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Site and stand characteristics of hazelnut bearing forests in temperate region of Himachal Pradesh

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ABSTRACT

Hazelnut, *Corylus colurna* L an important nut crop growing in temperate forests of western Himalayas in Shimla, Kinnaur, Kullu and Chamba districts of Himachal Pradesh. The hazelnut locally known as Thangi or Thangoli in Panwalli finds an important place in the dietary habit of the tribal people of Pangi valley and hill people of Shimla, Kinnaur and Kullu districts. The wild hazelnut needs to be conserved due to its narrow distribution range and proneness to genetic depletion following habitat destruction. The species normally forms the intermediated strata of the coniferous forest and is found associated with oak, fir, spruce, deodar, maple and walnut. In India the species is little known except in high Himalayan regions where it is used mainly by the locals, graziers and the tribals (Pangwal and Bhot) as food. The investigation aims at describing the site and quantitative characteristics of hazelnut bearing forests in Kotkhai forest range (Kotkhai division) and Sach forest range (Pangi Division) of Himachal Pradesh. The stand characteristics in different diameter classes generally showed an increasing trend in DBH and average height with the increase in diameter classes. Trees at the sites were found in 10-20 cm to >100 cm diameter classes with the absence of few classes in some ranges. Total tree density in the hazelnut bearing forest varied from 445 to 535 per hectare while total basal area varied from 8783.35 to 5978.08 cm^2 per hectare. The crown projection ratio for hazel tree and its associated species ranged from 13.19 to 23.81 and 12.12 to 26.63 respectively in hazelnut bearing communities of Kotkhai and Sach forest ranges.

Keywords: Hazelnut; diameter; density; basal area; crown projection ratio

INTRODUCTION

Hazelnut, *Corylus colurna* L belonging to family Betulaceae is multipurpose social forestry species having restricted range of 1800-3300 m amsl (Brandis 1971) in western Himalayas. The species provides not only fuel, fodder and timber but also yields edible nuts for consumption by humans as well as wildlife. The kernels are a rich source of proteins, carbohydrates, vitamins, poly-unsaturated

fatty acids and other mineral elements especially iron, calcium and potassium. The recent research shows that hazelnuts exert strong protective effect against many diseases such as coronary heart problems, some types of cancer and syndromes (Richardsons 1997). Presently the species is grown commercially in many European countries, USA, China and Australia and is consumed both as fresh and dry. The species is facing changes in its structure, density and composition due to global warming, climate change and anthropogenic pressure (Bargali et al 1998, Kumar et al 2004). The present investigation was undertaken to understand the site and quantitative characteristics of hazelnut bearing forests of Himachal Pradesh.

MATERIAL and METHODS

Study site: The experimental sites were selected in the hazelnut bearing forests of Pattidhank and Gajta in Kotkhai range of Theog forest division (North Latitude 30°-56' and 31°-17' and East Longitude 77°-16' and 77°-37') and Sali and Mindal in Sach range of Pangi forest division (North Latitude 32°48' and 33°13' and East Longitude 76°15' and 76°47') in Shimla and Chamba circles respectively of Himachal Pradesh.

Estimation of stand characteristics: After surveying the selected site, randomly four sample plots (20 x 25 m) per site were laid down in the area. Trees falling in each sample plot were enumerated to determine the stand density as number of plants per hectare. All trees with a diameter at breast height (DBH) of more than 10 cm were mapped and the species height and crown characteristics were recorded for each.

Crown width: The crown width was measured in two directions (northsouth and eastwest) and average was calculated as suggested by Assmann (1970) and Chaturvedi and Khanna (1982) as under:

$$CW = \frac{D_1 + D_2}{2}$$

where CW= Crown width (m), D_1= First measured crown diameter (m), D_2= Second measured crown diameter at right angle to the first measurement (m)

Crown projection ratio: It is the ratio which states that by how many times the crown diameter is larger than the stem diameter.

$$\text{Crown project ratio} = b/d$$

where b= Crown width, d= Stem diameter

Crown basal area: It refers to the ground area actually covered by the crown and calculated by using following relation:

$$\text{Basal area} = \pi d^2/4 \text{ or } g^2/4\pi$$

where d= Diameter, g= Girth

Site factors: The following site factors were accessed to understand influence on regeneration and growth of hazelnut:

***Solar influx*:** Light illumination was recorded by digital luxmeter under and outside the hazelnut canopy as under (Rao 1953):

$$\text{Solar influx (\%)} = \frac{\text{Total solar radiation beneath the canopy}}{\text{Total solar radiation in open}} \times 100$$

Soil samples: Soil characteristics of the site were studied by collecting soil samples at 0-15 cm depth from the forest floor in moisture boxes. A composite soil sample was taken from each site making a total of two soil samples per forest range. The samples were analysed in laboratory for different physico-chemical properties (Table 1). The per cent soil moisture was determined by removing soil moisture by oven-drying the sample until the weight was constant. The moisture content (%) was calculated from the sample weight before and after drying. Organic matter layer was measured as depth of the column from top of humus layer to the point under humus where soil existed.

