EFFECT OF ASPECT ON DISTRIBUTION PATTERN OF *ANOGEISSUS LATIFOLIA* (WALL EX BEDD) IN SUBTROPICAL BELT OF GARHWAL HIMALAYA, INDIA

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ABSTRACT

This paper reports on effect of aspect on distribution pattern of *Anogeissus latifolia* is an important fuel, fodder and timber species of sub-tropical belt of Garhwal Himalaya. The study was carried out in two aspects i.e., south-east (SE) aspect and south-west (SW) aspect in sub-tropical region (30^0 29' N and 78^0 24' E) of Garhwal Himalaya between 700 and 1000 m elevations. The total density and total basal cover values were 990 (SW aspect) and 1150 (SE aspect) trees ha^{-1} and 8.753 (SE aspect) and 10.448 m^2 ha^{-1} (SW aspect) respectively. The tree density and basal cover values for *A. latifolia* was 900 trees ha^{-1} and 6.767 m^2 ha^{-1} on SE aspect and 770 trees ha^{-1} and 7.630 m^2 ha^{-1} on SW aspect. The higher density of *A. latifolia* on SE aspect, could be due to warmer favorable conditions for new growth, which influenced higher girth classes of 11-20 and 21-30 cm. Similarly the higher total basal cover values of *A. latiflolia* on SW aspect might be due relatively low number of tree species and open habitat favored higher girth classes of 41-50 and 51-60 cm. The distribution pattern of species was contagious. The concentration of dominance was higher on SW aspect and lower on SE aspect. Similarly, the diversity followed a in reverse trend. The higher and lower values of equitability were on SE and SW aspects. The diversity values were 0.960 (SW aspect) and 1.155 (SE aspect).

Keywords: *Anogeissus latifolia* - *Distribution* pattern – Aspect – Garhwal – Himalaya – Sub - tropical

INTRODUCTION

In Garhwal Himalaya a number of forest types are found, varying with altitudes, geology and soil type (Champion and Seth 1968) and within one altitude the co-factors like aspect, topography, inclination of slope and soil type affect the forest composition (Shank and Noories 1950). The lower altitudes (up to 1000 m) are dominated by *Shorea robusta* mixed

with *A. latifolia*, *Terminalia* species, and *Adina cordifolia*. Regeneration status of trees can be predicted by the age structure of their populations (Marks 1974, Khan *et al*. 1987). The presence of sufficient number of seedlings, saplings and young trees in a given population indicates a successful regeneration (Saxena and Singh, 1984). The changes in structure, density and composition of Himalayan forests are appearing due to uncontrolled branch lopping, felling of trees for fuel wood, fodder and grazing (Bargali *et al.* 1998, Kumar *et al.* 2004). These biotic pressures play an important role in forest community dynamics (Whitemore 1984, Pickett and White 1985) and often regulate the recruitment and survival pattern of tree seedlings (Canham and Marks 1985).

Anogeissus latifolia locally known as Bakli belongs to a family combretaceae is a medium to large sized deciduous tree having feathery and rounded crown and dropping branches. *A. latifolia* occur throughout the tropical and sub-tropical regions of India except arid parts of North-West India and moist region of North-East India (Champion and Seth 1968). It often forms pure stand in the sub-Himalayan tract and Shiwalik hills (Luna, 2005). The chief associated species of *A. latifolia* are *Ougeinia oojenensis*, *Terminalia* species etc. *A. latifolia* is a light demander species and can resist drought conditions but prolog drought condition can lead the death of tree (Verma 1972). *A. latifolia* is heavily exploited by the villages last many years in sub-Himalayan tract of Garhwal Himalaya including present study area for fuel, fodder, minor timber and other basic requirements. In spite of close relationship between forest and man's subsistence economy (Singh and Singh, 1987) no quantitative study has been available on the effect of aspect on distribution pattern of *A. latifolia* and its importance for fuel, fodder and timber species of sub-tropical belt of Garhwal Himalaya. The present study therefore, taken up to understand effect of aspect on distribution pattern of *A. latifolia* in sub-tropical belt of Garhwal Himalaya, India

