International Journal of Bio-resource and Stress Management 2015, 6(6):754-758 DOI: 10.5958/0976-4038.2015.00115.3

Short Research Article

Ecological Variation among Natural Populations of *Terminalia chebula* Retz. in District Kangra, Himachal Pradesh

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Article History

Manuscript No. AR1470
Received in 21st September, 2015
Received in revised form 29th November, 2015
Accepted in final form 7th December, 2015

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Keywords

Natural population, phytosociology, diversity, dominance

Abstract

The present study was confined to three natural populations of *Terminalia chebula* Retz. distributed in district Kangra of Himachal Pradesh. Natural populations of *Terminalia chebula* Retz. In every natural population, 5 quadrats of 30×30 m^2 size determined by species area curve method were randomly laid to study tree species. In each quadrat, a sub-quadrat of 5×5 m^2 size for study of shrubs was selected. Among trees, *Terminalia chebula* was dominant tree species in Rakkar with IVI of 78.49, while Chir pine showed dominance in Praur and Bachhwain, with IVI of 142.38 and 133.01, respectively. Among shrubs *Lantana camara* was dominant species in Praur having IVI (96.37) , *Carrisa opaca* in Rakkar (IVI, 77.38) and *Myrcine africana* in Bachhwain (IVI,107.07). Population wise species diversity in trees ranged from 1.54 to 2.01, species dominance from 0.71 to 0.84, species richness 1.21 from to 1.88 and equitability from 0.75 to 0.87. Species diversity in shrubs ranged from 1.25 to 1.64, species dominance from 0.70 to 0.83, species richness from 0.76 to 1.68 and equitability from 0.91 to 0.92. The present study showed presence of mature and over mature trees of *Terminalia chebula* in its natural population and absence of young trees and natural regeneration indicating urgency for conservation, sustainable management and supporting regeneration of *Terminalia chebula* by artificial means.

1. Introduction

The genus *Terminalia* includes about 200 species of trees and shrubs distributed in the tropical and subtropical regions of the world. In India, 20 species belonging to four sections, namely *Catappa*, *Myrobalanus*, *Chuncea* and *Pentaptera* have been reported to be distributed in the tropical and subtropical states. *Terminalia chebula* Retz. commonly known as Harar having a trade name of chebulic myrobalans, belongs to family Combretaceae and is indigenous to India and South East Asia (Dymock et al., 1976). In India it is distributed throughout the greater part except arid zone (Troup, 1921). It is found in sub Himalayan tract from the Ravi eastward to West Bengal and Assam ascending up to an altitude of 1,600 m. Harar have been traditionally used in Indian system of medicine Ayurveda. It is an important herbal drug in Ayurvedic pharmacopeia and called the ''king of medicines'' (Khan and Jain, 2009) because of its multi-therapeutic value. Traditionally, *T. chebula* has been used to treat kidney and urinary disorders, nervous disorders, colic pain, chronic cough, sore throat, asthma, etc. It is also used as laxative, antitussive, diuretic, digestive, antidiabetic, and as a cardiotonic remedy (Khare, 2007; Chander and Chauhan, 2014). The fruit is rich in tannin and itscontent varies with geographical distribution Myrobalans are also employed in the preparation of ink and in dyeing as a mordant for the basic aniline dyes fruit pulp of *Terminalia chebula* is used in many of the standard preparations such as 'triphala' and 'chayvanprash' which is use as food supplement. In some states of India and gulf countries fruit jam is used as food supplement. India holds the monopoly in export of Chebulic myrobalans in the form of whole fruits or in crushed form or as extracts to the world market. UK, USA, Australia, Belgium, Pakistan and Malaya Federation are the main importers of crushed myrobalans, whereas, Australia, Bangladesh, France, Pakistan, UK and USA import whole myrobalans. Pakistan, New Zealand, Australia and Japan are the chief importers of myrobalans extract. The structural analysis of vegetation entails the floristic composition, stand density, basal area, vertical stratification and community types, while diversity provide information on species richness, distribution and rate of change in species

