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Assessment Of Tree Species Diversity And Community Structure In District Sonipat, Haryana

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Abstract

The present study was carried out in Sonipat district of Haryana and aim of the study was to present the scenario of Phytosociological analysis and diversity of various tree species with respect to the importance value index (IVI) .From study area 31 families (28 dicots, 1 monocot, and 2 gymnosperms) representing 57 genera and 62 species have been documented. In terms of the number of species, the Fabaceae family has been dominating with 13 genera and 14 species, followed by the Moraceae (2 genera and 6 species). Diversity indices, such as the Simpson index of dominance (Cd) 0.022, the Shannon Wiener index (H') 3.95, and the Pielou index for equitability (E) 0.956 recorded for trees, are determined by observed parameters. *Acacia nilotica* found to be most common tree species in the district Sonipat with the highest value of IVI (12.8) and minimum value observed for *Pithecellobium dulce* (1.2). In tree species, 27 species showed random distribution while the remaining 35 species showed contagious distribution Present study data match with Raunkiaer frequency value, indicates the distribution of tree species homogenous in nature. This study contributes to the appropriate knowledge of the tree species found in this region, which will helpful in the future planning of conservation initiatives.

Keywords: Trees, diversity, Sonipat, Density, frequency, abundance, A/F ratio

Introduction

Vegetation of an area tells us about the ecological process of any plant communities too. Plant communities of an area provide basic information on all ecological processes. So, plant communities are used as an environmental management unit and that is the reason for growing concern in applying phytosociological knowledge in nature conservation. The study of the qualitative and quantitative characters of any community helps environmental planners to make good strategies to maintain the ecosystem (Kumar *et al*., 2006). The growth and development of plants occurs in the form of communities in the present environment. Species diversity, structure and growth form are characteristic of every community. The analytical and synthetic characters are used to know the structure and composition of the plant community. Analytical characters are understood in open field areas. These are of two types: qualitative (such as floristic composition and physiognomy) and quantitative (density, frequency and abundance). Synthetic characters (presence, constancy and dominance depend upon data obtained from analytical characters.

It is assumed that no species found in any area can tell us about the adaptation capability of that community (Odum, 1971). Density helps to know the importance of each species in a community in any area. Frequency indicates the degree of dispersion of species in any area. Both density and frequency are important parameters to identify structure of a community. Numerical data help us to find the dominance species in the community. To identify the dominant species, there is a need to find the density, frequency and abundance of a species by using quadrat methods (Mahajan *et al*., 2017). For ecosystem stability most important tasks are to know the relationship of vegetation structure, composition and interaction among themselves. The study of quantitative characters such as density, frequency, diversity and richness of plants is helpful to understand the vegetation structure, composition and distribution pattern.

Material and methods

Study area's geographic location and climate:

On December 22, 1972, the Rohtak District was divided into District Sonipat, which is currently a portion of the Eastern Haryana Plain. It is located geographically between latitudes 28° 55' 42.8664" N and longitude 77° 5' 29.3712" E.

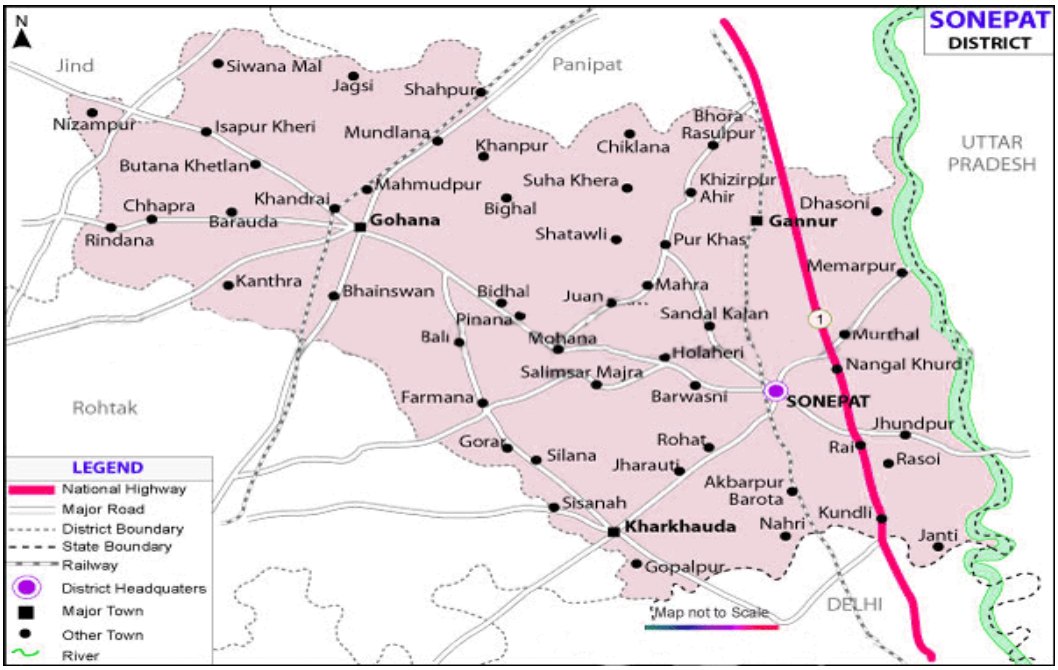

Figure 1: Study area

(www.sonipat district map)

