Research Article

ASSESSMENT OF WEIGHT TABLE FOR *Populus deltoides* GROWN IN NORTHERN HARYANA

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Abstract: *Populus deltoides*is an important agroforestry tree species adopted by the farmers in North India. The economic returns are comparatively better than rice-wheat rotation under well managed conditions. The presented investigation was carried out in the Yamunanagar district of Haryana state. The data on tree height, diameter at breast height was recorded on 91 randomly selected trees having diameter at breast height (1.37 m from surface) ranging from 14.2 to 35.4 cm. The trees were felled and cut into logs of acceptable merchantable lengths. The trees were felled and cut into logs of acceptable merchantable lengths. The data on log length, log diameter on both ends and at mid-point, and log weight were recorded. The regression equations were developed to predict the fresh weight of timber on basis of diameter at breast height (DBH) and tree height, and DBH alone. Results were statistically analyzed and found that all equations had very good-fit. Using R^2 as the indicator of best fit, the model proposed by Schumacher and Hall ($R^2 = 0.941$) was found the very appropriate to predict fresh weight for poplar plantation in Haryana. Single-entry model ($R^2 = 0.902$) was also recommended for predication of weight as it is not always easy to measure accurate height of the standing tree. These tables will be useful to the farmers, timber growers, wood contractors, state forest departments, research workers and the planners in their respective areas of concern for future plantation programmes.

Keywords: *Populus deltoides*, height and diameter

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Introduction

Nowadays Forest-based industries in India show significant deficits between wood requirements and supply. The paper industry in particular is plagued by raw material shortage in the face of continually increasing demand. Therefore, plantation timbers under social forestry, agroforestry and imported wood would be the means to fill the gap. *Populus deltoids* (typical eastern cottonwood from the USA) is an exotic and is currently the species of choice for agroforestry in the Indo-gangetic plains of the states of Uttar Pradesh (U.P.), Haryana and Punjab. Poplar (*Populus deltoides*), a native tree of USA introduced in India around 1950, is widely grown on a rotation of 6-8 years in all over northern India as an agro-forestry tree because of its desirable characters and multiple uses. A well-drained, deep and fertile soil is suitable for poplar. Poplar prefers neutral soils but can be grown well on soils having pH from 5.5 to 8.0. It is successfully planted only under irrigated conditions and success is restricted to correct choice of clone, spacing and better management practices. Poplar timber is usually sold by farmers on weight in both nearby markets or at the mill gate delivery basis. Therefore, they would like to know the fresh timber weight (biomass) produced by standing tree crop. Rather converting timber volume to weight through wood density. The wood-based industries especially the plywood industry requires the poplar wood raw material in fresh green condition. Therefore, to have an estimate of standing timber for plywood industry, the weight measurements of freshly cut trees up to 10 cm over bark were taken. The timber weight tables are useful and essential to estimate the sale price of standing trees. Several timber weight tables developed in the past for this species are from other states and locality [1-4]. Therefore, keeping in view, the present investigation was carried out to develop weight table on basis of DBH and tree height and DBH alone for the species.

Materials and Methods

The present investigation was carried out in the Yamunanagar district (77º 28' E

longitude and 30º 1' N latitude and elevation is 255 m (837 ft) above m.s.l. The mean monthly temperature of Yamunanagar ranges from 6. ºC in January to 39.4 ºC in summer months of May and June. The Yamunanagar region has maximum area under poplar plantation in Haryana. The Yamunanagar region is biggest timber market for trees grown under agro-forestry systems. Due to various forest-based industries, like those of plywood and paper, Yamunanagar has provided the tree growers a ready market for a variety of tree species especially Poplar and Eucalyptus. Trees with all possible DBH and height were selected for recording the data by visiting felling site in Yamunanagar district. The felled sample trees were measured for diameter at breast height (DBH), total tree height and merchantable bole height. Direct measurements on diameter at breast height (DBH) at 1.37m from ground level, total tree height, and merchantable bole height were taken after trees were felled. Felled trees were pruned to clear lateral branches along with lops and tops. Uprooted stump portion of felled trees were cut and main bole were cut into 2.59 m and 1.29 m sections upto a top diameter of 10 cm (over bark). Diameters at both ends of each section were recorded and mean diameter was calculated. Each section was then weighed on a weighing scale. Weights of all sections of a tree were summed up. Growth and biomass data were recorded using standard meter tape and weighing balance. The regression models were fitted with the observed and estimated values for weight and a simultaneous F test was performed for the intercept and slope. Evaluation of the goodness of fit of models was performed by calculating the coefficient of determination, residual mean square and standard error of estimate. For multi entry regression equations, the diameter (DBH) and height were used as independent variable. For single entry tables, only DBH was used as an independent variable. For regression form, the equations were used are given in [Table-1].