composition. Both structure and diversity of vegetation have strong functional role in controlling ecosystem processes like biomass production, cycling of water and nutrients (Gower et al., 1992). The structural attributes of plant community can be expressed both in qualitative and quantitative characters. The qualitative characters are physiognomy, stratification, abundance, dispersion, sociability, vitality and life form, whereas quantitative characters include density, frequency, dominance and basal area (Odum, 1983). These quantitative primary variables are used for deriving secondary variable and Importance Value Index (IVI) of a species in a given community. Harar is naturally found as a component of mixed forests. The study of its interaction and prevalence in a community is important with respect to its conservation. The natural populations of *Terminalia chebula* in Himachal Pradesh are only confined to few patches predominantly in Lower or Shivalik Chir pine forests type/sub type $9/C_{1a}$ in Himachal Pradesh where top storey of forest is occupied by *Pinus roxburghii*, *Terminalia chebula* and other associate tree species. An extensive search of literature failed to reveal any useful information on phytosociology of *T. chebula.* Keeping in view the socio- economic importance of the species, the present investigation **"***Ecological Variation Among Natural Populations of Terminalia chebula* Retz. in district Kangra, Himachal Pradesh" was carried out with objective to study the distribution pattern and ecological status of *Terminalia chebula* Retz. in three natural populations of district Kangra of Himachal Pradesh.

2. Materials and Methods

The present study was carried out in three natural populations of *Terminalia chebula* Retz. distributed in Kangra district of Himachal Pradesh during 2011-2012. The physical description of natural populations is given as Table 1. The climate of study sites is sub-tropical with cold winters. The temperature goes up to a maximum of 35 °C in summer and minimum of 3.2 °C in winters and rainfall is received in monsoon. The rainfall pattern is typical monsoon type with rainfall concentrated from July to September. To study the status of plant diversity at each population community analysis was carried out during rainy season when majority of the plants were at the peak of their growth. In every natural population, five quadrats of 30×30 m^2 size determined by species area curve method were randomly laid to study tree species. In each quadrat, a sub-quadrat of 5×5 m^2 size for shrubs was selected. Density of trees was calculated by counting trees in each sample plot. Basal area of each tree in the sample plot was determined by tree calliper. Density of shrubs was calculated by counting plants of different species in each sub-plot. The basal area of shrub was calculated by using digital calliper. Each species was analyzed quantitatively for various parameters viz., basal area, density and frequency. The field work was carried out within two years from 2011 to 2013. The vegetation data were quantitatively analyzed for density, percent frequency and abundance. Relative Frequency, Relative Density and Relative Basal Area were determined following Phillips (1959), while Importance Value Index (IVI) was calculated following Mishra (1989). The Species Richness was calculated by using the method 'Margalef's index of richness' (D_{mg}) (Magurran, 1988). Species Diversity, Dominance and Equitability were evaluated by using the following Shannon-Wiener (1963) Index of diversity, Simpson (1949) index of dominance, and Pielou (1975) Equitability (e) methods respectively.

Table 1: Physical description of sites, Populations

Population	District	Altitude (m)	Lattitude (N)	Longitude (E)
Praur	Kangra	995	32° 05′089′′	76° 27′223′′
Bachhwain	Kangra	948	32° 00′959′′	76° 26′783′′
Rakkar	Kangra	715	31° 46′679′′	76° 14′303′′