Most of the district is plain, with sandy and loamy soil that is suitable for a variety of agricultural practices and forest cover. It's hottest in June. This place experiences a cold season that lasts from late November to the middle of March. The average yearly rainfall during the southwest monsoon season, which lasts from July to September, varies from year to year. The changes in the weather observed during this time period are good for growing vegetation cover.

Study sites and field visits

In November 2020 to August 2022, mostly, regular field trips were conducted. In order to carry out an systematic research, the study area was divided up into various zones and areas. To carry out the community analysis of trees throughout the district Sonipat, the study area was randomly divided into different small zones- Study Area-I (Gohana and adjoining villages), II (Pinana and adjoining villages) and III (Sonipat city and adjoining villages). These study sites cover the agricultural lands, natural habitats and ponds near the area, park, lawns and other localities in order to get maximum representation of the different trees species. Systematic field assessments of the vegetation were conducted on a regular basis, covering nearly entire district. Each plant was photographed in its natural habitat to give a true representation of the various plant species. Professor B.D. Vashistha of Kurukshetra University's Department of Botany, Dr. Surender Bhardwaj,

Superintendent of MDU, Rohtak's Botanical Garden, and Dr. Savina, Assistant Professor, BPSMV, identified the unidentified specimens. In order to study the different species of trees, thirty 10 x 10meter (100 square meter) quadrats were randomly arranged in order during each field visit in a different location. The help of flora, books and other literature in the library (Duthie, 1903-22, Maheshwari, 1963, Jain *et al*., 2000, Kumar, 2001) was taken for the identification of unidentified specimens. For additional authentication; virtual herbaria were used for various web resources.

Phytosociological analysis

For doing phytosociological anaylysis, the analytical characters (density, frequency, and abundance) were studied by using standard methodologies (Curtis & Mclntosh, 1950) and (Mueller- Dombois & Ellenberg, 1974) and were calculated by applying the given below formulas:

Analytical characters

(a)Density

$$\text{Density} = \frac{\text{Total number of individuals of a species in all sampling units}}{\text{Total no. of sampling units studied}}$$

(b) Abundance

$$\text{Abundance} = \frac{\text{Total number of individuals of a species in all sampling units}}{\text{Total number of sampling units in which species occurred}}$$

(c) Frequency

$$\text{Frequency} = \frac{\text{Total number of in sampling units which species occurred}}{\text{Total no. of sampling units studied}} \times 100$$

Synthetic characters

(a) Relative Density

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

(b) Relative Frequency

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

(c) Relative dominance

To calculate relative dominance, first the species' basal area is calculated. The basal area of a tree is its cross-sectional area or diameter (d) above the ground at a height of 1.3 meter (4.5 feet) (DBH). After calculating the diameter of the tree, the formula (3.14/4 x d x d) is used to calculate the basal area. Relative dominance is calculated by dividing the basal area of the tree by the total basal area of all trees and multiplying by hundred. The value of the basal cover determines relative dominance of a species

$$\text{Basal area} = \frac{3.14\ d \times d}{4}$$ Where d = DBH (Diameter at breast height)

$$\text{Relative Dominance} = \frac{\text{Total basal area of the species}}{\text{Total basal area of all the species}} \times 100$$

(d) Important Value Index (IVI)

To calculate the important value index, the values of relative density, frequency, and dominance is added (Ajayi *et al*., 2015).

Important Value Index (IVI) = Relative density + Relative frequency + Relative dominance

Species Richness and Evenness: Species diversity indices

Various indices such as the Shannon–Wiener index, Simpson index, Pielou's Evenness Index etc. are used to describe the various attributes of species diversity (Yeom *et al*., 2011)

A. Simpson's Diversity Index

This index denoted as D, and is calculated as:

$D = \Sigma (Ni/N)^2$

Simpson's Diversity Index is a way to measure the diversity of species in a community. The value of D ranges between 0 and 1. With this index, 0 represents infinite diversity and 1, represents no diversity. That is, the

bigger the value of D, the lower the diversity.

B. Shannon-Wiener Diversity Index (H')

Denoted as H', and is calculated as: $H' = - \sum Ni/N (\ln Ni/N)$

The Shannon-Wiener Diversity Index was developed from the information theory and is based on measuring uncertainty. The degree of uncertainty of predicting the species of random sample is related to the diversity of a community. If in a community has low diversity (dominated by one species), the uncertainty of prediction is low, but if diversity is high, uncertainty is high.The value of the Shannon-Weaver diversity index usually ranges from 1.5 to 3.5 and only rarely exceeds 4.5.

