

Original Research Article

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Vegetation Structure, Floristic Composition and Species Diversity of *Acacia catechu* Bearing Forest Types in Western Himalaya, India

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ABSTRACT

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Six different *A. catechu* bearing forest types including one plantation of *A. catechu* were selected for phytosociological studies in the Western Himalayan region of India. 72 sample plots of 0.1ha were selected. The plant genetic spectrum was made up of 75 genera with 86 species belonging to 43 families. Vegetational analysis revealed that in Dry Shiwalik Sal forest, the dominant tree species was *Shorea robusta* while in Northern Dry Mixed Deciduous forest, Dry Deciduous Scrub forest and Dry Riverine forest, the dominant tree species was *Acacia catechu*. In Lower Shiwalik Chirpine forest, the dominant tree species was *Pinus roxburghii*. SDI for trees was higher under Northern Dry Mixed Deciduous Forest, while for shrubs and herbs it was higher under Dry Riverine forest and *Acacia catechu* plantations respectively. In all the sites of different forest types, the value of similarity index was quite high which can be attributed to similar environmental conditions.

Introduction

Forest composition, community structure and diversity patterns are important ecological attributes significantly correlated with prevailing environmental as well as anthropogenic variables (Gairola *et al.*, 2008; Ahmad *et al.*, 2010). The diversity of tree species is fundamental to total forest biodiversity, because trees provide resources and habitats for almost all other forest species (Huang *et al.*, 2003). Vegetation is a key factor in determining the structure of any ecosystem (Bhatt and Purohit, 2009). Within a plant community it determines

microclimate, energy budget, photosynthesis, water regimes, surface runoff and soil temperature. The plant community of a region is a function of time and altitude, however, slope, latitude, aspect, rainfall and humidity also play an important role in the formation of plant communities and their composition (Kharkwal *et al.*, 2005). The species diversity, floristic composition and vegetation structure are important to judge the state of natural forests in a region. The local communities residing in and around these forests are dependent upon forests for an array of ecosystem services and values.

Acacia catechu Willd. is a multipurpose

moderate sized deciduous tree found throughout the greater parts of India. There are 3 varieties of *A. catechu* viz. *catechu*, *catechuoides* and *sundra* found in India. *Catechu* (*catechu* proper) is found in Jammu and Kashmir, Uttar Pradesh and Himachal Pradesh below 1300 m elevation (Chauhan, 1999). Generally, it forms pure patches of *khair* forests but it is also found in association with *Acacia modesta*, *Pinus roxburghii*, *Mallotus philippensis*, *Dalbergia sissoo*, *Zizyphus mauritiana*, *Terminalia bellerica*, *T. chebula*, *Wendlandia exserta*, *Butea monosperma*, *Anogeissus latifolia*, *Lannea coromandelica* and *Shorea robusta* (Champion and Seth, 1968).

Catechu is a valuable bioresource and is exploited commercially for katha and cutch (tannin) in North India (Luna, 2005). It is equally significant for the rural communities as they are dependent on this tree to fulfill their need of fuel, fodder, building material etc. and hence *khair* has become an integral part of socio-economic and cultural life of the people inhabiting the lower hills of Himachal Pradesh. The aim of the present study is to generate quantitative information on species diversity in different *A. catechu* bearing forest types so that it can be beneficial for the foresters and villagers to be aware of their present condition.

Materials and Methods

Study area and data collection

The experimental area is located in the subtropical zone of Himachal Pradesh. The area is located between 32°19' to 30°31'N latitude and 77°19' to 75°50'E longitude and lies between 375 to 1552 m above sea level. This zone affected by all three extreme climatic conditions with high temperature in summers, very low in winter and heavy rainfall in rainy season and a mean annual

temperature ranging from 21 to 26°C. The mean annual rainfall varies from 1400 to 1800 mm and most of which concentrated during July-August.