3. Results and Discussion

The tree and shrub species that occurred in three natural populations of *Terminalia chebula* are presented in table 2, 3 and 4. There were 10, 10 and 7 tree species and 4, 7 and 6 shrub species in natural populations of Bachhwain, Rakkar and Praur respectively. In Bachhwain, *Pinus roxburghii* was dominant tree species with highest IVI (133.01) followed by *Terminalia chebula* as co-dominant species with IVI (57.98). Among the shrubs, *Murraya koenigii* was dominant species (IVI: 107.07), while *Rubus ellipticus* was co-dominant species (Table 2). In Rakkar *Terminalia chebul*a was dominant species having IVI (78.49) and *Pinus roxburghii* was co-dominant tree species with IVI (72.01). Among shrubs *Carrisa opaca* was dominant shrub species with IVI (77.38) followed by *Lantana camara* with IVI (75.03) (Table 3). In Praur, Chir pine was dominant tree species with IVI (142.38) and *Terminalia chebula* was co-dominant tree species with IVI (63.55). *Lantana camara* was dominant shrub species with IVI (96.73), while *Carrisa opaca* was co-dominant having IVI (85.37) (Table 4). Population wise species diversity in trees ranged from 1.54 to 2.01, species dominance from 0.71 to 0.84, species richness from 1.21 to 1.88 and equitability from 0.75 to 0.87. Species diversity in shrubs ranged from 1.25 to 1.64, species dominance from 0.70 to 0.83, species richness from 0.76 to 1.68 and equitability from 0.91 to 0.92 (Table 5).This distribution pattern of basal area in different forest communities may be attributed to the dominance of one species over other species in their respective habitat. In general, Harar and Chir pine had older crop in their habitat. The higher density of shrubs may be explained on account of more space and less tree cover allowing more shrubs to grow on the surface

Table 2: Density, basal area, per cent frequency and IVI of trees and shrubs in Bachhwain

Sl. no.	Species	Density (individual ha^{-1})	Abundance (AB)	Basal area (m^2 ha^{-1})	Per cent frequency	IVI
1.	*Albizia chinensis*	20	3	1.65	60	25.87
2.	*Bombax ceiba*	2	1	0.13	20	5.21
3.	*Cassia fistula*	16	3.5	0.36	40	14.99
4.	*Mallotus philippinensis*	18	2	0.28	80	23.18
5.	*Phoenix sylvestris*	7	1.5	0.05	40	10.37
6.	*Pinus roxburghii*	136	12.2	15.19	100	133.01
7.	*Pistacia integerrimma*	2	1	0.25	20	4.98
8.	*Syzygium cumini*	4	2	0.07	20	5.8
9.	*Terminalia bellirica*	16	3.5	1.05	40	17.85
10.	*Terminalia chebula*	49	4.4	4.93	100	57.98
	Total	270	34.10	23.97	520	300.00
Shrubs						
1.	*Carrisa opaca*	880.00	2.20	483.32	100.00	70.41
2.	*Myrsine africana*	1680.00	4.20	907.63	100.00	107.07
3.	*Murraya koenigii*	160.00	1.00	118.35	40.00	20.44
4.	*Rubus ellipticus*	1360.00	3.40	978.77	100.00	102.08
	Total	4840.00	10.80	2488.07	340.00	300.00

Table 3: Density, basal area, per cent frequency and IVI of trees and shrubs in Rakkar

Sl. no.	Species	Density (individual ha^{-1})	Abundance (AB)	Basal area (m^2 ha^{-1})	Per cent frequency	IVI
1.	*Acacia catechu*	67	15	0.37	40	35.03
2.	*Albizia chinensis*	7	2	2.81	40	29.71
3.	*Bombax ceiba*	2	1	0.11	20	6.46
4.	*Cassia fistula*	18	4	0.37	40	18.33
5.	*Emblica officinalis*	27	12	0.15	20	15.04
6.	*Mallotus philippinensis*	9	2	0.13	40	13.85
7.	*Phoenix sylvestris*	31	7	0.21	40	22.55
8.	*Pinus roxburghii*	60	14	6.71	40	72.01
9.	*Terminalia bellirica*	7	3	0.31	20	9.22
10.	*Terminalia chebula*	67	6	4.97	100	78.49
	Total	295	65	16.14	400	300.00
Shrubs						
1.	*Carrisa opaca*	1440	3.6	560.14	100	77.38
2.	*Colebrookea oppositifolia*	160	1	76.1	40	15.56
3.	*Indigofera pulchella*	240	1.5	128.76	40	19.71
4.	*Lantana camara*	1440	4.5	600.82	80	75.03
5.	*Murraya koenigii*	480	3	109.86	40	23.47
6.	*Myrsine africana*	560	2.33	169.31	60	32.3
7.	*Rubus ellipticus*	240	1.5	72.06	40	16.92
8.	*Woodfordia fruticosa*	560	2.33	318.58	60	39.63
	Total	5120.00	19.77	2035.64	460.00	300.00