C. Pielou's Evenness Index (J)

Denoted as J, and is calculated as:

$J = H'/\ln (S)$

Pielou's evenness is an index that measures diversity along with species richness. While species richness is the number of different species in a given area, evenness is the count of individuals of each species in an area. A calculated value of Pielou's evenness ranges from 0 (no evenness) to 1 (complete evenness)

Results and Discussion:

The diversity of trees, shrubs and herbs in an area reflects the strength of species diversity and the degree of interaction with other associated living organisms in that particular area (Shukla *et al*., 2021). Phytosociology also known as plant sociology or Phytocoenology is a branch of study used to identify the group of plants which are present in groups. This branch is helpful to understand the dynamics of each plant species occurring in a specific community and their relationship to other species in the same community (Mishra *et al*., 2012). Floristic information is essential for conservation of biodiversity too (Uddin and Hassan, 2003). Keeping this in mind, the present study has been designed to study the floristic composition and phytosociology on the various parameters of plant communities in Sonipat city and its adjoining areas.

Table 1: List of tree species documented at study site

Sr. No.	Family	Species
	Dicots	
1	Anacardiaceae	*Mangifera indica* L. (Aam)
2	Annonaceae	*Polyalthia longifolia* (Sonn.) Thwaites (Ashoka)
3	Apocynaceae	*Alstonia scholaris* (L.) R.Br. (Saptaparni), *Cascabela thevetia* (L.) Lippold (Pili Kaner)
4	Bignoniaceae	*Haplophragma adenophyllum* (Wall.ex G.Don) Dop (Marodphali), *Kigelia africana* (Lam). Benth.(Balam khira), *Jacaranda mimosifolia* D.Don (Neela gulmohar)
5	Boraginaceae	*Cordia myxa* L. (Lasura)
6	Caricaceae	*Carica papaya* L. (Papita)
7	Casuarinaceae	*Casuarina equisetifolia* L. (Casuarina)
8	Combretaceae	*Terminalia arjuna* (Gaeth.) Roxb. (Arjun)
9	Ebenaceae	*Diospyros cordifolia* Roxb. (Kaindu)
10	Euphorbiaceae	*Jatropha integerrima* Jacq. (Jatropha), *Ricinus communis* L. (Castor oil plant)

11	Fabaceae	*Acacia auriculiformis* Benth (Auri), *Acacia nilotica* (L.) Willd ex Del Benth. (Kikar), *Albizia lebbeck* (L.) Beth.(Siris), *Bauhinia variegata* L.(kachnar), *Butea monosperma* (Lam.) Taub (Dhak), *Cassia fistula* L. (Amaltas), *Dalbergia sissoo* Roxb. (Shisham), *Delonix regia* (Hook. Raf. (Gulmohar), *Leucaena leucocephala* (Lam.) de Wit. (Subabul), *Pithecellobium dulce* (Roxb.) Benth. (Jungli jlabi), *Prosopis juliflora* (Sw.) DC. (Pahari kikar), *Pongamia pinnata* (L.) Pierre (Karanj), *Senna siamea* (Lam.) H.S Irwin & Barneby (Kassod), *Tamarindus indica* L. (Imli)
12	Malvaceae	*Bombax ceiba* L. (Cotton tree), *Pterospermum acerifolium* (L.) Willd. (Kanak champa)
13	Meliaceae	*Azadirachta indica* A Juss. (Neem), *Melia azedarach* L. (Bakain), *Cedrela toona* M. Roem. (Tuna)
14	Moraceae	*Ficus benghalensis* L. (Bargad), *Ficus carica* L. (Angir), *Ficus racemosa* L. (Gular), *Ficus religiosa* L. (Pipal), *Ficus virens* Aiton. (Pilkhan), *Morus alba* L. (Shahtoot)
15	Moringaceae	*Moringa oleifera* Lamk. (Moringa)
16	Myrtaceae	*Callistemon lanceolatus* (Sm.) Sweet (Bottle brush), *Eucalyptus coccifera* Hook. (Safeda), *Psidium guajava* L. (Amrud), *Syzygium cumini* (L.) Skeels (Jamun)
17	Oleaceae	*Nyctanthes arbor-tristis* L. (Har-singhar)
18	Phyllanthaceae	*Phyllanthus emblica* L. (Amla)
19	Proteaceae	*Grevillea robusta* A.Cunn.ex R.Br. (Silk Oak)
20	Putranjivaceae	*Putranjiva roxburghii* Wall. (Putranjia)
21	Rhamnaceae	*Ziziphus jujuba* Mill. (Ber)
22	Rosaceae	*Prunus persica* (L.) Stokes. (Aadu)
23	Rubiaceae	*Neolamarckia cadamba* (Roxb.) Bosser (Kadam)
24	Rutaceae	*Aegle marmelos* (L.) Correa (Bel), *Citrus limetta* Risso (Mousami) *Murraya koenigii* (L.) Spreng. (Karipatta)
25	Salicaceae	*Populus alba* L. (Poplar)
26	Simaroubaceae	*Ailanthus excelsa* Roxb. (Tree of heaven)
27	Sapotaceae	*Madhuca longifolia* (J.Konig) J.F.Macbr. (Mahua)
28	Verbenaceae	*Tectona grandis* L.f. (Sagwan)
	Monocots	
29	Arecaceae	*Roystonea regia* (Kunth) O.F. Cook (Royal palm), *Phoenix dactylifera* L. (Date palm)