Six different *A. catechu* bearing forest types viz. Dry Shiwalik Sal forest, Northern Dry Mixed Deciduous forest, Dry Deciduous Scrub forest, Lower Shiwalik Chirpine forest and Dry Riverine forest including one plantation of *A. catechu* were chosen for phytosociological studies. In each forest type, 4 sites were studied and at each site, 4 sample plots were taken. In all, 72 sample plots of size 0.1 ha were taken. The observations were recorded for trees in all sample plots of 10 m x 10 m, while for shrub and herbs (except grasses) plots of size 5 m x 5 m and 1 m x 1 m were laid out in each tree sample plot, respectively.

Data analysis

Relative basal area, relative density and relative frequency were obtained from the percent frequency, density and basal area according to procedure given by Phillips (1959). IVI, was calculated for all species of trees, shrubs and herbs separately. Similarity index (SI) was determined by the method given by Sorenson (1948). Shannon index of general diversity (H) was calculated by using Margalef formulae (Odum 1971).

Results and Discussion

The data recorded revealed that the plant genetic spectrum comprised of 75 genera with 86 species belonging to 43 families (Table 1) except grasses. In Dry Shiwalik Sal forest, 13 tree, 9 shrub and 9 herb species were recorded. While in Northern Dry Mixed Deciduous forest, 18 tree, 12 shrub and 4 herb species were found. In case of Dry Deciduous Scrub forest, 18 tree, 15 shrub and 9 herb species were available whereas, in Lower Shiwalik Chirpine forest, 15 tree, 13 shrub

and 6 herb species were recorded. In Dry Riverine forest, 16 tree, 11 shrub and 7 herb species were found. While in *A. catechu* plantations, 12 shrub and 13 herb species were available. The Dry Deciduous Scrub forest and Northern Dry Mixed Deciduous forest had the maximum overall floristic composition while Dry Shivalik Sal forest had the least. In the former two forest types, ample light conditions were present while in latter; presence of thick crown cover of *Shorea robusta* barred it from reaching forest floor. Lesser number of herb species under Northern Dry Mixed Deciduous forest, Lower Shivalik Chirpine forest and Dry Riverine forest was due to pine needle-litter deposition on the forest floor which might have restricted germination of herbaceous flora (Gupta *et al.*, 2007) as *Pinus roxburghii* is one of the dominant species in the sub tropical Himalayan region and grows under hardy conditions which is in line with findings of Mukhia (2011) and Dangwal *et al.*, (2012) for species composition in Chirpine forests in Himalayas. Mueller (2003) opined that overstorey species enhance spatial heterogeneity of soil fertility resulting in change in shrub dynamics. The distribution of species is also regulated by altitude and physiographic regimes (Sharma *et al.*, 2010) and edaphic conditions, slope, aspect and moisture regime (Adhikari *et al.*, 2009).

Vegetational analysis (Table 1) revealed that in Dry Shivalik Sal forest, the dominant tree species was *Shorea robusta*>*Lannea coromandelica*>*Acacia catechu*. The dominant shrub species are *Randia dumetorum*>*Murraya koenigii*>*Woodfordia fruticosa*. Dominant herbaceous vegetation was *Bidens pilosa*>*Achyranthus aspera*>*Xanthium strumarium*. In Northern Dry Mixed Deciduous forest, the dominant tree species was *Acacia catechu*>*Pinus roxburghii*>*Bombax ceiba*. The dominant shrub species are *Celastrus paniculatus*>*Zizyphus mauritiana*>*Woodfordia fruticosa*.

Dominant herbaceous vegetation comprised of *Bidens pilosa*> *Parthenium hysterophorus*> *Urena lobata*.