MATERILS AND METHODS

The study was carried out in sub-tropical region (30^0 29' N and 78^0 24' E) on the south-east (SE) and south-west (SW) aspects at an elevation ranging from 700 to 1000 m asl in Garhwal Himalaya, India. The tree layer was studied by using 10 X 10 m quadrats. A total of 10 randomly placed quadrats were used on each of the two aspects. The size and number of quadrats were determined by the species area curve (Mishra 1968) and the running mean method (Kershaw 1973). In each quadrate tree more than ≥10 cm girth at breast height (gbh at 1.37 m from the ground) was individually measured for girth. The vegetation data were quantitatively analysed for abundance, density and frequency (Curtis and McIntosh, 1950) and total basal cover (TBC). The importance value index (IVI) was determined as the sum of the relative frequency, relative density and relative dominance (Curtis 1959). The tree components were further divided into six diameter classes viz., 10-20, 21-30, 31-40, 41-50, 51-60 and 61-70 cm. The diversity (H) was determined using Shannon and Wiener information function (Shannon and Wiener's, 1963) as

$$H= -\sum (Ni/N) \log_2 (Ni/N) \qquad i=l$$

Where, Ni is the importance value of each species, and N is the total importance value of all the species in a stand. The concentration of dominance (CD) was computed by Simpson's index (Simpson 1949) as:

$$CD = \sum (Ni/N)^2 \qquad i=1$$

Where, Ni and N are same as for Shannon Wiener information function.

The equitability (EC) was calculated following (Whittaker 1975) as:

$$EC= S/\log Ni - \log Ns$$

Where S= number of the species in the stand, and Ni and Ns are the density values of the most and least important species respectively. The ratio of abundance to frequency was calculated to determine the distribution pattern (%). This ratio indicates regular (<0.025), random (0.025-0.050) and contagious (>0.050) distribution pattern (Curtis and Cottam 1956). Dominance-diversity (D-D) curves for trees were plotted by a co-ordinate point IVI on the y-axis and its position in the sequence of species from highest to lowest IVI on the x-axis (Whittaker 1975).

RESULTS AND DISCUSSION

Tree layer vegetation characters differed markedly between the two aspects of the same vegetation type (Table-1). On SE aspect a total of seven tree species i.e., *Anogeissus latifolia*, *Acacia catechu, Emblica officinalis, Ougeinia oojenensis, Lannea coromandelica, Bauhinia retusa* and *Terminalia tomentosa* were recorded whereas, on SW aspect only three species i.e., *Anogeissus latifolia, Acacia catechu* and *Lannea coromandelica* constituted forest cover. *A. latifolia* was the dominant species on both aspects and present throughout the studied sampling units. The tree density was higher on the SE aspect and lower on the SW aspect, which indicates new growth on SE aspect. Between the aspects the least dominant species were *Bauhinia retusa* (SE aspect) and *A. catechu* (SW aspect). In the present study, total density values were 990 trees ha^{-1} (SW aspect) and 1150 trees ha^{-1} (SE aspect), and basal cover values were 8.753 m^2 ha^{-1} (SE aspect) and 10.448 m^2 ha^{-1} (SW aspect).

Table1 Frequency (%), density (trees ha^{-1}), total basal cover (m^2 ha^{-1}) of trees on two aspects of Garhwal Himalaya, India

Name of species	South-east aspect			South-west aspect		
	Frequency (%)	Density (Trees/ha)	Total Basal Cover (m^2/ha)	Frequency (%)	Density (Trees/ha)	Total Basal Cover (m^2/ha)
Anogeissus latifolia	100	900	6.767	100	770	7.630
Acacia catechu	20	30	0.178	40	70	0.705
Emblica officnalis	20	50	0.382			
Ougeinia oojenensis	10	20	0.043			
Lannea coromandelica	70	130	1.313	80	150	2.113
Bauhinia retusa	10	10	0.020			
Terminalia tomentosa	10	10	0.050			
Total		1150	8.753		990	10.448

