

Genetic assessment and variation study among different populations of *Shorea robusta* Gaertn. f. in Jharkhand, India

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ABSTRACT

Shorea robusta Gaertn. f. is one of the most extensively dispersed and economically significant species. It contributes about 10.87 percent to the growing stock of the country and designated as state tree of Jharkhand and Chhattisgarh. It is found predominantly and naturally throughout the Jharkhand, but the populations are getting degenerated and of poor vigor. To study the growth pattern among different populations, identify populations for collecting seeds to raise future plantations and devise the conservation strategies, 15 distinct populations were studied for plant height (PH), diameter at breast height (DBH), basal girth (BG), clear bole length (CBL), crown length (CL) and individual tree volume across the Jharkhand. Under the study, the Saranda population was found superior for all the studied economical traits viz. mean plant height (21.73 m), mean diameter at breast height (0.45 m), mean clear bole length (13.42 m) and mean tree volume (2 m³). Hence, Saranda population can be utilized as seed source for raising plantations in Jharkhand. The correlation analysis revealed positive and significant correlation of tree volume with DBH, BG and pH. Therefore, the tree volume can be utilized for selecting the superior trees for further tree improvement programs.

Key words: *Shorea robusta, Genetic assessment, Tree improvement, Seed source*

Introduction

Shorea robusta Gaertn. f. is one of the most important timber species belongs to the family Dipterocarpaceae (Ashton, 1982). It is found throughout central India, from the Eastern Ghats to the Eastern Vindhya and Satpura mountains, and is assumed to originate from northeast India (Kulkarni, 1956). In more humid regions, it is ever-green; in drier climates, it is dry-deciduous, losing

most of its leaves from February to April and then regaining them in April and May. It may reach heights of 50 meters and widths of 4 meters. Champion and Seth (1968) divided the Indian sal forest into two main categories: moist tropical sal forest and dry tropical woodland. Sal forests are found in regions with average annual precipitation of 1000-2000 mm, a dry season that lasts no longer than four months, and minimum and maximum temperatures of 2 °C and 40 °C, respectively (Tewari, 1995). One

of the most important hardwoods in India, it has a strong, durable, and fire-resistant wood with coarse grains. Freshly cut wood, initially light in color but eventually turning brown. The wood is robust and sticky. The wood is highly sought after for making furniture. Suoheimo *et al.* (1999) state that genetic diversity and natural population distribution patterns are critical to developing and conserving *S. robusta* and other forest plant species. It is state tree of Jharkhand and distributed naturally throughout the state. It plays significant role in livelihood generation of the tribal people in the state. Historically, the Sal Forest in Saranda region was considered as best Sal Forest of the Asia, but since last few decades the sal trees are losing vigor and turned into poor stands or degenerated forest. Hence, it was the high time to study the growth pattern in different populations of the sal and identify the best population which can serve as the seed source for raising seedlings and establishing the plantations.

Materials and Method

The study was conducted in entire forest area of Jharkhand which is located between 22°00'–24°37'N and 83°15'–87°01'E. The study area fell into three agro-climatic sub-zones which covers 23,721 sq. km, or 29.64 percent of the total land area (FSI, 2021). Jharkhand can be split into North and South Jharkhand, the Damodar Valley, the Santhal Pargana uplands, the Peatland region, the Ranchi Plateau, and the Singhbhum region based on its geomorphological features. To divide the sampling region for Sal occurrence points, the grid mapping methods (5 x 5 km) devised by the Survey of India (SoI) was utilized. Jharkhand's Sal Forest is covered by 2263 grids in total, some of which are right next to the district line. Every grid has dimensions of 5 x 5 kilometers. To carry out the present study, twenty percent of the total forested land (4744 km² out of 23721 km²) was considered and covered by 189 grids. For the quantitative evaluation of the forest, 450 sal occurrences were documented throughout the study area. These layers allowed for the identification of 15 populations of sal. Within each population, 30 individual trees were randomly examined, ensuring that each tree was at least 100 meters away from the others. Each tree's growth information viz. Plant height (PH), Basal Girth (BG), Girth at Breast Height (GBH), Diameter at Breast Height (DBH), Clear Bole Length (CBL), Crown Length (CL) was

recorded for evaluating the performance of the population. To study the productivity and vigour of the studied populations, the individual tree Volume (Vol.) was calculated using the regression equation (FSI, 1996). The correlation among the studied traits was also determined by Pearson's correlation analysis (r). The degree of relationship between two variables has been ascertained by computing a coefficient called the coefficient of correlation, which consistently offers a quantitative evaluation of the degree of similarity between two variables (Kumar and Singh, 2019).