	Gymnosperm	
30	Araucariaceae	*Araucaria angustifolia* (Bertol) Kuntze (Monkey puzzle)
31	Cycadaceae	*Cycas revoluta* Thunb (Cycas palm)

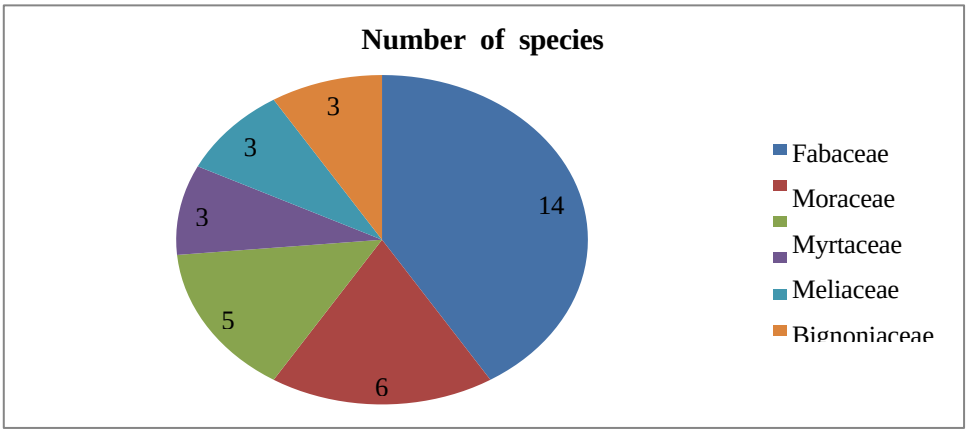

Figure 2: Dominant families of tree species

In terms of the number of species, the Fabaceae family has been dominating with 13 genera and 14 species, followed by the Moraceae (2 genera and 6 species),

Table 2: Average density, frequency, abundance, relative value, IVI value, A/F ratio and frequency class of tree species of district Sonipat

Sr.No	Name of Plant species	Density	Frequency (%)	Abundance	RD	RF	Relative Dominance	A/F	IVI	Frequency Class
1	*Acacia auriculiformis*	0.3	20	1.5	0.4	0.7	0.5	0.08	1.6	A
2	*Acacia nilotica*	5.1	90	5.6	6.5	3.3	3.1	0.06	12.9	E
3	*Aegle marmelos*	0.6	26	2.1	0.7	0.9	0.9	0.08	2.5	B
4	*Albizia lebbeck*	3.4	90	3.7	4.2	3.3	2.1	0.04	9.6	E
5	*Alstonia scholaris*	3.1	90	3.4	3.8	3.3	1.4	0.04	8.5	E
6	*Ailanthus excels*	0.3	19	1.7	0.4	0.7	2	0.09	3.1	A
7	*Araucaria angustifolia*	0.3	20	1.3	0.4	0.7	0.5	0.07	1.6	A
8	*Azadirachta indica.*	4.3	92	4.7	5.3	3.3	1.6	0.05	10.2	E
9	*Bombax ceiba*	0.1	11	1.1	0.1	0.4	3.8	0.10	4.3	A
10	*Bauhinia variegata*	0.8	38	2.1	1	1.4	0.3	0.06	2.7	B
11	*Butea monosperma*	0.8	38	2.1	1	1.4	0.8	0.06	3.2	B

