



Vegetation Analysis Of Shrub Species In District Sonipat Haryana, India

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Abstract

In the present study, community analysis of shrub species in terms of diversity, density, frequency and abundance in District Sonipat, Haryana has been done by quadrat methods. At every study site, 30 quadrats of 10 m x 10 m (100 sq m) size were laid. From the study area, 35 shrub species (24 ornamental and 11 wild) have been documented that belong to twenty two families (18 dicots, 3 monocots and 1 gymnosperm) constituting 35 species and 32 genera. Euphorbiaceae has been found to be the most dominant family (2 genera, 4 species), followed by Apocynaceae (3 genera, 3 species). In comparative analysis of IVI value, *Bougainvillea spectabilis* (7.2) have been found to be dominant species among all shrubs found in the studied area. The minimum IVI value was observed for the species *Capparis sepiaria* and *Barleria prionitis* (0.5). On distribution pattern, the 24 species showed contagious distribution (> 0.05) whereas the remaining 11 species in the study area, showed random distribution, (0.025-0.05). The Unmatch of class distribution of Shrub vegetation of district Sonipat with Raunkier frequency law diagram document the heterogenous nature of Shrub community. In the current study, the value of Simpson Index is 0.038, Shannon index is 3.38 for shrubs indicating diversity of shrubs. The value for Pielou index is 0.951 reflecting even distribution of all the species at study site.

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Keywords: Shrub, Sonipat, Density, frequency, abundance, A/F ratio

Introduction

Plant diversity of an area helps to assess the plant wealth and its potentiality of any given area (Panda *et al.*, 2014). Floristic studies are helpful to find data about any plant group taxonomically as well as ethnobotanically. Floristic inventory helps to find the vegetation of any area, important to understand and to conserve biodiversity of that area. The knowledge of floristic composition is important to know the overall structure and functioning of the ecosystem. For proper assessment smaller areas provide better outputs as they can be thoroughly investigated (Kaur *et al.*, 2016). Documentation of vegetation is an important method to get the information about the floristic diversity of any region and to know about the basic knowledge of local area vegetation. 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). Based on relative density, relative frequency, relative dominance and IVI value we can identify richly and poorly established plant species (Theertha *et al.*, 2021).

Material and methods

Geographical location and climatic condition of study area: On December 22, 1972, the Rohtak District was divided into District Sonapat, which is now a part of the Eastern Haryana Plain. Geographically, it lies between latitudes 28° 55' 42.8664" N and longitude 77° 5' 29.3712" E. The districts of Panipat, Jind, and Rohtak surround the district from the north, west, and south-west, respectively, within the state boundary. Delhi and Uttar Pradesh border it on the east and south respectively. With its loamy and sandy soil texture, the majority of the district is plain and ideal for both forest cover and various agricultural practices. June is the warmest month. The cold season here starts by late November and extends up to the middle of March month. During the southwest monsoon season, from July to September, the annual rainfall varies (average 653 mm) from year to year. The weather conditions recorded in this period are most suitable for growing vegetation cover of shrubs (<https://sonipat.gov.in/>).

Study sites and field visits

In November 2020 to August 2022, mostly, regular field trips were conducted. In order to carry out a systematic research, the study area was divided up into various zones and areas.

Table 1: Study site (covered area) of district Sonipat

Sonipat district Area: 2,13080 ha				
Sr.no	Small zones	Name of area	Study site Land area	Total Area covered (ha) 34,448
1	Area –I	Gohana and adjoining villages (as Baroda, Butana, Barota)	4 Parks, General land area	8700
2	Area –II	Pinana and adjoining villages (as Khanpur, Mohana)	2 parks General land area	4365
3	Area-III	Sonipat city and adjoining villages (as Barwasni, Murthal)	7 parks, general land area	21,383

In order to cover almost the entire district, extensive field assessments of the vegetation were regularly carried out. To provide an accurate representation of the different plant species, every plant was photographed in nature. Unidentified specimens were identified by Professor B.D. Vashistha of Kurukshetra University's Department of Botany, Dr. Surender Bhardwaj, Superintendent of the Botanical Garden at MDU, Rohtak, and Dr. Savina, Assistant Professor, BPSMV. During each field visit in a distinct location, thirty quadrats, each measuring 10 × 10 m (100 sq. m) in size, were placed in order at random to study the shrub species.