In Dry Deciduous Scrub forest, the dominant tree species were *Acacia catechu*>*Pinus roxburghii*>*Dalbergia sissoo*. The dominant shrub species are *Randia dumetorum*>*Zizyphus oxyphylla*>*Adhatoda vasica*. Dominant herbaceous vegetation comprised of *Parthenium hysterophorus*> *Artemisia vulgaris*>*Achyranthus aspera*. In Lower Shivalik Chirpine forest, the dominant tree species was *Pinus roxburghii*>*Acacia catechu*>*Bombax ceiba*. The dominant shrub species are *Zizyphus oxyphylla*>*Carrisa carandus*>*Rubus elliptica*. Dominant herbaceous vegetation comprised of *Bidens pilosa*>*Achyranthus aspera*>*Trifolium repens*.

In Dry Riverine forest, the dominant tree species was *Acacia catechu*>*Dalbergia sissoo*>*Pinus roxburghii*. The dominant shrub species are *Zizyphus mauritiana*>*Murraya koenigii*>*Woodfordia fruticosa*. Dominant herbaceous vegetation comprised of *Parthenium hysterophorus*>*Bidens pilosa*>*Cassia tora*. In *Acacia catechu* plantations, the dominant tree species was *Acacia catechu*. The dominant shrub species are *Murraya koenigii*>*Carissa carandus*> *Dodonea viscosa*. Dominant herbaceous vegetation comprised of *Achyranthus aspera*> *Parthenium hysterophorus*> *Bidens pilosa*.

The Shannon Diversity Index for trees was higher for Northern Dry Mixed Deciduous forest followed by Dry Deciduous Scrub forest, Dry Shivalik Sal forest, Dry Riverine forest and Lower Shivalik Chirpine forest (Table 2). The proportion of different species is more in Northern Dry Mixed Deciduous forest and Dry Deciduous Scrub forest as compared to other forest types (Table 1) resulting in high diversity.

Table.1 Phytosociological studies under different *A. catechu* bearing forest types