RESULTS and DISCUSSION

The perusal of data in Table 2 reveals that maximum number (535/ha) of stems were found in Gajta forest with 75 trees of *Corylus colurna*, 130 of conifer species and 330 of other broadleaved species followed by Pattidhank (485/ha), Sali (450/ha) and Msindal (445/ha) forests. However maximum number of *C colurna* trees per hectare was present in Mindal (235/ha) followed by Sali (200/ha), Pattidhank (145/ha) and Gajta (75/ha) forests. These figures lie within the reported range given by different researchers (Dhaulkhnadi et al 2008, Rawat and Kapoor 2008, Mir et al 2011, Kumar 2012) for the western Himalayan temperate forest.

The crown projection ratio for hazel trees and its associated species ranged from 13.19 to 23.81 and 12.12 to 26.63 respectively in hazelnut bearing communities of Kotkhai and Sach respectively. The solar influx was found to range from 23.25 to 39.06 per cent while the depth of organic matter ranged from 2.28 to 3.60 cm. It was also evident that there was little variation in sand, silt and clay proportion in both the forest ranges. The soil texture at Pattidhank and Gajta forests of Kotkhai forest range was found to be sandy clay loam whereas it was sandy loam in Sali and Mindal forests of Sach forest range. The organic carbon ranged from 2.28 to 3.60 per cent with maximum content recorded at Pattidhank and

Table 1. Chemical characteristics of soil and methods used for nutrient estimation

Nutrient	Method employed
Available N (kg/ha)	Alkaline Potassium permanganate method (Subbiah and Asija 1956)
Available P (kg/ha)	Extraction with 0.05 M $NaHCO_3$ (Olsen et al 1954)
Available K (kg/ha)	Flame photometer method
Organic carbon (%)	Wet digestion method (Walkley and Black 1934)
Soil pH	1:2.5 water suspension method (Jackson 1973)

minimum at Gajta forest. Similarly the pH of the soil was found to be slightly acidic to nearly neutral and it ranged between 5.89 to 6.91. However there was little variation in moisture content and it ranged between 9.27 to 9.76 per cent at different sites. It is also evident from the data in Table 2 that the available nitrogen was more at Sali (353.75 kg/ha) followed by Gajta (348.33kg/ha), Pattidhank (340.78 kg/ha) and Mindal (338.35 kg/ha) forests. The available phosphorus was found to be maximum at Gajta (32.00 kg/ha) followed by Pattidhank (31.50 kg/ha), Sali (30.90 kg/ha) and Mindal (29.40 kg/ha) hazel bearing forests. Similarly available potassium was maximum at Gajta (444.50 kg/ha) followed by Pattidhank (443.50 kg/ha), Sali (437.30 kg/ha) and Mindal (434.60 kg/ha) forests.

The overall natural regeneration was highest at Gajta forest (29.07%) followed by Sali (26.25%), Pattidhank (8.75%) and Mindal (6.56 %) (Table 2). The better regeneration at Gajta and Sali might be attributed to more organic carbon of 3.60 and 3.37 per cent, available nitrogen of 348.33 and 353.75 kg/ha, available phosphorus of 32.0 and 30.90 kg/ha and available potassium of 444.50 and 437.30 kg/ha respectively (Table 2). The observations find support from the work of Ali et al (2009) and Lanker (2007) in yew forest, Mahajan (2010) in Chir pine forest and Kumar (2012) in Chilgoza bearing forest. The three elements nitrogen, phosphorus and potassium differ in basic transformation mechanism through which the available pools are built up in forest soil. Sufficient amount of nitrogen, phosphorus and potassium are added annually in temperate forest soils through precipitation and litter fall (Boyle and Ek 1972).

The diameter classes ranged from 0-10 cm to >100 cm for trees of hazelnut and its associated species at Pattidhank, Gajta, Sali and Mindal (Table 3). However the diameter classes 80 to >100 cm and 90 to >100 cm were completely absent from Pattidhank and Gajta forests. In general the average DBH and height showed an increasing trend from lower to

Table 2. Site characteristics status of hazelnut bearing forests in Kotkhai and Sach forest ranges