Phytosociological analysis

For doing phytosociological analysis, the analytical characters (density, frequency, and abundance) were studied by using standard methodologies (Curtis & McIntosh, 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

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

Synthetic characters**(a) Relative Density**

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

(b) Relative Frequency

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

(c) Important Value Index (IVI)

The IVI was calculated from the herbaceous data by adding the relative frequency and density for each species and dividing by two. The following formulae were used in the calculation (Abba, 2015 and Abba et al., 2021)

$$\text{Importance Value Index (IVI)} = \frac{\text{Relative Density} + \text{Relative Frequency}}{2}$$

Species Richness and Evenness: Species diversity indices**A. Simpson's Diversity Index**

This index denoted as D, and is calculated as:

$$D = \sum (N_i / N)^2$$

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:

$$H' = - \sum N_i / N (\ln N_i / N)$$

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:

Data generated has been represented in the form of tables, graphs and charts. Name and total number of species as per family has been represented in table 2.

Table 2. List of shrub species documented at study site

Sr.no	Family	Species
	Dicots	
1	Acanthaceae	<i>Adhatoda vasica</i> (L.) Nees. (Vasa), <i>Barleria prionitis</i> L. (Kala bansa)
2	Apocynaceae	<i>Plumeria alba</i> L. (Plumeria), <i>Nerium oleander</i> L. (Kaner), <i>Tabernaemontana divaricata</i> (L.) R. Br. ex Roem. & Schult. (Chandni)

3	Asclepiadaceae	<i>Calotropis procera</i> (Aiton) R.Br. (Aak), <i>Calotropis gigantea</i> (L.) W.T.Aiton (Safed aak)
4	Asteraceae	<i>Helianthus annuus</i> L. (Surajmukhi)
5	Bignoniaceae	<i>Tecoma stans</i> (L.) Juss.Ex. Kunth (Piliya)
6	Cactaceae	<i>Opuntia monacantha</i> (Willd) Haw. (Common Prickly pear)
7	Capparaceae	<i>Capparis sepiaria</i> L. (Hins)
8	Euphorbiaceae	<i>Codiaeum variegatum</i> (L.) A.Juss (Fire croton), <i>Euphorbia royleana</i> Boiss. (Danda thor), <i>Euphorbia tirucalli</i> L. (Pencil plant), <i>Euphorbia tithymaloides</i> L. (Christmas candle)
9	Lythraceae	<i>Punica granatum</i> L. (Anar), <i>Lawsonia inermis</i> L. (Mehandi)
10	Malvaceae	<i>Abutilon indicum</i> (L.) Sweet (Kanghi), <i>Hibiscus rosa sinensis</i> L. (Gurhal)
11	Nyctaginaceae	<i>Bougainvillea spectabilis</i> Willd. (Bougainvillea)
12	Oleaceae	<i>Jasminum officinale</i> L. (Jasmine)
13	Rhamnaceae	<i>Ziziphus nummularia</i> (Burm.f.) Wight& Arn. (Jhar)
14	Rosaceae	<i>Rosa indica</i> L. (Gulab)
15	Rubiaceae	<i>Hamelia patens</i> Jacq. (Firebush), <i>Ixora coccinea</i> L. (Rugmini)
16	Rutaceae	<i>Citrus limon</i> (L.) Osbeck (Nimbu), <i>Murraya paniculata</i> (L.) Jack (Kamini)
17	Solanaceae	<i>Withania somnifera</i> (L.) Dunal (Ashwagandha), <i>Cestrum nocturnum</i> L. (Raat ki rani)
18	Verbenaceae	<i>Lantana camara</i> L. (Raimuniya)
Monocots		
19	Arecaceae	<i>Rhapis excelsa</i> (Thunb.) A. Henry (Lady palm)
20	Asparagaceae	<i>Agave americana</i> L. (Century plant), <i>Furcraea foetida</i> (L.) Haw. (Green aloe)
21	Cannaceae	<i>Canna glauca</i> L. (Keli)
22	Cupressaceae	<i>Thuja plicata</i> Donn ex D.Don (Morpankhi)

Twenty two families (18 dicots, 3 monocots, and 1 gymnosperm) constituting 35 species and 32 genera of shrub species have been recorded from the study site. Wild shrub species such as *Abutilon indicum*, *Adhatoda vasica*, *Calotropis procera*, *Calotropis gigantea*, *Lawsonia inermis*, *Withania somnifera*, and *Ziziphus nummularia*, have been observed. Some of the ornamental species that have been recorded includes *Plumeria alba*, *Nerium oleander*, *Tabernaemontana divaricata*, *Helianthus annuus*, *Tecoma stans*, *Opuntia monacantha*, *Codiaeum variegatum*, *Euphorbia royleana*, *Euphorbia tirucalli* and *Euphorbia tithymaloides*.