12	*Callistemon lanceolatus*	1.1	51	2.2	1.4	1.8	2.3	0.04	5.5	C
13	*Carica papaya*	0.5	31	1.7	0.6	1.1	0.7	0.05	2.4	B
14	*Cascabela thevetia*	1.8	70	2.5	2.2	2.5	0.5	0.04	5.2	D
15	*Cassia fistula*	0.5	33	1.6	0.6	1.2	0.8	0.05	2.6	B
16	*Casuarina equisetifolia.*	0.2	15	1.5	0.2	0.5	0.9	0.10	1.6	A
17	*Cedrela toona*	0.9	36	2.5	1.1	1.3	0.5	0.07	2.9	B
18	*Citrus limetta*	0.7	36	2	0.9	1.3	1.1	0.06	3.3	B
19	*Cordia myxa*	0.2	19	1.3	0.2	0.7	0.9	0.07	1.8	A
20	*Cycas revoluta*	0.3	18	1.5	0.4	0.7	1.4	0.08	2.5	A
21	*Dalbergia sissoo*	4.6	90	5.1	5.7	3.3	2.3	0.06	11.3	E
22	*Delonix regia*	1.8	70	2.5	2.2	2.5	2	0.04	6.7	D
23	*Diospyros melanoxylon*	0.2	14	1	0.2	0.5	0.7	0.07	1.4	A
24	*Eucalyptus coccifera*	2.9	68	4.2	3.6	2.5	0.9	0.06	7	D
25	*Ficus benghalensis*	0.5	35	1.4	0.6	1.3	7.5	0.04	9.4	B
26	*Ficus carica*	0.2	16	1.2	0.2	0.6	0.7	0.08	1.5	A
27	*Ficus racemosa*	3.1	91	3.4	3.8	3.3	3.1	0.04	10.2	E
28	*Ficus religiosa*	1.2	54	2.3	1.5	2	6	0.04	9.5	C
29	*Ficus virens*	0.2	17	1.1	0.2	0.6	7.8	0.06	8.6	A
30	*Grevillea robusta*	0.8	37	2.2	1	1.3	0.3	0.06	2.6	B
31	*Haplophragma adenophyllum*	0.3	19	1.6	0.4	0.7	0.9	0.08	2	A
32	*Jacaranda mimosifolia*	0	1	0.2	0	0	0.8	0.20	0.8	A
33	*Jatropha integerrima*	1.1	51	2.2	1.4	1.8	0.7	0.04	3.9	C
34	*Kigelia Africana*	0.6	34	1.9	0.7	1.2	4.4	0.06	6.3	B
35	*Leucaena leucocephala*	2.4	71	3.3	3	2.6	0.9	0.05	6.5	D

36	*Madhuca longifolia*	0.3	19	1.3	0.4	0.7	1.1	0.07	2.2	A
37	*Mangifera indica*	1	46	3.2	1.2	1.7	2	0.07	4.9	C
38	*Melia azedarach*	3.4	90	3.6	4.2	3.3	1.6	0.04	9.1	E
39	*Moringa oleifera*	0.5	30	1.6	0.6	1.1	2.3	0.05	4	B
40	*Morus alba*	1.3	51	2.5	1.6	1.8	1.4	0.05	4.8	C
41	*Murraya koenigii*	0.4	20	2	0.5	0.7	1.1	0.10	2.3	A
42	*Neolamarckia cadamba*	0.8	38	1.9	1	1.4	0.8	0.05	3.2	B
43	*Nyctanthes arbor-tristis*	0.3	20	1.6	0.4	0.7	0.6	0.08	1.7	A
44	*Phoenix dactylifera*	1	47	2.1	1.2	1.7	1.4	0.04	4.3	C
45	*Phyllanthus emblica*	1	50	2	1.2	1.8	0.5	0.04	3.5	C
46	*Pithecellobium dulce*	0.2	13	1.3	0.2	0.5	0.5	0.10	1.2	A
47	*Pongamia pinnata*	2.9	58	5	3.6	2.1	1.3	0.09	7	C
48	*Populus alba*	0.9	34	2.4	1.1	1.2	0.9	0.07	3.2	B
49	*Polyalthia longifolia*	1.7	40	3.6	2.1	1.4	0.5	0.09	4	B
50	*Prosopis juliflora*	4.4	85	5	5.5	3.1	2	0.06	10.6	E
51	*Prunus persica*	0.3	20	1.6	0.4	0.7	0.9	0.08	2	A
52	*Psidium guajava*	1.3	54	2.5	1.6	2	1.1	0.05	4.7	C
53	*Pterospermum acerifolium*	0.3	20	1.5	0.4	0.7	1	0.08	2.1	A
54	*Putranjiva roxburghii*	1	50	1.9	1.2	1.8	2.9	0.04	5.9	C
55	*Ricinus communis*	2.5	70	3.5	3.1	2.5	0.6	0.05	6.2	D
56	*Roystonea regia*	1.6	49	3.2	2	1.8	2	0.07	5.8	C
57	*Senna siamea*	2.8	90	3.1	3.5	3.3	1.1	0.03	7.9	E
58	*Syzygium cumini*	1.5	70	2.1	1.9	2.5	0.7	0.03	5.1	D
59	*Tamarindus indica*	0.8	49	1.6	1	1.8	0.4	0.03	3.2	C

60	*Tectona grandis*	1.2	48	2.5	1.5	1.7	0.6	0.05	3.8	C
61	*Terminalia arjuna*	1.3	52	2.4	1.6	1.9	1.4	0.05	4.9	C
62	*Ziziphus jujuba*	0.6	36	1.8	0.7	1.3	4.4	0.05	6.4	B