Results and Discussion

Genetic assessment and variation study

To better analyse the variation among the studied 15 populations, the growth traits viz. Plant height (PH), Basal Girth (BG), Girth at Breast Height (GBH), Diameter at Breast Height (DBH), Clear Bole Length (CBL), Crown Length (CL) were recorded and mean, standard error (SE) and standard deviation (SD) for each trait were estimated (Table 2). The studied populations were found different and a large range of variation was estimated based on the studied traits. The significantly higher tree volume was recorded for Saranda population (2.00 m³) followed by Simdega population (1.73 m³), Koderma population (1.50 m³), Bokaro population (1.46 m³), and Latehar population (1.45 m³). The lowest value of individual tree volume was observed for Khunti population (0.61 m³). The significantly highest value above the mean for DBH was found for the Saranda population (0.45 m), followed by the Latehar population (0.44 m), Simdega population (0.43 m), Bokaro population and Koderma population (0.40 m), and the lowest value was recorded for Ramgarh population (0.25 m) (Figure 1). In the case of character plant height (PH), the significantly highest value above the mean was found for the Saranda population (21.73 m), followed by the Sahibganj population (20.05 m), Gumla population (20.02 m), PTR population (19.95 m), Chatra (S) population (19.87 m), and the lowest value below the mean for tree height was found for Latehar population (16.61 m). In the case of character clear bole length (CBL), the significantly highest value above the mean was found for the Saranda population (13.42 m), followed by the Sahibganj population (12.65 m), Bokaro population (12.57 m), Chatra (S) population (12.37 m), Gumla

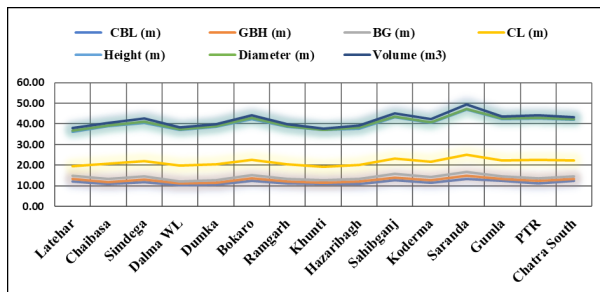


Fig. 1. Variation among populations for growth-contributing traits

population (12.33 m), the Latehar population (11.97 m), and the lowest value below the mean for clear bole length (CBL) was found for Dalma WL population (10.18 m). In the case of character basal girth (BG), the significantly highest value above the mean was found for the Saranda population (2.05 m), followed by the Sahibganj population (1.94 m), Simdega population (1.72 m), Latehar population (1.63 m), Bokaro populations (1.53 m), and the lowest value below the mean for basal girth was found for Khunti population (0.96 m). In the case of character crown length (CL), the significantly highest value above the mean was found for the PTR population (8.75 m), followed by the Saranda population (8.31 m), followed by the Gumla population (7.68 m), followed by the Dalma WL population (7.58 m), and the lowest value below the mean for crown length was found for Latehar population (4.64 m). Similar trends were observed by Sahoo *et al.* (2022) in *Eucalyptus tereticornis* species and Kumar and Singh (2019) in *Melia composita*.

Correlation among traits

The correlation coefficient is a statistical measure of

the relationship between two or more variables. It does not, however, express the degree to which one variable is dependent on another. It gauges the degree of symmetry and association between two variables. Genotypic selection for volume and growth improvement will be effective only when the relationship between the volume and growth-contributing traits is well established. The improvement of one trait depends on the correlation of that trait in a positive direction or negative direction with another trait. The trait tree volume was found to be significantly highly correlated with DBH, and GBH at a 0.1% level of significance, however, it was significantly positively correlated with PH and BG at 5% and 1% levels of significance respectively (Table 1). At the same time, the trait tree volume was non-significant with crown length and clear bole length. The trait DBH was significantly positively correlated with GBH and BG at 0.1% and 1% levels of significance respectively, but negatively correlated with CL. There was a non-significant relationship between DBH and CBL. The trait plant height (PH) was found to be significantly positively correlated with clear bole length (CBL) at 5% significance, but non-significant with GBH, BG, and CL. The trait crown length (CL) was negatively correlated with GBH but non-significant with CBL and BG as well. The trait basal girth (BG) was significantly positively correlated with GBH and clear bole length at 5% and 1% levels of significance. Both Tewari *et al.* (2012) in *Prosopis juliflora* and Gupta *et al.* (2012) in *Acacia catechu* made similar observations. Finally, the trait GBH was found non-significant with clear bole length. Both Tewari *et al.* (2012) in *Prosopis juliflora*, Sahoo *et al.* (2021) in *Eucalyptus* species, Kumar and Singh (2019) in *Melia* species, and Gupta *et al.*,