Saxena and Singh (1982), Tiwari (1982) and Bargali *et al.* (1987) reported the values of density ranging from 420 to 1640 trees ha^{-1} for various temperate forests in the Kumaun Himalaya. Rajwar (1991) reported density values between 1020 and 2460 trees ha^{-1} and total basal cover values between 46.17 and 71.23 m^2 ha^{-1} in temperate forests of Uttarkashi, Garhwal Himalaya. Upadhaya *et al*. (2004) reported values of density between 938 and 1476 stem ha^{-1} for woody species of north-east forests of India. The other studies include lowland tropical forests (716 and 1440 stem ha^{-1}) in Kurupukari, Guyana (Johnston and Gillman 1995), terrace firm forest (1561 stem ha^{-1}) in Amazonian Ecuader (Valencia *et al.* 1994) and 1176-1496 stem ha^{-1} in sub-tropical humid forest in Meghalaya (Jamir 2000). The total basal cover values of present study ranged from 8.753 to 10.448 m^2 ha^{-1} which indicate the upper values were close to equatorial forests (10-45 m^2 ha^{-1}) in Kango Island, Zaire (Mosango 1991). In sub-tropical forests of the Garhwal Himalaya, the values of total density and total basal cover ranged from 832 to 884 trees ha^{-1} and 14.30 to 24.83 m^2 ha^{-1} respectively (Kumar *et al*. 2004). The higher density of *A. latifolia* on SE aspect could be due to warmers and favorable conditions for the new growth. Similarly, the higher total basal cover values of *A. latifolia* on SW aspect might be due to relatively open canopy and moist conditions which favour the trees of higher girth classes of 41-50 and 51-60. Density values of other similar forests of *A. latifolia* were also carried out on aspects and disturbance basis (Table-2)**.** Agnihotri *et al.* (2006) also reported that aspect and physiographic positions, particularly on hills are expected to influence vegetation cover, because the south and east facing slopes have early sun-shine of the day, while north and west aspects receive sun-shine during the later part of the day.

Table 2 Density and dominance (%) of *Anogeissus latifolia* in different forest sites of Garhwal Himalaya, India (IVI-Importance value index, UD-undisturbed; MD-mildly disturbed and HD-Highly disturbed)

Altitude	Aspect	Forest type	Species richness	Density (Tree ha^{-1})	IVI	
800-1300	East	*Anogeissus latifolia* (mixed)	5	62.16	56.94	Bhatt *et al*., 2003
	West	*Anogeissus latifolia* (mixed)	4	34.61	37.90	
	North	*Pinus roxburghii* (mixed)	3	13.51	15.86	
	South	*Anogeissus latifolia* (mixed)	3	81.57	74.25	
	Disturbance					
900-1300	MD	*Anogeissus latifolia* (mixed)	10	37.56	32.61	Kumar *et al.*, 2004
	HD	*Anogeissus latifolia* (mixed)	8	31.43	23.92	
300-400	UD	*Holoptelea integrifolia* (mixed)	12	6.31	5.14	Kumar *et al.*, 2005
	MD	*Holoptelea integrifolia* (mixed)	12	4.21	5.32	
	HD	*Anogeissus latifolia* (mixed)	11	28.66	24.11	
	Aspect					
700-1000	South-east	*Anogeissus latifolia* (mixed)	7	78.26	65.88	Present study
	South-west	*Anogeissus latifolia* (mixed)	3	77.77	65.42	

Table 3 Concentration of dominance (CD), species diversity (H), equitability (EC) and distribution pattern (%) of trees on two aspects of Garhwal Himalaya, India

Aspects	CD	H	EC	Distribution pattern (%)		
				Regular	Random	Contagious
South-East	0.188	1.155	3.582	52.13	-	47.89
South-West	0.349	0.960	2.880	31.25	-	68.75

In the present study the concentration of dominance was higher on SW aspect and lower on SE aspect; however the diversity showed a reverse trend. The values of equitability were higher on SE aspect and lower on SW aspects (Table 3). The trees diversity values of the present study (0.960 and 1.155) are lower than the value reported (2.766) for sub-tropical forests of Garhwal Himalaya (Kumar *et al,* 2004). On SE aspect most of the species were distributed regularly followed by contagious and no specie was recorded random in distribution. Regular distribution occurs where severe competition between the individuals while random distribution is found only in very uniform environment (Panchal and Pandey 2004). However, on SW aspect distribution pattern for most of the species was contagious followed by regular. Several workers (Grieg-Smith 1957, Singh and Yadav 1974) have reported contagious distribution in natural vegetation. Topography, soil, climate and geographical location influenced the species diversity of forest. There is a great diversity in the floristic pattern due to altitudinal variation coupled with rainfall (Bisht and Lodhiyal, 2005). Similarity index reflects the area of changes of species composition along varying topographic and environment requirements (Nautiyal *et al.* 1997). The highest dissimilarity between lowest and highest altitudinal zones is attributed to variations in slope (Inamati *et al.* 2007).