Species	Family	F1				F2				F3				F4				F5				F6			
		RF	RD	RDM	IVI	RF	RD	RDM	IVI	RF	RD	RDM	IVI	RF	RD	RDM	IVI	RF	RD	RDM	IVI	RF	RD	RDM	IVI
TREES																									
<i>Acacia catechu</i> Willd.	Mimosaceae	12.50	5.50	8.90	26.09	9.76	25.60	5.03	40.40	11.40	27.90	3.80	43.20	12.50	27.90	5.34	45.70	12.50	34.60	6.90	54.00	100.0	100.0	100.0	300.0
<i>Albizia chinensis</i> (Osbeck) Merr.	Fabaceae	-	-	-	-	7.33	5.89	3.44	16.56	-	-	-	-	9.45	6.35	3.24	18.89	-	-	-	-	-	-	-	-
<i>Albizia lebbek</i> (L.) Benth.	Fabaceae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.30	2.60	3.20	12.00	-	-	-	-
<i>Anogeissus latifolia</i> (Roxb. ex DC.) Wall. ex Bedd.	Combretaceae	6.30	3.90	6.90	17.10	2.40	2.50	6.40	11.30	5.70	5.08	5.50	17.00					6.30	3.90	5.70	15.80	-	-	-	-
<i>Bauhinia variegata</i> Linn.	Caesalpiniaceae	12.50	7.10	5.80	25.40	-	-	-	-	5.70	3.50	2.80	12.05	6.34	2.55	2.67	11.55	-	-	-	-	-	-	-	-
<i>Bombax ceiba</i> Linn.	Malvaceae	-	-	-	-	9.80	5.80	10.4	25.9	2.89	1.20	5.78	9.68	12.50	6.31	6.95	25.68	12.45	5.10	11.80	29.43	-	-	-	-
<i>Butea monosperma</i> (Lam.) Taub.	Fabaceae	-	-	-	-	-	-	-	-	2.89	2.28	10.74	15.60	-	-	-	-	-	-	-	-	-	-	-	-
<i>Cassia fistula</i> Linn.	Fabaceae	6.30	6.30	3.80	16.40	4.90	2.50	7.45	15.09	5.70	2.29	2.50	10.50	-	-	-	-	3.10	1.34	4.14	8.50	-	-	-	-
<i>Dalbergia sissoo</i> Roxb. ex DC.	Fabaceae	6.30	6.30	9.50	22.10	2.40	1.69	3.30	7.40	11.40	10.50	4.67	26.60	6.34	2.50	6.14	14.99	12.56	26.89	8.13	47.53	-	-	-	-
<i>Diospyros montana</i> Roxb.	Ebenaceae	-	-	-	-	2.40	1.69	7.67	11.67	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Emblica officinalis</i> Linn.	Euphorbiaceae	9.40	9.50	3.40	22.20	-	-	-	-	11.39	8.09	1.50	21.14	6.34	6.34	1.40	14.0	6.30	3.79	2.89	13.01	-	-	-	-
<i>Ficus glomerata</i> Roxb.	Moraceae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.30	2.56	11.89	20.67	-	-	-	-
<i>Flacourtia indica</i> (Burm. f.) Merr.	Salicaceae	-	-	-	-	7.30	6.56	1.89	15.78	2.86	2.30	1.30	6.47	6.25	3.80	3.04	13.09	3.12	1.28	1.92	6.32	-	-	-	-
<i>Grewia optiva</i> J. R. Drumm.	Tiliaceae	-	-	-	-	4.88	3.31	1.78	9.96	2.86	1.16	6.30	10.32	3.12	1.27	6.01	10.40	6.25	2.56	5.49	14.30	-	-	-	-
<i>Holoptelea integrifolia</i> (Roxb.)	Ulmaceae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.12	1.28	4.70	9.11	-	-	-	-
<i>Lannea coromandelica</i> (Houtt.) Merr.	Anacardiaceae	9.37	11.02	7.77	28.17	-	-	-	-	2.86	6.98	6.48	16.32	-	-	-	-	-	-	-	-	-	-	-	-
<i>Limonia acidissima</i> Linn.	Rutaceae	-	-	-	-	2.44	2.48	2.20	7.12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Mallotus philippensis</i> (Lamk) Muell. Arg.	Euphorbiaceae	6.25	3.94	6.63	16.82	9.76	9.91	4.79	24.46	8.57	5.81	4.39	18.77	6.25	3.80	5.56	15.61	6.25	3.85	4.80	14.90	-	-	-	-
<i>Ougeinia oojeinensis</i> (Roxb.) Hochr.	Fabaceae	3.12	1.57	4.14	8.84	9.76	3.31	3.69	16.76	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Phoenix sylvestris</i>	Arecaceae	-	-	-	-	-	-	-	-	2.86	4.65	6.67	14.18	3.12	1.27	2.88	7.27	-	-	-	-	-	-	-	-