Basal area for tree species

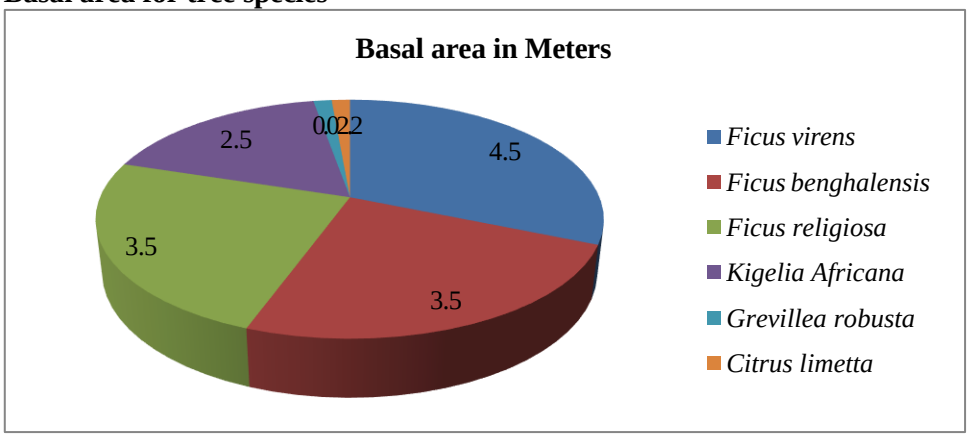

Figure 3: Basal area for tree species

Ficus virens has the highest basal area in metres (4.5) followed by *Ficus benghalensis* (3.5), *Ficus religiosa* (3.5), *Ziziphus mauritiana* (2.5), *Kigelia Africana* (2.5), *Bombax ceiba* (2.2) . The *Grevillea robusta* and *citrus limetta* have the lowest basal area value of 0.2.

IVI value for dominant tree species

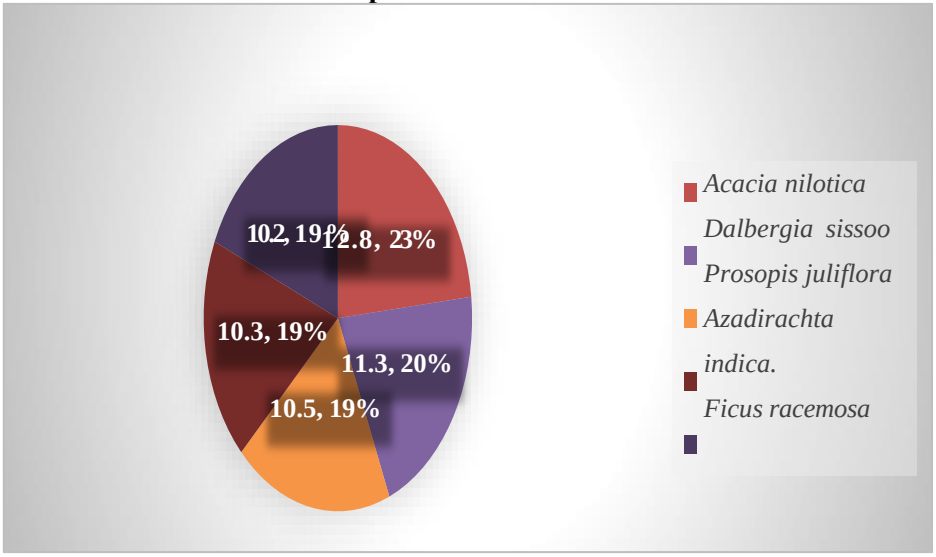

Figure 4: IVI value for dominant tree species

For knowing the complete dominating species in any area, it is important to know about the Important Value Index (IVI). According to data generated, it has been found that *Acacia nilotica* the most common tree species in the district Sonipat with the highest value of IVI (12.8). *Delbergia sissoo* (11.3), the next-highest value species, followed by *Prosopis juliflora* (10.5), *Azadirachta indica* (10.3) and *Ficus racemosa* (10.2). *Pithecellobium dulce* (1.2) which is found in a few villages only, and *Jacaranda mimosifolia* (0.8), which is only found as one or two species in Sonipat city.