Dominance-diversity curves were plotted between Importance value index and species sequence Figure-1. The curves fit the geometric series which conforms to the niche pre-emption hypothesis (Whittaker 1975). The geometric series pattern of species abundance is found primarily in species-poor (and often harsh) environments or in the very early stages of a succession (Whittaker 1972, Panchal and Pandey, 2004).

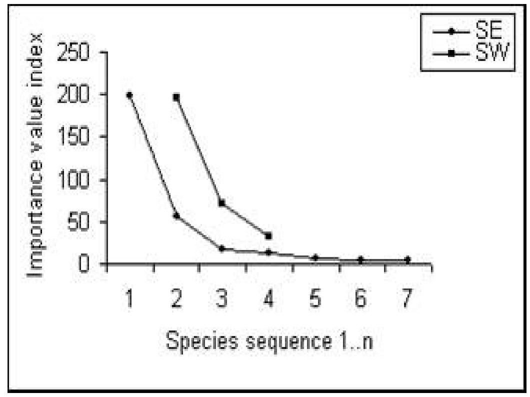
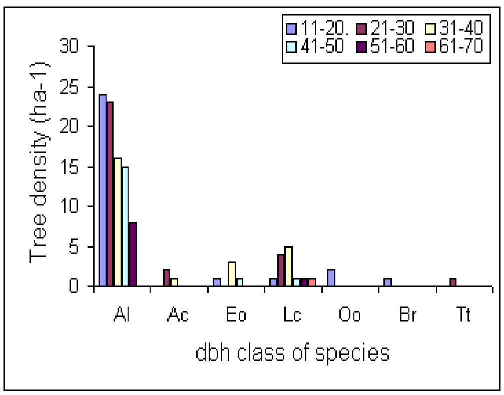
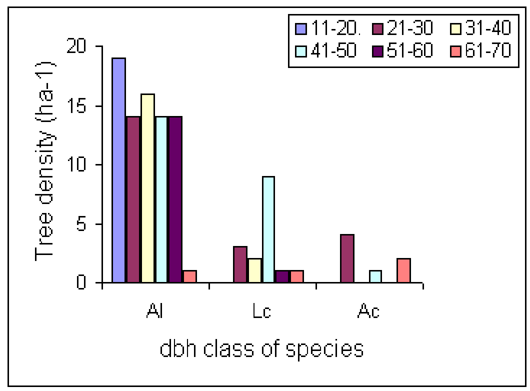


Figure1 Dominance-diversity (d-d) curves of trees on two aspects of Garhwal Himalaya, India



2(a)



2(b)

Figure 2a (Al-*Anogeissus latifolia,* Ac-*Acacia catechu* Eo-*Emblica officinalis* Oo- *Ougeinia oojenensis*, Lc-*Lannea coromandelica,*Br-*Bauhinia retusa*, Tt-*Terminalia tomentosa*)

Figure 2b (Al-*Anogeissus latifolia*, Lc-*Lannea coromandelica*, Ac-*Acacia catechu*) indicated density-diameter distribution of trees on two aspects of Garhwal Himalaya, India

Owing to its extensive distribution it grows on a wide variety of soils and geology. Sandy soil and low pH as well as low and high calcium content are not suitable for its growth (Joshi, 1959). Adequate moisture supply is essential for its growth, both water logging and drier conditions are harmful for its growth. Mudumalai Forest Division study revealed that slightly acidic soil reaction (pH 6.0-6.5) was found favorable for its better growth of *Anogeissus latifolia* and also emerges in hardy and clayey soil (Singh *et al.* 1988). In a similar study from this region Kumar *et al*. (2006) have also reported dominance of *A. latifolia* on aspects with clayey soil and pH between 6.1 to 6.6.

The diameter-distribution of trees has been often used to represent the population structure of forests (Saxena *et al*. 1984, Khan *et al.* 1987). The natures of curves are also used to interpret the characters of vegetations. The density of higher dbh classes in general was low in all the three stands on the sites. Similar trend was also reported by Roa *et al.* (1990). The change in the shape of the curve of disturbed sites may be the result of selective felling of individuals of higher diameter classes.

CONCLUSIONS

The results of the study indicated the dominance of *Anogeissus latifolia* on both aspects. To conclude in sub-tropical belt of Garhwal Himalaya due to variation in microclimatic conditions tree layer species composition differed markedly on both aspects in the same forest.

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