Parameter	Kotkhai		Sach	
	Pattidhank	Gajta	Sali	Mindal
Average # trees/ha				
Corylus colurna	145	75	200	235
Conifer spp	155	130	155	35
Other spp	185	330	105	175
Solar influx (%)	25.58	23.25	39.06	27.46
Established stocking (%)				
C colurna	0.31	0.00	11.25	0.00
Associated species	0.78	11.95	5.95	1.56
Regeneration (%)	8.75	29.07	26.25	6.56
Crown projection ratio				
C colurna	14.72	23.81	23.67	13.19
Associated species	26.63	12.44	16.34	12.12
Organic matter layer (cm)	2.58	1.70	2.73	1.67
Soil Texture	Sandy clay loam	Sandy clay loam	Sandy loam	Sandy loam
Organic carbon (%)	3.60	2.28	3.37	2.86
pH	5.89	5.97	6.91	6.57
SMC (%)	9.27	9.65	9.62	9.76
Available N (kg/ha)	340.78	348.33	353.75	338.35
Available P (kg/ha)	31.50	32.00	30.90	29.40
Available K (kg/ha)	443.50	444.50	437.30	434.60

Table 3. Effect of diameter classes on growth and tree characteristics in hazelnut bearing forests

Diameter class (cm)	Average DBH (cm)	Average height (m)	Average # trees/ha	Average basal area/ha (cm^2)	Average crown basal area/ha (m^2)
			Kotkhai forest range		
Pattidhank					
10-20	16.71	10.25	55.00	240.27	573.85
20-30	27.71	11.20	120.00	1057.07	1465.60
30-40	34.90	13.06	150.00	1619.30	2574.20
40-50	44.77	13.62	70.00	1201.42	1547.85
50-60	54.62	15.34	55.00	1261.40	1242.35
60-70	67.68	13.00	15.00	227.41	392.00
70-80	74.04	22.00	20.00	371.22	793.65
80-90	-	-	-	-	-
90-100	-	-	-	-	-
>100	-	-	-	-	-
Total			485.00	5978.08	8589.50
Gajta					
10 -20	15.96	6.06	65.00	144.02	570.70
20-30	25.39	10.24	165.00	884.42	2647.15
30-40	35.23	14.78	105.00	1039.16	2276.50
40-50	44.59	16.07	105.00	1651.05	1633.25
50-60	56.69	14.60	25.00	631.17	459.10
60-70	65.64	17.94	45.00	1524.78	1080.70
70-80	77.23	17.45	20.00	937.50	475.00
80-90	85.99	26.50	5.00	290.20	72.90
90-100	-	-	-	-	-
>100	-	-	-	-	-
Total	-	-	535.00	7102.32	9215.30
			Sach forest range		
Sali					
10-20	14.47	7.51	175.00	376.02	2243.28
20-30	24.52	12.29	85.00	386.68	1318.00
30-40	33.09	13.11	55.00	466.38	1000.24
40-50	42.74	14.60	25.00	306.12	313.16
50-60	53.70	17.14	40.00	906.60	1092.27
60-70	60.51	17.42	25.00	718.55	716.49
70-80	78.03	20.75	20.00	956.21	722.48
80-90	84.00	23.00	20.00	1109.18	827.33
90-100	-	-	-	-	-
>100	156.05	24.00	5.00	955.81	168.39
Total			450.00	6181.54	8401.64

Mindal					
10 -20	18.31	6.25	10.00	394.61	0.90
20-30	25.84	9.10	80.00	813.10	1280.75
30-40	34.60	13.56	175.00	1579.10	3423.45
40-50	43.97	11.55	90.00	1296.70	1659.25
50-60	52.02	16.16	15.00	293.39	347.05
60-70	71.66	17.16	30.00	880.97	524.85
70-80	76.43	17.50	5.00	95.64	110.25
80-90	-	-	-	-	-
90-100	98.72	18.75	10.00	404.86	306.60
>100	113.32	22.33	30.00	3025.60	1140.25
Total			445.00	8783.90	8863.35

higher diameter classes. Similarly the maximum number of trees per hectare was obtained in lower and medium diameter classes (10 to 50 cm) at all the selected sites.

The maximum number of trees per hectare was seen in 30-40 cm (150), 20-30 cm (165), 10-20 cm (175) and 30-40 cm (175) in Pattidhank, Gajta, Sali and Mindal forests respectively. Jamoh (2014) found maximum number of trees concentrated between the medium diameter classes in oak forest. However the maximum basal area per hectare was recorded in medium and higher diameter classes viz 30-40 cm (1619.30 cm^2), 40-50 cm (1651.05 cm^2), 80-90 cm (1109.18 cm^2) and >100 cm (3025.60 cm^2) diameter classes in hazel bearing forests of Pattidhank, Gajta, Sali and Mindal respectively. It can thus be postulated that low tree density and high basal area in a particular stand indicate high biotic pressure in the area.