Frequency class of tree species

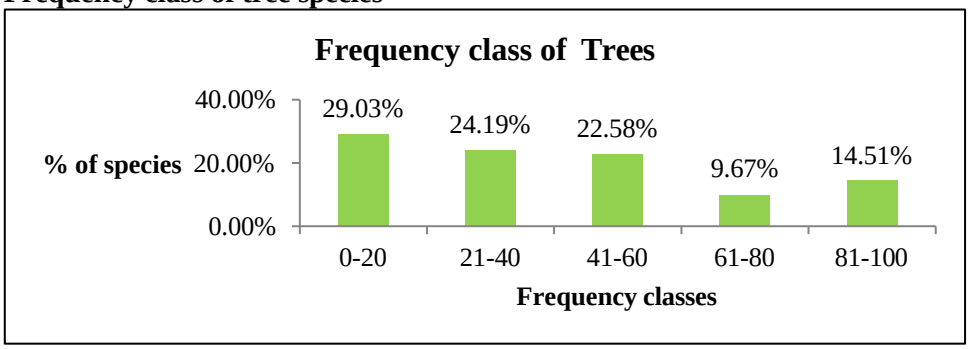

Figure 5: Frequency class of tree species

Total number of tree species that belong to frequency class A (18), B (15), C (14), D (6) and E (9). Present study data match with Raunkiaer frequency value, indicates the distribution of tree species homogenous in nature.

Distribution pattern of tree species (Spatial distribution)

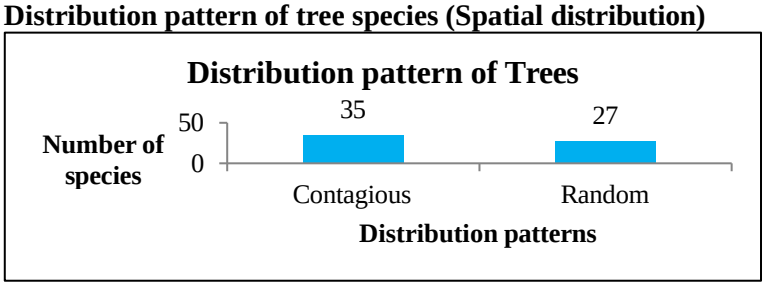

Figure 6: Distribution pattern of tree species

In tree species, 27 species showed random distribution while the remaining 35 species showed contagious

distribution (Fig 6). Contagious distribution is a highly common type of distribution in plants due to the clustering of individuals around their parents (for vegetative reproduction, poor seed dispersal) (Singh, 2006).

Area wise comparison of dominated tree species

Table 3: Comparison of density, frequency and abundance of five dominant tree species present in three areas of district Sonipat

Name of species		Villages of district Sonipat(Area I,II and III)		
	Density, Frequency and abundance	Average value for Gohana, Barota, Baroda, Butana	Average value for Pinana, Mohana, Khanpur	Average value for Sonipat, Murthal, Barwasni
Acacia nilotica	D	5.8	5.2	4.2
	F	90	90	90
	A	6.1	5.8	4.6
Azadirachta indica.	D	4.8	4.2	3.9
	F	92.5	93.3	90
	A	5.2	4.5	4.2
Dalbergia sissoo	D	5.2	4.8	3.7
	F	90	90	90
	A	5.7	5.3	3
Melia azedarach	D	3.7	3.3	3
	F	90	90	90
	A	3.9	3.6	3.3
Prosopis juliflora	D	5	4.9	3.3
	F	90	90	73.3
	A	5.5	5.4	3.9

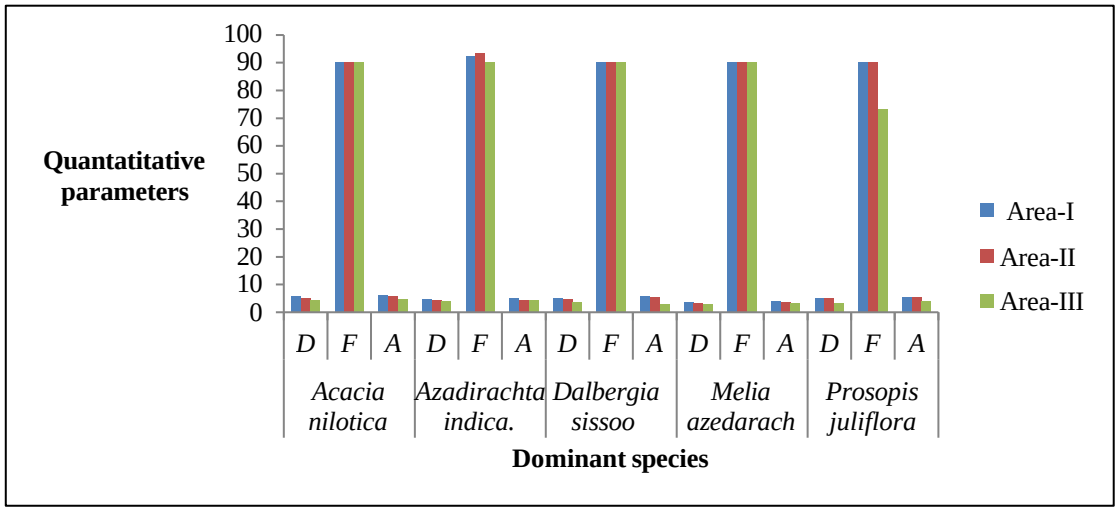

Figure 7: Comparative data for dominant tree species

At study area, maximum values for density, frequency, and abundance has been recorded for *Acacia nilotica*, *Dalbergia sissoo*, *Melia azedarach*, and *Prosopis juliflora Azadirachta indica*,, in Area-I (Gohana and its neighbouring villages) and Area –II (Pinana and its adjacent villages) but these species number found to be less in Area –III (Sonipat City and its nearby villages) as compared to other areas.