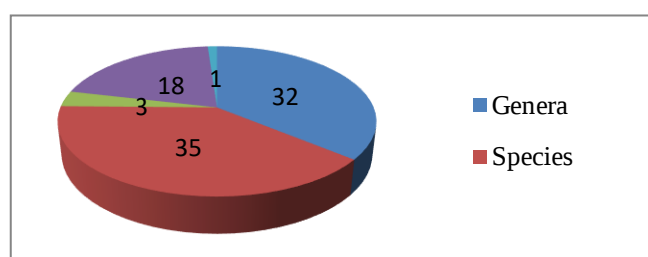


Figure 1: Representing no. of families, genera and species of Dicots, Monocots and Gymnosperms

Table 3: Average density, frequency, abundance, relative value, A/F ratio, IVI value and frequency class of shrub species in district Sonipat

	Name of species	Density	Frequency (%)	Abundance	Relative density	Relative frequency	IVI (RD+RF/2)	A/F	Frequency class
1	<i>Abutilon indicum</i>	2.5	65	3.6	6.3	4.5	5.4	0.06	D

2	<i>Adhatoda vasica</i>	0.5	19	2.3	1.3	1.3	1.3	0.12	A
3	<i>Agave americana</i>	1.3	49	2.5	3.3	3.4	3.4	0.05	C
4	<i>Barleria prionitis</i>	0.1	12	0.9	0.3	0.8	0.5	0.08	A
5	<i>Bougainvillea spectabilis</i>	3.4	82	4.1	8.6	5.7	7.2	0.05	E
6	<i>Calotropis procera</i>	2.5	73	3.2	6.3	5.1	5.7	0.04	D
7	<i>Calotropis gigantean</i>	0.8	36	2.1	2.0	2.5	2.3	0.06	B
8	<i>Canna glauca</i>	0.8	44	1.9	2.0	3.1	2.5	0.04	C
9	<i>Capparis sepiaria</i>	0.1	11	0.9	0.3	0.8	0.5	0.08	A
10	<i>Cestrum nocturnum</i>	0.5	24	1.9	1.3	1.7	1.5	0.08	B
11	<i>Citrus limon</i>	0.4	20	1.8	1.0	1.4	1.2	0.09	A
12	<i>Codiaeum variegatum</i>	1.2	42	2.8	3.0	2.9	3.0	0.07	C
13	<i>Euphorbia royleana</i>	0.6	27	2	1.5	1.9	1.7	0.07	B
14	<i>Euphorbia tithymaloides</i>	0.4	24	1.9	1.0	1.7	1.3	0.08	B
15	<i>Euphorbia tirucalli</i>	0.5	26	1.8	1.3	1.8	1.5	0.07	B
16	<i>Furcraea foetida</i>	1.1	43	2.6	2.8	3.0	2.9	0.06	C
17	<i>Hamelia patens</i>	0.9	38	2.3	2.3	2.6	2.5	0.06	B
18	<i>Helianthus annuus</i>	1.6	53	2.9	4.1	3.7	3.9	0.05	C
23	<i>Lawsonia inermis</i>	0.3	19	1.7	0.8	1.3	1.0	0.09	A
24	<i>Murraya paniculata</i>	0.9	36	2.4	2.3	2.5	2.4	0.07	B
25	<i>Nerium oleander</i>	2.7	75	3.5	6.8	5.2	6.0	0.05	D
26	<i>Opuntia monacantha</i>	0.4	21	1.9	1.0	1.5	1.2	0.09	B
27	<i>Plumeria alba</i>	0.9	39	2.3	2.3	2.7	2.5	0.06	B
28	<i>Punica granatum</i>	0.4	23	1.7	1.0	1.6	1.3	0.07	B

29	<i>Rhapis excelsa</i>	1.1	49	2.3	2.8	3.4	3.1	0.05	C
30	<i>Rosa indica</i>	2.4	81	2.9	6.1	5.6	5.9	0.04	E
31	<i>Tabernaemontana divaricata</i>	1	39	2.5	2.5	2.7	2.6	0.06	B
32	<i>Tecoma stans</i>	0.8	42	1.9	2.0	2.9	2.5	0.05	C
33	<i>Thuja plicata</i>	0.8	33	2.3	2.0	2.3	2.2	0.07	B
34	<i>Withania somnifera</i>	1.2	48	2.4	3.0	3.3	3.2	0.05	C
35	<i>Ziziphus nummularia</i>	1.5	50	2.8	3.8	3.5	3.6	0.06	C