Table 1. Pearson’s correlation coefficient among the growth-contributing traits

	CBL (m)	GBH (m)	BG (m)	CL (m)	PH (m)	DBH (m)	Vol (m³)
CBL (m)	1						
GBH (m)	0.55 ^{ns}	1					
BG (m)	0.75 [*]	0.89 ^{**}	1				
CL (m)	0.07 ^{ns}	-0.12	0.02 ^{ns}	1			
PH (m)	0.75 [*]	0.30 ^{ns}	0.54 ^{ns}	0.70 ^{ns}	1		
DBH (m)	0.56 ^{ns}	0.99 ^{***}	0.89 ^{**}	-0.11	0.32 ^{ns}	1	
Vol (m³)	0.62 ^{ns}	0.94 ^{***}	0.91 ^{**}	0.09 ^{ns}	0.71 [*]	0.95 ^{***}	1

CBL (Clear bole length), GBH (Girth at breast height), BG (Basal girth), CL (Crown length), PH (Plant Height), DBH (Diameter at breast height), Vol (tree Volume)

Significance Levels 0.05(*) 0.01(**) 0.001(***)
If correlation r => 0.71 0.83 0.92

Table 2. Morphological diversity among different populations for growth contributing trait

Population	CBL (m)	GBH (m)	BG (m)	CL (m)	PH (m)	DBH (m)	Volume (m ³)
Latehar	11.97 ^d	1.46 ^a	1.63 ^c	4.64	16.61	0.44 ^a	1.45 ^{c,d}
Chaibasa	10.78	1.17	1.31	7.40	18.18	0.37	1.26
Simdega	11.67	1.35 ^b	1.72 ^c	7.10	18.77	0.43 ^a	1.73 ^b
Dalma WL	10.18	0.97	1.02	7.58 ^c	17.43	0.31	0.90
Dumka	10.67	0.99	1.09	7.65 ^c	18.32	0.32	0.89
Bokaro	12.57 ^b	1.24 ^c	1.53 ^d	7.27	19.83 ^b	0.40 ^b	1.46 ^{c,d}
Ramgarh	11.35	0.86	1.04	7.05	18.40	0.25	0.73
Khunti	10.87	0.79	0.96	6.73	17.60	0.27	0.61
Hazaribagh	10.90	1.13	1.25	6.82	17.72	0.36	0.97
Sahibganj	12.65 ^b	1.23 ^{c,d}	1.94 ^b	7.40	20.05 ^b	0.39 ^b	1.37 ^d
Koderma	11.44	1.24 ^c	1.46	7.38	18.82	0.40 ^b	1.50 ^c
Saranda	13.42 ^a	1.40 ^b	2.05 ^a	8.31 ^b	21.73 ^a	0.45 ^a	2.00 ^a
Gumla	12.33 ^c	1.01	1.21	7.68 ^c	20.02 ^b	0.32	0.99
PTR	11.2	1.18 ^d	1.39	8.75 ^a	19.95 ^b	0.37	1.28
Chatra (S)	12.37 ^{c,b}	1.05	1.25	7.5	19.87 ^b	0.34	1
Mean	11.62	1.13	1.39	7.28	18.89	0.36	1.21
SE	0.23	0.05	0.09	0.23	0.35	0.02	0.10
Range	10.18 - 13.42	0.79 - 1.41	0.96 - 2.05	4.64 - 8.75	16.61 - 21.73	0.25 - 0.45	0.61 - 2.00

CBL (Clear bole length), GBH (Girth at breast height), BG (Basal girth), CL (Crown length), PH (Plant Height), DBH (Diameter at breast height), Vol (tree Volume)

(2012) in *Acacia catechu* made similar observations. The success of phenotypic selection depends on the degree of genetic diversity for important economic traits found in the population and how those traits interact (Lone and Tewari, 2008).

Summary and Conclusion

The tree volume is positively and significantly correlated with most of the studied traits, hence the selection of trees for tree improvement programs and seed collection will be rewarding based on tree volume. As historically Saranda Forest was considered as Asia's best Sal Forest and in the present study also most of the trees in the region were found superior and of seed origin compared to the other studied populations. The tree volume of Saranda population (2m³) was found significantly higher than other studied populations. Hence, it can be concluded that the Saranda population is more vigorous and can be utilized as seed source for raising seedlings and establishing plantations. It can also be utilized for selecting Plus Trees for conducting progeny testing and genetic improvement works.

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Conflict of interest

Authors are declaring that there is no conflict-of-interest exit.

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