Table-2 Standard green timber weight table for *P. deltoids* based on W =0.068H$^{0.892}$D$^{1.785}$

DBH\H	10	12	14	16	18	20	22	24	26	28	30
10	32.60	38.36	44.01								
12	45.14	53.11	60.95	68.66							
14	59.44	69.94	80.26	90.41	100.43	110.33					
16	75.44	88.77	101.86	114.75	127.47	140.04	152.47	164.78			
18	93.10	109.54	125.70	141.61	157.30	172.81	188.15	203.34			
20	112.36	132.22	151.71	170.91	189.85	208.57	227.08	245.42	263.59		
22	133.21	156.74	179.85	202.61	225.07	247.26	269.21	290.94	312.48		
24	155.59	183.08	210.08	236.67	262.89	288.81	314.45	339.84	365.00		
26		211.21	242.35	273.02	303.28	333.18	362.75	392.04	421.07	449.85	
28			276.63	311.64	346.18	380.31	414.07	447.50	480.63	513.49	546.10
30				352.49	391.56	430.16	468.34	506.15	543.63	580.80	617.68
32					439.37	482.69	525.54	567.97	610.02	651.72	693.11
34						537.86	585.61	632.89	679.75	726.22	772.34
36							648.52	700.88	752.78	804.24	855.31
38								771.91	829.06	885.74	941.99
40									908.57	970.68	1032.32

Results and Discussion

Trees with all possible DBH and height were selected for recording the data by visiting felling site in Yamunanagar district. Ninety one trees were randomly selected for recording actual weight corresponding to diameter at breast height (DBH). Actual weight of poplar trees corresponding to their DBH were used for development of weight table. The trees diameter at the breast height varies from 14.2 cm to 35.4 cm. The actual weight of trees corresponding to diameter at breast of the trees is graphically presented in [Fig-1].

Green timber weight

In general, fresh weight is estimated using regression equations that provide a weight estimate from simple measurements such as diameter at a height of 1.37 m, total height or height to fork and some expression of tree form [5-8]. Avery and Burkhart [9] scientifically preferred to weigh a series of sample trees and to relate tree-weight to measurable tree dimensions like DBH and tree height through regression analysis similar to those of volume predication. Some estimation of biomass of Populus deltoides have been worked out by Toky et al. [10], Rizvi et al. [11]. These equations may be local (when weight is a function of a single variable such as d) or standard (when weight is a function of two or more variables, usually d and h). We have used two different regression equations to estimate the timber fresh weight, out of which one for standard timber weight equations and one for local timber weight equation. Lohani and Sharma [1], Sharma [2] Chaturvedi [3] and Dhanda and Verma [4] have developed volume and weight tables for P. deltoids based on data from states other than Haryana.

Table-1 Regression equation for timber volume estimation of *P. deltoides*

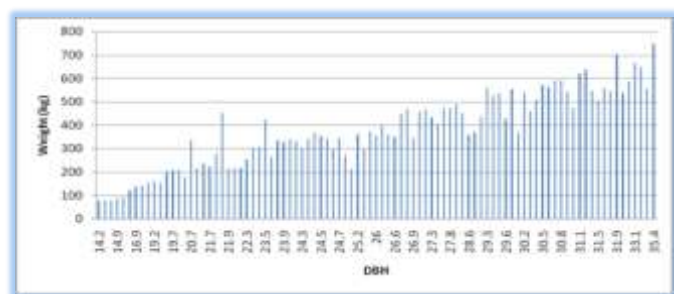| Model Name	Regression equation	Coefficient of determination (R^2)	Standard error
Logarithmic (Schumacher and Hall)	W =0.068H$^{0.892}$D$^{1.785}$	0.940	0.130
Single-entry	$\sqrt{W}$ = -2.682 + 0.843D	0.900	1.403