However, in terms of relative value, the highest value recorded for *Bougainvillea spectabilis* (relative density 8.6, relative frequency 5.7) followed by *Hibiscus rosa sinensis* (relative density 7.3, relative frequency 5.9), *Nerium oleander* (relative density 6.8, relative frequency 5.2), *Abutilon indicum* (relative density 6.3, relative frequency 4.5), *Rosa indica* (relative density 6.1, relative frequency 5.6). The lowest value was recorded for *Capparis sepiaria* and *Barleria prionitis* (relative density 0.3, relative frequency 0.8)



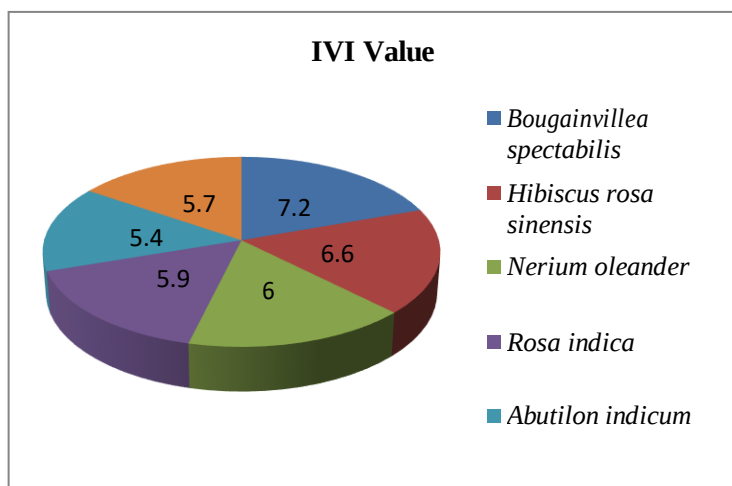


Figure 2: IVI value for shrub species

However, in terms of IVI value, *Bougainvillea spectabilis* (7.2) have been found to be dominant species among all shrubs found in the studied area, followed by *Hibiscus rosa sinensis* (6.6), *Nerium oleander* (6), *Rosa indica* (5.9), *Calotropis procera* (5.7), *Abutilon indicum* (5.4), *Helianthus annuus* (3.9), *Ziziphus nummularia* (3.6) and *Agave Americana* (3.4). The minimum IVI value was observed for the species *Capparis sepiaria* and *Barleria prionitis* (0.5). This value indicating that these two species were found to be lower in the district Sonipat.

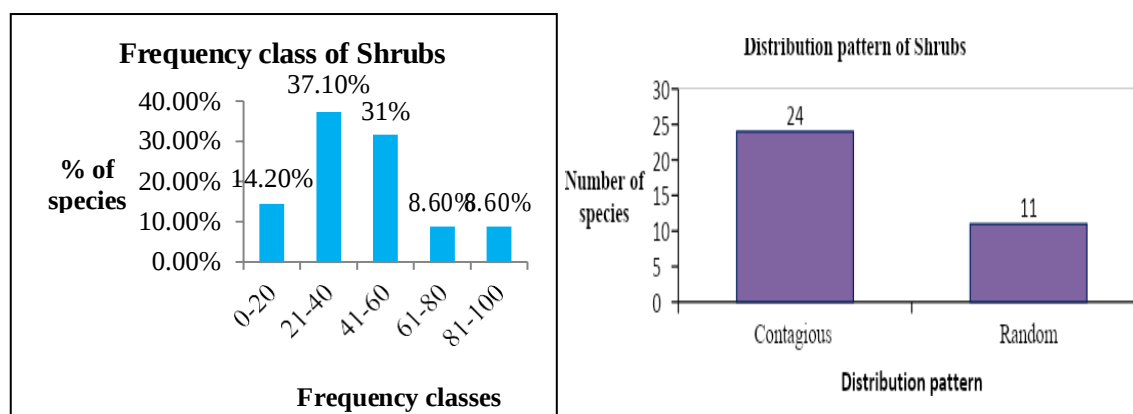


Figure 3: Frequency class and Distribution pattern of shrub species

From the observed value, it has been found that 5 species belong to frequency class A, 13 to frequency class B, 11 to frequency C, 3 to frequency D, and 3 to frequency class E. An unmatched of the frequency class value with Raunkiaer diagram indicates heterogenous nature of shrub community. The distribution patterns of various species are represented using the abundance to frequency (A/F) ratio. A species' distribution pattern is determined by its ratio, which can be contagious (>0.05), random ($0.025-0.05$), or regular (<0.025). On distribution pattern, the 24 species showed contagious distribution (> 0.05) whereas the remaining 11 species in the study area, showed random distribution, ($0.025-0.05$).

