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Yield table of *Acacia catechu* for the Lateritic-Humid Tropics

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ABSTRACT

Acacia catechu is one of the important Non-Timber Forest Product resources of India which is used to extract *katha* and *kutch* from heartwood. Local yield table is very important for estimation of yield on site. Hence a study was conducted to develop a yield table for the heart wood weight for different diameter at breast height and height for the lateratic humid tropics. A total of 48 trees representing VI dbh classes of 5 cm interval were felled and their rootswere excavated to quantify the stem volume, stem heartwood volume and heart wood weight of stem and root. The polynomial regression model was used to develop the yield table for the prediction of heart wood weight by using the yield as the dependent variable and the dbh with height as the independent variables.

INTRODUCTION

Khair (*Acacia catechu* Wight & Arn.) is a medium sized deciduous tree with a moderately straight and cylindrical stem. It iswidely distributed in the Indian sub continent under varying climatic and edaphic conditions (Troup 1921). In Konkan, this species is scattered on natural plains as well on farm fields and private lands. The species is known for its valuable heart wood, which is used in the manufacture of Katha and Cutch. The total area under *khair* is estimated to be about 5800 sq km in the country, with the annual consumption of 63,000 tons of *khair* heart wood for above mentioned products. It has been estimated that about 3000 to 3500 tons of katha is produced annually by small scale and cottage industries in the country. However, the annual demand of this species is increasing exponentially as numerous small cottage industries are establishing every year. The farmers of this region sale the wood on the unit tree basis to the local merchant without the complete knowledge of its yield and are usually under paid. This could be due to non-availability of local yield table for the region. Therefore, the development of yield table for the region is very essential and that will help in predicting yield of heartwood from the tree. Hence, an attempt was made to develop the yield table for the konkan region of Maharastra belonging to the humid tropical condition.

MATERIALS AND METHODS

Khair trees distributed in the Konkan region were selected for the estimation of heart wood yield. The sampling area was located in the Western Ghats at an elevation of 350 msl. The location receives an annual rainfall of 3500 mm and has a minimum temperature of 21 °C and maximum of 34 °C. The soil is Lateritic type comprising of moist deciduous forest type. Forty eight healthy treesequally distributed in the various diameter classes were destructively sampled from established plantations located at Central Experimental Station, Wakavali of Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli and

natural trees scattered in the campus. A total of five trees from each diameter classes (class interval: 5) were selected and their D B H (diameter at breast height) was recorded. Selected trees were felled at collar height and their roots were excavated upto the coarse root (2 cm diameter) portion. Felled trees were cut into logs of 1 m length after measuring the total height, then logs were weighed and diameter at base, middle and top of the log was recorded with the help of a Caliper. Bark and sap wood portion of the logs was scarped with the help of antree axe and bill hookwith upmost care so as to retain the complete heartwood portion. The scrapped logs containing only heartwood were weighed and measured for their top, middle and basal diameter. Similarly, the total root weight and root heartwood was recordedfor all the excavated roots of the trees. Total stem volume and stem heartwood volume of all trees belonged to different diameter classes was calculated by Samalian's formula as below:

Volume: $V = A_1 + A_2 \times L$

Where: V is the volume of the Log in m^3, A_1 is the area of the small end of the log in m^2, A_2 is the area of the large end of the log in m^2 and L is the length of the log in m.

All these parameters were analyzed to evaluate the variations between diameter classes using a MS-DOS based MSTAT statistical software. A linear regression was developed between d. b. h. and heartwood yield (stem heartwood weight, root heartwood weight and total heartwood weight) using a SPSS version 7.5 software. Lastly, the yield table for *khair* for predicting the heart wood yield at different height and diameterswas developed from the regression equation.

RESULTS AND DISCUSSION

All the trees sampled in the experiment ranged from 4.33 to 26.6 cm D.B.H. (diameter at breast height) and were grouped into VI diameter classes of 0-5 cm interval each. Similarly, the average tree height ranged from 5.34 (0-5 cm class) to 16.06 m (25-30 cm class). It was observed that the stem volume and heartwood volume increased along the diameter classes and varied significantly (Table 1). Furthermore, stem heart wood weight, root heartwood weight, total heartwood weight and total tree weight varied significantly among the various diameter classes (Table 1). This variation among the diameter classes may be due to different age factor. Similar observations were also reported by Mishra and Singh (1985) and Kumar (1998) in *A. catechu.* Interestingly, it was observed that the heartwood formation of *A. catechu* occurred only after the attainment of 5 cm DBH. Hence, trees with less than 5 cm DBH cannot be recommended for Katha extraction. It was recorded that *khair* trees contained considerable amount of heartwood of nearly 40-50 percent after attainment 15 cm DBH. Hence, as the heartwood content of the trees increased proportionately to that of the stem weight, commercial harvesting can be initiated when tree attain a diameter of 15 cm and onwards. The root contributed considerable amount of heartwood weight and in almost all the diameter classes 24 percent of the total heartwood weight was represented by root heart wood. Hence, it is mandatory that root portion of the tree is to be excavated for economical harvest of this species resulting in 24 percent more income to the farmer. Overall it may be concluded that highest heartwood biomass can be obtained with increase in diameter of stem and tree height. This result is also in conformity with the findings made by Singh and Jain (1987), Kumar (1998) and Thakur et al. (2008) in *A. catechu*.