Fig-1 Actual weight of sampled trees corresponding to the DBH

Schumacher and Hall Model: For this regression equation, Coefficient of determination (R^2) is 0.94and standard error of estimate is 0.130(as given in [Table-1]. The value of determination coefficient being quite high (R^2=0.94) implies that this estimates fresh green timber weight of poplar very near to the actual.

Based on the above regression equation, the estimated table for green timber weight is given in [Table-2]. Standard timber weight of poplar trees of 22 cm DBH varied from 133.21 kg to 312.48 kg depending upon the tree height variation from 10 m to 26 m [Table-2]. The tree having height of 24 m and 36 cm DBH contain weight of 700.88 kg.

Single-entry Model

In practice, it is not always easy to measure total height of each standing tree, which is both time consuming and cumbersome. Therefore, regression equation of timber weight based on DBH alone was also worked out. As shown above in [Table-1] Coefficient of determination (R^2) is 0.902and standard error of estimate is 1.403. About 90.2% of variation in the character timber volume is explained by the variation in the character D. Weight table based on this regression equation is given in [Table-3]. The results showed that for estimating fresh timber weight of poplar trees, the DBH alone can also be relied upon, as per significance of coefficient of determination (R^2). It implies that we can estimate the weight of fresh timber with the regression equation based on DBH alone. The single-entry equation is recommended by Dhanda and Verma [4] and Tewari [12] also, as it is not always easy to measure accurate height. However more reliable estimate of tree weight over wider area can be obtained from the regression equation based on both tree height and DBH, as the tree height is better of site characters while the DBH is influenced by planting density. The coefficient of determination (R^2) in case of Schumacher and Hall model (0.941) is relatively higher than those of single-entry model (0.902). The fitted weight equations presented provided good estimation of the weight of individuals of *Populus deltoides*. Using R^2 as the indicator of best fit, the model proposed by Schumacher and Hall was found appropriate to predict volume for poplar plantation in Haryana. Tewari [12] reported that Schumacher and Hall model was fittest model for predicting the weight and volume of Tecomella undulate. Mathematical expressions of the model are W=aHb1Db2, where W is fresh weight of timber (kg), H is the height (m) and D is the diameter at a height of 1.37 m (cm).

Application of research: These timber weight tables will be useful to the farmers, timber growers, wood contractors, state forest departments, research workers and the planners in their respective areas of concern for future plantation programmes.

Research Category: Forest Mensuration

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Table-3 Green timber weight for *P. deltoiodes* based on √W = -2.682 +0.843D

DBH (cm)	Weight (kg)
10.0	33.078
10.5	38.106
11.0	43.490
11.5	49.229
12.0	55.323
12.5	61.774
13.0	68.579
13.5	75.741
14.0	83.258
14.5	91.130
15.0	99.358
15.5	107.942
16.0	116.881
16.5	126.176
17.0	135.827
17.5	145.833
18.0	156.194
18.5	166.911
19.0	177.984
19.5	189.412
20.0	201.196
20.5	213.336
21.0	225.831
21.5	238.681
22.0	251.888
22.5	265.449
23.0	279.367
23.5	293.640
24.0	308.268
24.5	323.252
25.0	338.592
25.5	354.287
26.0	370.338
26.5	386.744
27.0	403.506
27.5	420.624
28.0	438.097
28.5	455.926
29.0	474.110
29.5	492.650
30.0	511.545
30.5	530.796
31.0	550.403
31.5	570.365
32.0	590.683
32.5	611.356
33.0	632.385
33.5	653.770
34.0	675.510
34.5	697.605
35.0	720.057
35.5	742.863
36.0	766.026
36.5	789.544
37.0	813.417
37.5	837.646
38.0	862.231
38.5	887.171
39.0	912.467
39.5	938.118
40.0	964.125

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