(L.) Roxb.																									
<i>Pinus roxburghii</i> Sarg.	Pinaceae	3.12	0.79	19.52	23.43	7.32	16.53	13.38	37.22	8.57	6.98	17.21	32.76	12.5	31.64	25.73	69.87	6.25	6.41	16.87	29.53	-	-	-	-
<i>Pyrus pashia</i> Buch. Ham. D.Don	Rosaceae	-	-	-	-	7.32	5.79	2.18	15.28	5.71	3.49	2.32	11.52	6.25	2.53	2.21	10.99	3.12	1.28	4.37	8.78	-	-	-	-
<i>Shorea robusta</i> Gaertn. f.	Dipterocarpaceae	12.5	36.22	10.62	59.33	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
<i>Syzygium cumini</i> (L.) Skeels	Myrtaceae	6.25	3.94	3.87	14.06	2.44	0.83	5.30	8.57	-	-	-	-	-	-	-	-	3.12	1.28	4.09	8.50				
<i>Terminalia arjuna</i> Wight & Arn.	Combretaceae	-	-	-	-	2.44	0.83	12.65	15.92	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Terminalia bellerica</i> (Gaertn.) Roxb.	Combretaceae	-	-	-	-	-	-	-	-	2.86	2.33	10.54	15.73	3.12	1.27	15.33	19.72	-	-	-	-	-	-	-	-
<i>Terminalia chebula</i> Retz.	Combretaceae	-	-	-	-	-	-	-	-	-	-	-	-	3.12	1.27	11.77	16.16	-	-	-	-	-	-	-	-
<i>Terminalia tomentosa</i> Roxb. (ex DC) Wight & Arn.	Combretaceae	6.25	3.94	9.16	19.34	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Toona ciliata</i> M.Roem.	Meliaceae	-	-	-	-	2.44	1.65	4.56	8.65	2.86	3.49	3.25	9.60	3.12	1.27	1.80	6.19	3.12	1.28	3.24	7.65	-	-	-	-
<i>Wendlandia exserta</i> (Roxb.) DC.	Rubiaceae	-	-	-	-	4.88	3.31	3.75	11.93	2.86	1.16	4.59	8.61	-	-	-	-	-	-	-	-	-	-	-	-
SHRUBS																									
<i>Adhatoda vasica</i> Linn.	Acanthaceae	-	-	-	-	-	-	-	-	8.00	24.44	0.67	33.12	3.33	4.17	0.60	8.10	3.45	8.91	3.69	16.05	5.00	6.13	0.77	11.90
<i>Asparagus adscendens</i> Roxb.	Asparagaceae	-	-	-	-	14.81	15.79	0.18	30.78	8.00	7.56	0.20	15.75	13.33	16.25	0.09	29.67	13.79	12.54	0.25	26.59	5.00	2.45	0.10	7.55
<i>Bauhinia vahlii</i> Wight & Arn.	Caesalpiniaceae	19.05	18.52	3.40	40.96	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.00	1.84	3.36	10.20
<i>Calotropis procera</i> W.T.Aiton	Apocynaceae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.45	1.32	4.48	9.25	-	-	-	-
<i>Carissa carandas</i> Linn.	Apocynaceae	9.52	10.37	15.39	35.29	11.11	14.83	6.38	32.32	8.00	10.22	4.91	23.13	13.33	15.41	5.13	33.88	13.79	10.23	5.87	29.89	20.00	29.45	7.29	56.74
<i>Celastrus paniculatus</i> Willd.	Celastraceae	4.76	1.48	7.40	13.64	3.70	1.44	37.70	42.84	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Clematis acuminata</i> DC.	Ranunculaceae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.00	1.23	0.3	6.56
<i>Cissampelos pareira</i> Linn.	Menispermaceae	14.29	13.33	0.25	27.88	14.82	16.27	0.16	31.24	12.00	7.56	0.10	19.65	13.33	15.42	0.10	28.84	13.79	10.20	0.25	27.24	15.00	7.98	0.25	23.22
<i>Cryptolepis buchanani</i> Roem. & Schult.	Apocynaceae	-	-	-	-	-	-	-	-	16.00	7.11	2.86	25.97	-	-	-	-	-	-	-	-	-	-	-	-
<i>Desmodium pulchellum</i> (L.) Benth.	Fabaceae	9.52	7.41	12.58	29.51	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Dodonaea viscosa</i> (L.) Jacq.	Sapindaceae	-	-	-	-	-	-	-	-	4.00	4.00	2.10	10.10	3.33	4.58	5.22	13.14	-	-	-	-	5.00	1.23	20.65	26.87
<i>Flemingia fruticosa</i> Wall. ex Benth.	Fabaceae	-	-	-	-	-	-	-	-	4.00	3.11	1.39	8.50	-	-	-	-	-	-	-	-	-	-	-	-