Species richness Indices

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

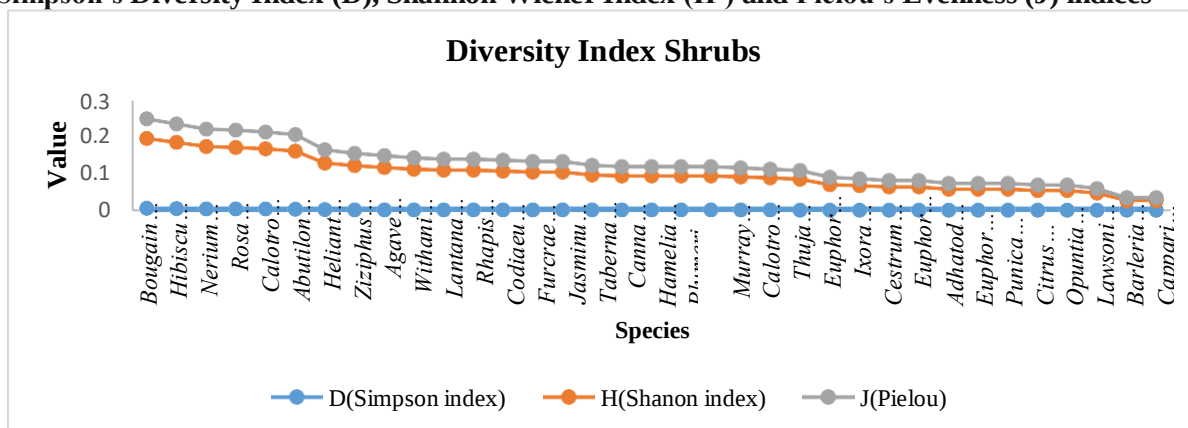


Figure 4: Diversity index for shrubs

In the current study, the value of Simpson Index is 0.038, Shannon index is 3.38 for shrubs indicating less diversity shrubs. The value for Pielou index is 0.951 reflecting even distribution of all the species at study site (Fig 4).

Area wise comparison of dominated shrub species

Table 4: Comparison of density, frequency and abundance of four dominant species present in three areas of district Sonipat

Name of species	Density, Frequency And Abundance	Villages of district Sonipat (Area I, II and III)		
		Gohana, Barota, Baroda, Butana	Pinana, Mohana, Khanpur	Sonipat, Murthal, Barwasni
<i>Abutilon indicum</i>	D	2.3	2.6	2.5
	F	65.0	83.3	63.3
	A	3.4	4	3.4
<i>Bougainvillea spectabilis</i>	D	3.3	3.0	3.8
	F	80	83.3	83.3
	A	4.1	3.6	4.7
<i>Hibiscus rosa sinensis</i>	D	2.5	2.4	3.0
	F	82.5	86.7	86.7
	A	3.1	2.7	3.5
<i>Nerium oleander</i>	D	2.7	2.1	3.4
	F	75	70	80
	A	3.5	3.0	4

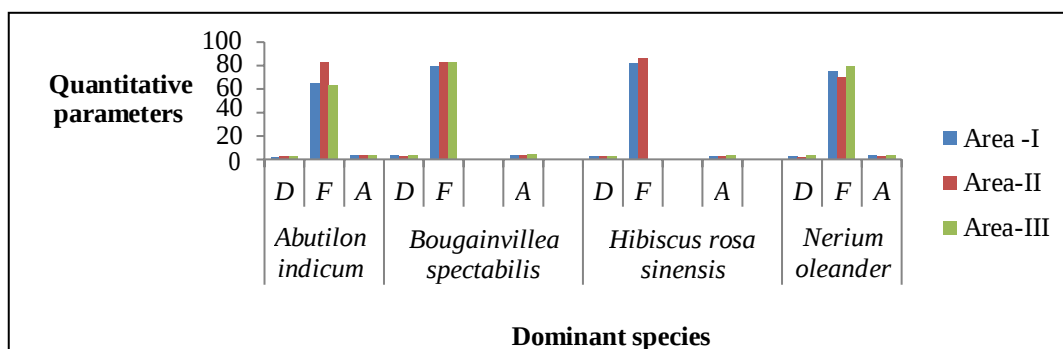


Figure 5: Comparative data of dominated shrub species

Area wise comparative data of four dominant species has been represented. It has been observed that *Bougainvillea spectabilis* possess highest density, frequency and abundance (3.8, 83.3%, 4.7)

in Area III (Sonipat city and surrounding villages) as well as in Area I (Gohana and surrounding villages) (3.3, 80%, 4.1) and *Abutilon indicum* (2.6, 83.3%, 4) has been found dominating in area II (Pinana and surrounding villages).

Conflict of interests: Authors declare no conflict of interests.

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