It is also evident that the maximum crown basal area per hectare (9215.30 m^2) was observed in Gajta forest which may be attributed to higher number of stem per hectare. Overall the maximum crown basal area was recorded in 30-40 cm (2574.20 m^2) at Pattidhank, 20-30 cm (2647.15 m^2) at Gajta, 10-20 cm (2243.28 m^2) at Sali and 30-40 cm (3423.45 m^2) at Mindal, diameter classes. Thus higher crown basal area was reported in the diameter classes that had highest number of stems. Almost similar results and variations have been reported by Kumar (2012) in Chilgoza pure forest, Singh (2004) in Deodar, Sharma (2006) in fir and spruce, Lanker (2007) and Ali et al (2009) in yew and Mahajan (2010) in Chir pine forests.

CONCLUSION

From the investigation carried on the site and stand characteristics of hazelnut bearing forests it is concluded that the soil was found to be slightly acidic to nearly

neutral with better growing conditions at all the sites despite poor status of natural regeneration. Thinning is recommended as silvicultural treatment due to presence of excess number of trees in lower diameter classes. Removal of all over mature trees in higher diameter classes to secure better growing conditions and optimum utilization of site potential is also needed.

REFERENCES

Ali A, Shamet GS and Kumar R 2009. Evaluation of natural regeneration status and site quality characteristics of *Taxus wallichiana* forest in Himachal Pradesh. Annals of Biology **25(2):** 159-162.

Assmann E 1970. Principles of forest yield study. Pergamon Press, New York, 506p.

Bargali K, Usman and Joshi M 1998. Effect of forest covers on certain site and soil characteristics in Kumaun Himalayas. Indian Journal of Forestry **21(3):** 224-227.

Boyle JR and Ek AR 1972. An evaluation of some effects of bole and branch pulpwood harvesting on site macronutrients. Canadian Journal of Forest Research **2:** 407-412.

Brandis D 1971. Indian trees. Bishen Singh Mahinder Pal Singh, Dehradun, Uttarakhand, India, 624p

Chaturvedi, AN and Khanna LS 1982. Forest mensuration. International Book Distributors, Dehra Dun, Uttarakhand, India, 407p.

Dhaulkhandi M, Dobhal BS and Kumar M 2008. Community structure and regeneration potential of natural forest site in Gangotri, India. Journal of Basic and Applied Sciences **4(1):** 49-52.

Jackson ML 1973. Soil chemical analysis. Prentice Hall of India Pvt Ltd, New Delhi, India, pp 20-30.

Jamoh N 2014. Study of sand characteristics of *Quercus leucotrichophora* A Camus in different types of forests. MSc thesis, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh, India, 82p.

Kumar M, Sharma CM and Rajwar GS 2004. Study on the community structure and diversity of subtropical forest of Garhwal Himalayas. Indian Forester **130(2):** 207-214.

Kumar R 2012. Studies of site characteristics, natural regeneration and nursery techniques in chilgoza pine (*Pinus gerardiana* Wall) in Kinnaur, HP. MSc thesis, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh, India, 172p.

Lanker UM 2007. Studies on some edapho-ecological characteristics and regeneration status of Himalayan Yew (*Taxus baccata* Hook F sy *T Wallichiana* Zucc). MSc thesis, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh, India, 113p.

Mahajan A 2010. Effect of forest composition on regeneration and growth attributes of Chir pine. MSc thesis, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh, India, 85p.

Mir AZ, Giri N and Kumar P 2011. Ecological studies of woody species in Chaupal forest division of Himachal Pradesh. Indian Journal of Forestry **34(4):** 433-438.

Olsen SR, Cole CV, Watanable FS and Dean LA 1954. Estimation of available phosphorus by extraction with sodium carbonate. USDA, Washington DC, USA, # 939.

Rao HS 1953. Vegetative propagation and forest tree improvement. Indian Forester **79(3):** 176-182.

Rawat RS and Kapoor KS 2008. Natural regeneration of *Alnus nitida* Endl as affected by biotic disturbances in Kullu valley of Himachal Himalayas. Indian Journal of Forestry **31(3):** 337-341.

Richardsons DG 1997. Health benefits of eating hazelnut: implications for blood lipid profiles, coronary heart diseases and cancer risks. Acta Horticulturae **445:** 295-333.

Sharma Y 2006. Studies on stand parameters and natural regeneration status of silver fir and spruce in Himachal Pradesh. MSc thesis, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh, India, 83p.

Singh A 2004. Biometric studies on stand characteristics of different aged deodar forests. MSc thesis, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh, India, 71p.

Subbiah BV and Asija GL 1956. A rapid procedure for the estimation of available nitrogen in soils. Current Science **25:** 259-260.

Walkley AJ and Black IA 1934. Estimation of soil organic carbon by chronic acid titration method. Soil Science **37:** 29-28.

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