<i>Hamiltonia suaveolens</i> (Roxb.)	Rubiaceae	-	-	-	-	3.70	1.44	4.92	10.06	-	-	-	-	-	-	-	-	3.45	1.32	1.05	5.82	-	-	-	-
<i>Ipomea carnea</i> Jacq.	Convolvulaceae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.00	1.84	19.41	26.25
<i>Indigofera pulchella</i> Roxb.	Fabaceae	-	-	-	-	-	-	-	-	-	-	-	3.33	1.67	3.79	8.79	-	-	-	-	-	-	-	-	-
<i>Lantana camara</i> Linn.	Verbenaceae	4.76	3.70	4.39	12.86	3.70	5.74	7.03	16.47	4.00	4.00	2.09	10.09	-	-	-	-	10.34	13.86	7.01	31.22	10.00	4.29	9.94	24.24
<i>Lonicera japonica</i> Thunb.	Caprifoliaceae	-	-	-	-	-	-	-	-	4.00	2.22	0.28	6.50	-	-	-	-	-	-	-	-	-	-	-	-
<i>Murraya koenigii</i> (L.) Spreng.	Rutaceae	14.29	17.78	9.41	41.47	7.41	12.44	5.94	25.79	8.00	11.11	2.12	21.24	10.00	16.25	4.61	30.86	13.79	22.77	5.63	42.19	15.00	41.10	4.63	60.74
<i>Pogostemon plectrantoides</i> Desf.	Lamiaceae	-	-	-	-	7.41	7.18	1.47	16.05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Randia dumetorum</i> Lam.	Rubiaceae	9.52	14.81	32.95	57.29	-	-	-	-	4.00	4.44	40.09	48.53	-	-	-	-	-	-	-	-	-	-	-	-
<i>Randia spinosa</i> (Thunb.) Poir	Rubiaceae	-	-	-	-	-	-	-	-	-	-	-	-	3.33	1.67	18.42	23.42	-	-	-	-	-	-	-	-
<i>Roylea cinerea</i> (D. Don) Baill.	Lamiaceae	-	-	-	-	3.70	4.79	0.25	8.74	-	-	-	-	-	-	-	-	3.45	3.30	0.43	7.18	-	-	-	-
<i>Rubus elliptica</i> Sm.	Rosaceae	-	-	-	-	-	-	-	-	-	-	-	-	6.67	2.5	22.72	31.88	-	-	-	-	-	-	-	-
<i>Vallisneria spiralis</i> (L.) Kuntze	Apocynaceae	-	-	-	-	7.41	4.31	0.53	12.25	4.00	2.67	0.07	6.74	10.00	7.92	0.29	18.21	-	-	-	-	-	-	-	-
<i>Vitex negundo</i> Linn.	Verbenaceae	-	-	-	-	-	-	-	-	4.00	0.89	7.65	12.54	-	-	-	-	-	-	-	-	-	-	-	-
<i>Vitis parviflora</i> Baker	Vitaceae	-	-	-	-	-	-	-	-	-	-	-	-	6.67	3.75	0.90	11.31	-	-	-	-	-	-	-	-
<i>Woodfordia fruticosa</i> (L.) Kurz	Lythraceae	14.29	12.59	14.23	41.11	11.11	7.18	15.12	33.42	4.00	2.22	6.35	12.57	3.33	1.25	16.42	20.99	10.35	4.29	19.90	34.54	-	-	-	-
<i>Ziziphus mauritiana</i> Lam.	Rhamnaceae	-	-	-	-	11.11	8.61	20.33	40.05	-	-	-	-	-	-	-	-	10.34	8.25	51.44	70.03	5.00	1.23	15.66	21.89
<i>Ziziphus oxyphylla</i> Edgew.	Rhamnaceae	-	-	-	-	-	-	-	-	8.00	8.44	29.12	45.57	10.00	9.17	21.72	40.89	-	-	-	-	-	-	-	-
HERBS																									
<i>Achyranthes aspera</i> Linn.	Amaranthaceae	21.05	28.25	0.39	49.69	-	-	-	-	21.05	23.08	5.86	49.99	30.00	17.16	8.57	55.73	6.67	11.67	1.09	19.43	18.75	18.47	0.94	38.16
<i>Ageratum conyzoides</i> Linn.	Asteraceae	-	-	-	-	-	-	-	-	10.53	20.07	2.83	33.42	10.00	11.83	13.44	35.27	-	-	-	-	6.25	17.19	3.09	26.54
<i>Anisomeles indica</i> (L.) Kuntze	Lamiaceae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.67	3.89	7.88	18.44	-	-	-	-
<i>Abrus precatorius</i> Linn.	Leguminaceae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.25	1.91	0.94	9.10
<i>Artemisia vulgaris</i> Linn.	Asteraceae	-	-	-	-	-	-	-	-	15.79	19.40	20.03	55.22	-	-	-	-	-	-	-	-	-	-	-	-
<i>Barleria cristata</i> Linn.	Acanthaceae	-	-	-	-	12.5	20.46	13.24	46.19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Bidens pilosa</i> Linn.	Asteraceae	15.79	33.18	4.23	53.21	37.5	50.76	34.68	122.94	10.53	15.05	16.36	41.93	20.00	18.94	48.61	87.54	13.33	12.78	23.69	49.80	6.25	14.01	14.18	34.44
<i>Boerhaavia diffusa</i> Linn.	Nyctaginaceae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.25	1.91	3.36	11.52