Species richness Indices

Simpson's Diversity Index (D), Shannon Wiener Index (H') and Pielou's Evenness (J) indices

In the current study, the value of Simpson Index is 0.022, Shannon index is 3.95 for trees, indicating more diversity for trees. The value for Pielou index is 0.956, reflecting even distribution of all tree species at study site.

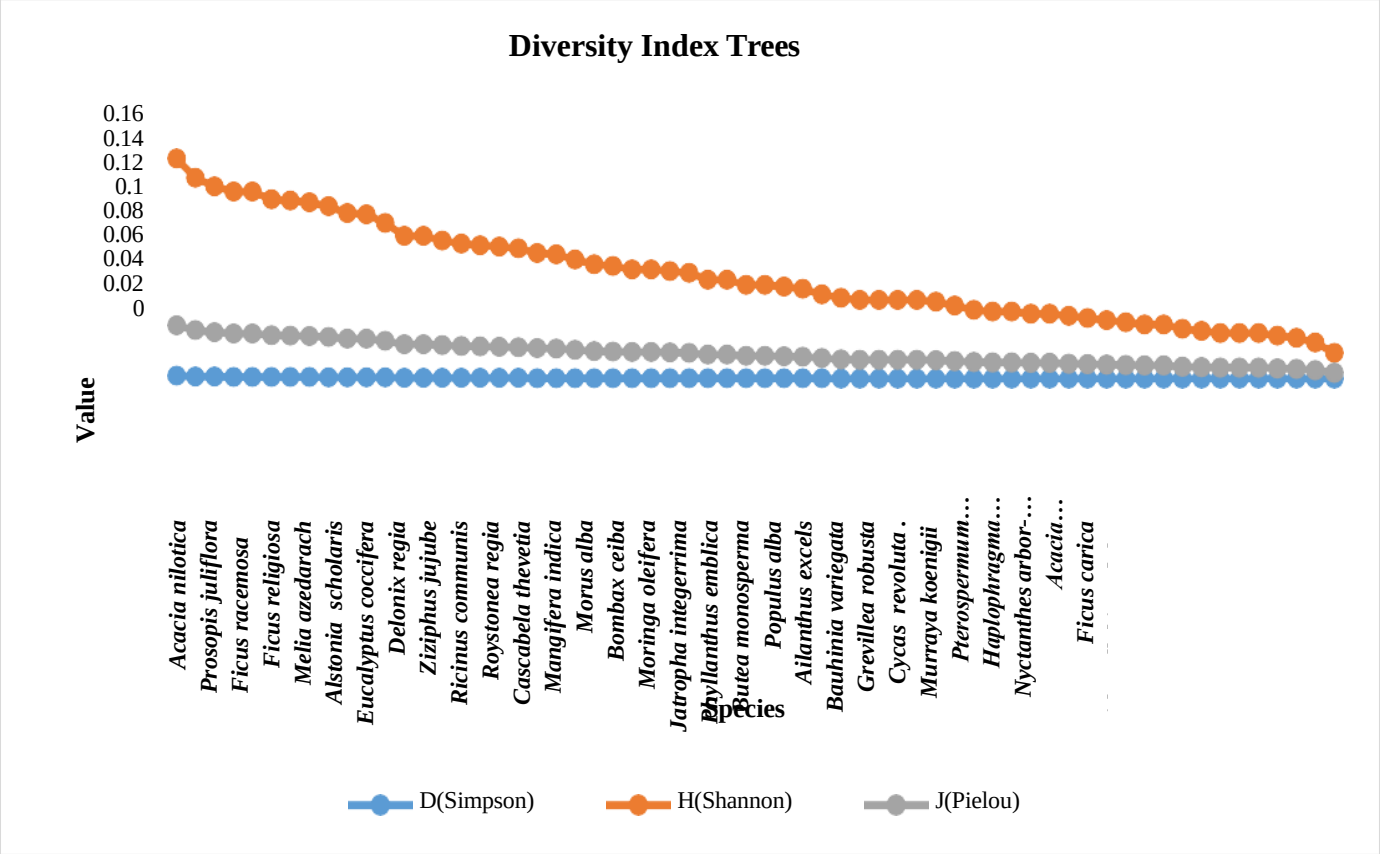

Figure 8: Species richness Indices Conflict of interests: Authors declare no conflict of interests.

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