-270	1	0.08	21-24	3	0.16
>270	1	0.08			

which indicates that the forests of the study site has good regeneration. These results are in line with the results reported by Tarakeswara *et al*. (2018) in the deciduous forests of North-Central Eastern Ghats where majority of the tree species were represented in 31-60 cm girth class with 41 per cent of the individuals and trees showed a reverse J shaped curve. It was found that 28.43 per cent of the tree species in the study site had the height range of 12m to 15m (Table 8). Only 0.16 per cent of the trees were found to have the height more than 21m. This result is similar to the result reported by Tarakeswara *et al.* (2018) in the deciduous forests of Northcentral Eastern Ghats where majority of the species had the height class 5-15m.

Abundance to frequency ratio analyzed shows that all the woody species were contiguously distributed. According to Odum (1971) contiguous distribution is common in nature and formed as a result of small but significant variations in the ambient environmental conditions. He also reported that random distribution is found in very uniform environments only and regular distribution occurs where severe competition exists between individuals. Abundance to frequency results obtained in the present study is similar to the study conducted by Sahu *et al*. (2012) in dry deciduous forest of Malyagiri hill ranges. Thakur *et al*. (2020) reported that majority of western Himalayan trees also had contiguous distribution.

The study gives an insight into the floristic composition and diversity of the heritage site of GKVK Campus and also indicates the influence of changes in land use pattern around the natural habitat. Conservation of the biodiversity is a challenge. There is a need for comprehensive understanding of the diversity and species composition of an ecosystem for conservation and management. This work will provide baseline data for future conservation and management practices in the heritage site of GKVK.

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