Table 4: Density, basal area, per cent frequency and IVI of trees and shrubs in Praur

Sl. no.	Species	Density (individual ha^{-1})	Abundance (AB)	Basal area (m^2 ha^{-1})	Percent frequency	IVI
1.	*Albizia chinensis*	9	1.33	0.27	60	16.17
2.	*Cassia fistula*	7	1	0.05	60	14.35
3.	*Mallotus philippinensis*	9	2	0.15	40	11.54
4.	*Phoenix sylvestris*	38	4.25	0.44	80	30.18
5.	*Pinus roxburghii*	164	14.8	14.17	100	142.38
6.	*Terminalia bellirica*	18	2.67	0.85	60	21.83
7.	*Terminalia chebula*	71	6.4	4.24	100	63.55
	Total	316	32.45	20.17	500	300.00
Shrubs						
1.	*Carrisa opaca*	1040	3.25	1014.39	80	85.37
2.	*Lantana camara*	960	2.4	1264.89	100	96.73
3.	*Murraya koenigii*	400	2.5	235.67	40	30.74
4.	*Myrsine africana*	400	2.5	151.62	40	28.12
5.	*Rubus ellipticus*	400	1.67	338.37	60	39.82
6.	*Ziziphus mauritiana*	240	3	204.7	20	19.24
	Total	3440.00	15.32	3209.63	340.00	300.00

Table 5: Vegetation indices of trees and shrubs under natural Populations of *Terminalia chebula* Retz

Population	Plant category	Shannon -wiener index	Simpson's dominance	Species richness	Equitability (e)
Bachhwain	Trees	1.72	0.75	1.88	0.75
	Shrubs	1.25	0.70	0.76	0.91
Rakkar	Trees	2.01	0.84	1.84	0.87
	Shrubs	1.88	0.83	1.68	0.91
Praur	Trees	1.54	0.71	1.21	0.79
		1.64	0.77	1.33	0.92

floor. Singh et al. (1994) have reported density value ranging from 250-2070 tree ha^{-1} and shrub density 1460-1660 shrubs ha^{-1} for different Central Himalayan forests. The higher basal area denotes the presence of higher number of mature trees and shrubs in natural populations. These values were quite lower than the values reported by Kumar and Bhatt (2006) to sub-tropical forests of Garhwal Himalaya. The present study confirms that natural populations of *Terminalia chebula* consist of thickly populated village and each village exploits forest resources for their basic needs from these forests (Kumar and Bhatt, 2006). Similar results have been obtained during the studies in similar ecosystems by Sharma and Kant (2014), Kumar and Bhatt (2006); Tripathi et al. (2010); Jhangir (2004). The distribution of Harar and Chirpine is very narrow and the patches are more or less exposed to southern which being dry expose these stands to intense and frequent forest fires which is in conformity to other similar investigations, Jhangir (2004); Sharma et al. (2009). The recorded diversity indices values lie within the reported by Pandey (2001); Kumar et al. (2010).

4. Conclusion

Disproportionate growth in human and livestock population over the last few decades is posing significant threat to natural populations of *Terminalia chebula* due to its over-exploitation. The present study confirms the presence of mature and over mature trees of *Terminalia chebula* that too in limited number and complete absence of its natural regeneration and young trees in its natural population thereby indicating urgency of conservation, sustainable management and regeneration by artificial means of this economically valuable tree species.

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