<i>Cassia mimosoides</i> Linn.	Caesalpinaceae	-	-	-	-	-	-	-	-	15.79	3.68	2.24	21.71	-	-	-	-	-	-	-	-	-	-	-	-
<i>Cassia tora</i> Linn.	Caesalpinaceae	10.53	9.86	3.02	23.41	-	-	-	-	-	-	-	-	-	-	-	-	6.67	11.11	22.30	40.07	6.25	6.37	6.13	18.75
<i>Cynoglossum wallichii</i> G. Don	Boraginaceae	5.26	5.83	16.09	27.19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Chenopodium album</i> Linn.	Chenopodiaceae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.25	3.18	5.49	14.92
<i>Chenopodium ambrosioides</i> Linn.	Chenopodiaceae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.25	2.54	3.78	12.57
<i>Dioscorea sativa</i> Thunb.	Dioscoreaceae	-	-	-	-	-	-	-	-	5.26	1.34	14.53	21.13	-	-	-	-	-	-	-	-	-	-	-	-
<i>Erua scandens</i> Mart.	Amaranthaceae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	20.00	12.22	2.36	34.58	-	-	-	-
<i>Herpetospermum pedunculatum</i> Ser. C.B. Clarke	Cucurbitaceae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.25	1.27	8.59	16.12
<i>Leucas lanata</i> Benth.	Lamiaceae	-	-	-	-	-	-	-	-	10.53	4.01	6.21	20.75	-	-	-	-	-	-	-	-	-	-	-	-
<i>Marsdenia tenacissima</i> (Roxb.)	Apocynaceae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.25	1.91	13.47	21.63
<i>Parthenium hysterophorus</i> Linn.	Asteraceae	-	-	-	-	12.5	15.15	45.88	73.53	10.53	13.38	31.98	55.88	-	-	-	-	26.67	38.33	36.71	101.71	6.25	11.46	17.10	34.82
<i>Phlogacanthus pubinervius</i> T. Anders.	Acanthaceae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.25	1.91	20.44	28.60
<i>Phlomis bracteosa</i> Royle ex Benth.	Lamiaceae	10.53	5.38	12.22	28.12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Polygonum hydropiper</i> Linn.	Polygonaceae	-	-	-	-	-	-	-	-	-	-	-	-	10.00	20.71	11.44	42.16	-	-	-	-	-	-	-	-
<i>Rubus niveus</i> Thunb.	Rosaceae	5.26	1.35	29.41	36.02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Siegesbeckia orientalis</i> Linn.	Asteraceae	10.53	7.17	0.44	18.14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Trifolium repens</i> Linn.	Fabaceae	-	-	-	-	-	-	-	-	-	-	-	-	20.00	26.63	1.84	48.47	-	-	-	-	6.25	15.92	0.56	22.73
<i>Urena lobata</i> Linn.	Malvaceae	10.53	4.93	3.98	19.44	37.5	13.64	6.21	57.34	-	-	-	-	10.00	4.73	16.11	30.85	20.00	10.00	5.97	35.97	6.25	1.91	1.92	10.08
<i>Xanthium strumarium</i> Linn.	Asteraceae	10.53	4.04	30.20	44.77	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table.2 Shannon Diversity Index in different *A. catechu* bearing forest types