Various models were considered for the development of regression equation to predict the heart wood yield of *A. catechu.* Among them, the equation developed using a polynomial (at 2) had better fit and R^2 values (0.95) *viz.* $y=ax + b$, $Y= a \ln(x) + b$, $Y=a e^{bX}$, $Y= aX^2 + b X + c$. Singh and Jain (1987) have strongly recommended polynomial regression model to determine the yield of heartwood in *Acacia catechu* from North India. Furthermore, the independent variables used in the form of D^2H (D= DBH and H= Tree Height) for the development of equation contributed positively towards yield prediction of this species. This was in line with the recommendations made by the Forest Survey of India (1996) for the preparation of volume tables for various species including *A. catechu*. The regression equation developed to predict the total heart wood (stem+ root) yield of *A. catechu* is:

Table 1: Volume and Yield Parameters of Stem and Root Heart Wood for different diameter classes

Diameter classes (cm)	Total stem volume (m^3)	Heartwood volume (m^3)	Stem heart wood ($kg\ tree^{-1}$)	Root heart wood ($kg\ tree^{-1}$)	Total heart wood ($kg\ tree^{-1}$)	Percent heartwood weight of the total tree weight
I. 0-5	0.0020	0.0005	0.00	0.07	0.07	1.67
II. 5-10	0.0157	0.0073	9.48	3.17	12.14	36.74
III. 10-15	0.0410	0.0218	28.83	11.42	40.25	46.18
IV. 15-20	0.1098	0.0568	71.33	21.92	93.25	46.66
V. 20-25	0.1830	0.1105	125.23	30.17	155.40	47.41
VI. 25-30	0.3802	0.2230	204.45	71.67	276.12	45.01
S.E.(m)	0.02	0.01	9.25	2.42	11.26	11.26
C.D.@ 5%	0.05	0.03	26.94	7.04	32.80	32.8

Table 2: Yield table for total heartwood (stem+ root) for different

DBH(cm)	HEIGHT(m)														
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
1															
2															
3			1.357												
4			1.756	2.060	2.364	2.668	2.973	3.277							
5				2.744	3.220	3.696	4.172	4.649							
6					4.268	4.954	5.641	6.329	7.018						
7						6.444	7.382	8.320	9.260	10.202					
8						8.167	9.395	10.625	11.856	13.090	14.326				
9						10.125	11.683	13.245	14.810	16.378	17.950	19.525			
10							14.249	16.185	18.125	20.070	22.021	23.977			
11								19.447	21.806	24.173	26.546	28.928	31.317		
12								23.037	25.859	28.691	31.534	34.387	37.251		
13								26.959	30.289	33.633	36.992	40.366	43.754	47.157	
14								31.218	35.102	39.007	42.931	46.874	50.837	54.820	
15									40.306	44.820	49.359	53.924	58.515	63.132	
16										51.081	56.288	61.529	66.803	72.110	77.451
17										57.799	63.729	69.701	75.716	81.773	87.873
18										64.986	71.694	78.456	85.272	92.141	99.063
19										72.651	80.197	87.810	95.488	103.234	111.045
20										80.806	89.251	97.777	106.385	115.074	123.845
21										89.463	98.870	108.376	117.982	127.686	137.490
22											109.070	119.625	130.299	141.093	152.007
23											119.866	131.542	143.361	155.322	167.426
24												144.148	157.189	170.399	183.778
25												157.462	171.808	186.353	201.097
26													187.244	203.212	219.414
27													203.522	221.008	238.766
28													*220.670*	*239.773*	*259.189*
29														*259.538*	*280.720*
30														*280.339*	*303.400*

R^2=0.96, N=48, Values are in Kg $tree^{-1}$

Table 3: Yield parameters of *Acacia catechu* in different diameter classes

Diameter class (cm)	Stem Volume (m^3)	Height (m)	Stem Heartwood volume (m^3)	Stem Weight (kg)	Stem Heartwood weight (kg)	Root weight (kg)	Root heartwood weight (kg)	Total (Stem + Root) weight (kg)	Total (Stem + Root) heartwood weight (kg)
0-5	0.003	5.87	0.001	5.33	0.00	1.17	0.00	6.50	0.00
5-10	0.012	7.33	0.002	23.71	5.81	5.70	2.20	29.41	8.01
10-15	0.041	10.65	0.008	60.20	23.30	17.10	8.90	77.30	31.20
15-20	0.101	13.34	0.019	141.90	55.93	35.50	19.90	177.40	75.83
20-25	0.135	13.55	0.031	233.30	105.70	54.00	29.00	287.30	134.70
25-30	0.240	15.14	0.055	369.17	183.00	122.00	68.00	491.17	251.00
S.E. (m)	0.01	0.28	0.00	14.85	11.07	3.46	2.16	16.27	12.37
C.D.	0.04	0.83	0.00	43.81	32.65	10.21	6.38	47.99	26.49

$$Y=25.48(D^2H)^2 + 189.7(D^2H)- 0.8446$$

Where: Y = total heart wood yield of *Khair*, D= diameter at breast height and H= height of the stem.

In the yield table, the heart formation occurred in a tree that attained a height of 3 m with diameter of 3 cm. The economic yield starts from tree that attains D B H of 15 cm and height 9 m and above, as per the table it yields 40.30 kg total heart from a tree. Similarly, tree with 30 cm D B H and 15 m height may produce 303.4 kg total heart wood (Table 2). The yield table developed can be used to estimate the heart wood yield of *Acacia catechu* in the Konkan region of Maharashtra.

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