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Biomass Production of Conifer Tree Species of Shankaryacharya Reserve Forest in Kashmir Valley

Shazmeen Qasba[*1], T.H. Masoodi*, S.J.A. Bhat*, Irfan Rashid Thokar, Nasir Rashid* and Amir Bhat***

**Faculty of Forestry, Sher-e-Kashmir University of Agricultural Sciences & Technology of Kashmir, Benihama, Ganderbal (J&K), India-191 201*

****Department of Botany M.V.M College, Barkatullah University Bhopal (M.P)*

*E-mail: [*1]shazmeen4@gmail.com*

Abstract—*The present investigation entitled " Biomass production of Conifer tree Species of Shankaryacharya Reserve Forest in Kashmir valley" was carried out, during the year 2011 and 2012. Locally also known as Sulaiman Teng, the study site is situated between an altitude of 1575 to 1967 m amsl and a latitude of 34°04'35.56" N and 74°51'08.63" E longitude. The reserve forest over looks famous Dal lake and presents a beautiful look of Srinagar city on the eastern side. Biomass production by conifers was worked out at three different aspects along the altitudinal range. Among all conifer species in entire reserve forest Cedrus deodara exhibited maximum total volume of 3711.5 m^3 ha^{-1}, total biomass production of 127.5 tons ha^{-1}, Pinus helpensis appeared to be co-dominant species with, total volume of 1923.9 m^3 ha^{-1}, total biomass production of 86.2 tons ha^{-1}. The overall total volume, total biomass, by all coniferous species was 13505.6 m^3 ha^{-1}, 503 tons ha^{-1} respectively. The study concludes that Shankaracharya resrve forest currently serves as a repository of plant diversity and is comprised of comprehensive rich ecological niches. The conservation of these niches by seeking maintenance of high biodiversity values within the forest zone, minimizing biodiversity losses due to any developmental activity and integration of biodiversity conservation is the need of the hour to harness economic and ecological services in future.*

Keywords*: Biomass production, Shankaryacharya, Conifer tree Species , Reserve Forest*

1. INTRODUCTION

Forest biomass assessment is also important for national development planning as well as for scientific studies of ecosystem productivity and carbon budgets (Zianis and Mencuccini, 2004).Biomass is a key property of ecosystems (Chapin et al., 2002). In forests, the live aboveground biomass (AGB) pool plays an important role in the global carbon cycle, accounting for a significant fraction of the total carbon pool and nutrient stocks (Brown and Lugo, 1984). The above ground biomass estimates are still an important source of uncertainty in the carbon balance from the various regions in part because of its unreliable estimates and great variation across landscapes and forest types (Houghton, 2007). Therefore, improved local and regional above ground biomass estimates provide essential data that will not only

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enable the extrapolation of biomass stocks to ecosystems or biome-wide carbon cycle modeling but will also allow reliable emission estimates from land use change scenarios (Houghton et al., 2009).

SHANKARACHARYA RESERVE FOREST hillock also known as SULIMAN TENG or TAKHT-I- SULIMAN in Kashmir is one of such groves famous for religious tourism all over the country. This sacred groves is one of the first instances of traditional conservation in Kashmir. The present study was; undertaken to study the Biomass production of Conifer tree Species of Shankaryacharya Reserve Forest in Kashmir valley.

2. MATERIALS AND METHODS

The present investigations were carried out on Shankaracharya reserve forest during 2011-2012. The reserve forest is maintained by the Forest Department, Government of Jammu and Kashmir for religious, aesthetic and recreational purposes. The study site is located between 34°04′ 35.56″ to 34°05′ 25.08″ N latitude and 74°50′ 03.16″ to 74°51′ 08.63″ E longitude. The altitude of the study site varies from 1575 to 1967 m asl. The following attributes were recorded to estimate volume biomass of conifers recorded in the reserve forest.

Standing volume and biomass of conifers

Stem volume

The standing timber volume and biomass was determined using procedures followed by (Whittaker, 1967). The following attributes were recorded to determine volume and biomass of conifers recorded at the hillock.

Diameter of trees (cm)

Diameter at breast height was recorded by using diameter tape. The number of trees was recorded simply by counting the number of trees of each species.

Height of trees (m)

Height of all standing conifer trees was recorded by using Ravi Altimeter.

Basal area (m^2)

Basal area (BA) = $\pi D^2/4$, where d = diameter at breast height

Prabolic volume of the stem (m^3)

Prabolic volume of the stem (VP) = 1/2 BA x H where, “ BA =Basal area”, H =height of the tree

Conic surface volume (m^3)

Conic surface volume (SC) = ½ breast height circumference × height of the stem.

The average volume of timber obtained for the tree was multiplied by number of trees in the compartments to estimate the timber volume and stem biomass of conifers for the entire hillock.