Forest Types	Trees	Shrubs	Herbs
Dry Shivalik Sal Forest	0.85	0.68	0.45
Northern Dry Mixed Deciduous Forest	0.94	0.70	0.26
Dry Deciduous Scrub Forest	0.90	0.77	0.59
Lower Shivalik Chirpine Forest	0.79	0.81	0.57
Dry Riverine Forest	0.84	0.83	0.54
<i>Acacia catechu</i> plantations	0.00	0.64	0.65
CD _{0.05}	0.10	0.17	0.30

Table.3 Similarity index under different *A. catechu* bearing forest types

Similarity	F ₂	F ₃	F ₄	F ₅	F ₆
	Trees				
F ₁	69.57	81.81	54.54	76.19	15.38
F ₂	-	100	86.96	123.81	11.11
F ₃	-	-	130	109.09	11.11
F ₄	-	-	-	110	13.33
F ₅	-	-	-	-	12.5
Shrubs					
F ₁	80	66.67	44.44	58.82	66.67
F ₂	-	66.67	63.16	120	82.35
F ₃	-	-	94.74	80	70
F ₄	-	-	-	66.67	70.59
F ₅	-	-	-	-	106.67
Herbs					
F ₁	33.33	25	50	61.54	44.44
F ₂	-	54.54	75	66.67	57.14
F ₃	-	-	72.73	42.86	76.92
F ₄	-	-	-	53.33	71.43
F ₅	-	-	-	-	53.33

F₁ - Dry Shivalik Sal Forest
 F₂ - Northern Dry Mixed Deciduous Forest
 F₃ - Dry Deciduous Scrub Forest

F₄ - Lower Shivalik Chirpine Forest
 F₅ - Dry Riverine Forest
 F₆ - *A. catechu* plantations

Similarity index deciphers the interrelatedness of each forest type and enables to understand the hidden process of succession of different forest types. Under different forest types (Table 3), in case of trees, the higher value of similarity index was observed under F₄

(Lower Shivalik Chirpine forest): F₃ (Dry Deciduous Scrub forest) followed by F₂ (Northern Dry Mixed Deciduous forest): F₅ (Dry Riverine forest) and F₄ (Lower Shivalik Chirpine forest): F₅ (Dry Riverine forest). In case of shrubs, the higher value was observed

under F₂ (Northern Dry Mixed Deciduous forest): F₅ (Dry Riverine forest) followed by F₅ (Dry Riverine forest): F₆ (*A. catechu* plantations) and F₃ (Dry Deciduous Scrub forest): F₄ (Lower Shiwalik Chirpine forest). While for herbs, the higher value was observed under F₃ (Dry Deciduous Scrub forest): F₆ (*A. catechu* plantations) followed by F₂ (Northern Dry Mixed Deciduous forest): F₄ (Lower Shiwalik Chirpine forest) and F₃ (Dry Deciduous Scrub forest): F₄ (Lower Shiwalik Chirpine forest). Suyal *et al.*, (2010) opined that close proximity results in high similarity index of vegetation. Chandra *et al.*, (2010) studied vegetational diversity in Garhwal Himalaya and reported high similarity index between sites having similar environmental conditions. Kharkwal *et al.*, (2005) concluded that the distribution and species richness pattern largely depend upon the altitude and climatic variables like rainfall, temperature and these parameters decrease with increase in elevation. Low similarity between different forest stands indicates the microclimatic variations and hence species composition.

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