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Branch volume and biomass

Branch volume was determined as per formula proposed by Deleunze *et al.*, 1996.

$$\text{Branch Volume} = (D^2{}_{avg})/ 4 \times L \times \pi$$

Where,

$(D^2{}_{avg})$ = Average diameter of branch

L = Branch Length

The green branch volume obtained was oven dried to determine branch wood dry biomass using wood density factor as proposed by Chidumaya (1990).

$$B_{dwi} = B_{fwi\,/\,1\,+}\,M_{cdbi} \text{ Where,}$$

B_{dwi}= oven dry weight of branches

B_{fwi}= Fresh weigt of branches

M_{cdbi}= Moisture content of branches on oven dry weight basis

Needle biomass

The crown of the mean sample trees of each conifer species was measured from tip to base of the live crown with the help of clinometers. The crown was divided into four quarters of equal length. Two branches was randomly sampled from each quarter of the crown. All needles of the sample branches were harvested and weighed to find the green needle biomass. The needle biomass of remaining branches of each sample tree and species was determined by model developed by Manserud and Marshal (1999) for *Pinus ponderosa*. A subsample of needles was taken to laboratory for determination of dry needle biomass.

$$Y = b_0X_1^{b1}\ X2^{b2}\ X3^{b3}\ X4^{b4}\ldots\ldots\ldots\ldots\ldots \sum$$

Where

b_0 = 0.0377	Y = needle biomass
b1= 1.1896	X_1= branch diameter (cm)
b2= 1.0096	X_2 = branch length (m)
b3=0.1846	X_3= foliated length (m)
b4=0.5995	X_4 = distance from top of tree (m)

b1, b2, b3, b4 are regression constraints

3. STATISTICAL ANALYSIS

The data collected in the field was statistically analysed according to well designed procedures prescribed by Gomez and Gomez (1984).

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4. RESULT/DISCUSSION

The analysis of data pertaining to total volume and biomass production of Conifer tree Species of Shankaryacharya Reserve Forest in Kashmir valley along an altitudinal gradient is presented in Table 1 The results revealed that on middle altitude *Cedrus deodara* recorded with highest total volume of 3553.0 m^3 ha^{-1} and total biomass of 118.1 tons ha^{-1} , *Cedrus deodara* also recorded with highest total volume of 3870.0 m^3 ha^{-1} and total biomass of 137.0 tons ha^{-1} on upper altitude . Similar results have been reported by Pal *et al.* (2013) in Chanderbadni sacred grove in Garhwal Himalaya, Uttarakhand, India. These workers also found that *Cedrus deodara* was the dominant tree species among all other conifers recorded in this forest grove. *Pinus helpensis* emerged as co-dominant species with total volume of 1923.9 m^3 ha^{-1}, total biomass 86.2 ton ha^{-1}respectively. *Cupressus torulosa* averaged with total volume of 919.9 m^3 ha^{-1}, total biomass of 47.52 tons ha^{-1} on lower altitude and on middle altitude total volume of 466.1 m^3 ha^{-1}, total biomass of 23.9 tons $ha^{-1,}$ .The lowest total volume and total biomass of 475.9m^3 ha^{-1}, 13.8 tons ha^{-1} was displayed by *Pinus canariensis* . The over all total volume and total biomass, by all coniferous species on Shankaracharya reserved forest was 13505.6 m^3 $ha^{-1,}$ 503 tons ha^1 respectively. The total biomass values (503.22 t ha^{-1}) reported for six conifer species in the present study at Shankaracharya forest are almost similar to the ranges reported for the mixed coniferous forests elsewhere in the world (*Abies alba* 144.0 t ha^{-1}, Vyskot (1972); *Picea abies* 202 t ha^{-1}, Devillez *et al.* (1973); *Pinus taeda* 112 t ha^{-1}, Ralston (1973) as well as in India for Kumaun Himalayan conifer forests (*P. roxburghii* 113-283 t ha^{-1}), Similar varied biomass production in various forests have been reported by Tandon *et al.* (1998).

Table 1: Total volume and biomass production of Conifer tree Species of Shankaryacharya Reserve Forest in Kashmir valley

Species	Altitude	Total volume (m^3 ha^{-1})	Total biomass (ton ha^{-1})
Cupressus torulosa	Lower	919.9	47.52
	Middle	466.1	23.9
Pinus helpensis	Middle	1923.9	86.2
Cedrus deodara	Middle	3553.0	118.1
	Upper	3870.0	137.0
Pinus wallichiana	Upper	1794.6	60.1
Pinus roxburghii	Middle	502.2	16.6
Pinus canariensis	Middle	475.9	13.8
Total		**13505.6**	**503.22**

5. CONCLUSION:

Among all the conifers recorded on the study site, *Cedrus deodara* recorded the maximum biomass production. Thus this conifer will provide a long term carbon fixation capacity as compared to other conifer species. The growth of exotic pines introduced in the area is on the lower side against the reported values for these species in their natural zone of occurrence.

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