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Research Note

Growth performance and variability of *Dalbergia sissoo* Roxb. clones

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Abstract
The study was undertaken at Forest College and Research Institute, Mettupalayam to ascertain the growth performance and variability of *Dalbergia sissoo* clones. Twenty clones collected from plus trees in different parts of India were assessed for three characters namely collar diameter, height and volume index. Based on the growth performance at six months after planting, five clones namely FCRIDSC 3, FCRIDSC 4, FCRIDSC 7, FCRIDSC 8 and FCRIDSC 16 were found be superior. GCV, heritability and genetic gain for all the traits investigated were high and hence selection based on these traits would be effective.

Keywords: *Dalbergia sissoo*, Clones, Heritability, Genetic gain.

Wood is the major raw material for many industries around the world. Increasing population, economic growth and industrialization increased the demand for wood and wood based products. The pulp and paper industry is considered as one of the largest consumers of forest based raw material. The paper industry in India comprises of more than 800 mills and it provides direct and indirect employment to 1.3 million people. In Asia Pacific region the per capita consumption of paper had increased from 5 kg to 12 kg per annum between 2003 and 2012. The world average of paper consumption for the same period was estimated to be 50 to 40 kg (CRISIL, 2012).

In recent times initiatives have been taken up by many paper industries for incorporation of fast growing species like M*elia dubia*, *Dalbergia sissoo* and *Anthocephalus cadamba* etc. in the above mentioned programmes. As an alternate species *Dalbergia sissoo* had been widely recognised for its pulping potential. *Dalbergia sissoo* is commonly known as Shisham or Sissoo belonging to the family Fabaceae and subfamily Faboideae. The wood is highly durable and used for veneer, furniture, cabinets etc. The calorific value of the sapwood is about 4900 kcal kg^{-1} and that of heartwood is about 5200 kcal kg^{-1}. Recently it has been identified as one of the prominent alternate pulpwood species whose fibre can be used for producing paper. Chinnaraj and Malimuthu (2011) had recorded screened pulp yield of 46.5% and a kappa number of 21.6 in sissoo. However, studies on utilization of the available variability for genetic improvement in this aspect are scanty. Hence, it is important to identify superior genotypes having adequate variability in order to utilize them in tree improvement programmes. With this background a study was initiated in Forest College and Research Institute, Mettupalayam to assess the growth performance and the genetic variability of sissoo clones.

Twenty clones of sissoo collected from plus trees located in natural populations, plantations and roadside avenues from different parts of India were used in this investigation (Table 1). Biometric traits such as height, basal girth, Girth at Breast Height (GBH), age and volume were considered for selection of plus trees (Pitcher and Dorn, 1967). Four month old rooted cuttings made from the plus trees (PT's) were planted in Forest College and Research Institute, Mettupalayam, Tamil Nadu (11.20°N and 76.56°S) following a row column design in three replications. A total of 360 ramets with 18 ramets in each clone were planted at 2x2 m spacing. Biometric observations *viz*., height and collar diameter were measured at two months interval from the date of planting for

all the ramets and volume index was estimated following Manavalan (1990). The observations taken at sixth month was used for analysis of variance (Sukhatme and Amble, 1989) while coefficients of variation was estimated by Burton and Devane (1953). The heritability was calculated following Lush (1940) and genetic gain was estimated by Burton and Devane (1953).

The data on morphological traits of 20 clones is presented in Table 2. The collar diameter, height and volume Index of the assembled clones at six MAP ranged from 22.25 to 10.42 mm, 151.10 to 94.84 cm and 652.41 to 103.09 cm^3 respectively. Out of the 20 clones five clones viz., FCRIDSC 3, FCRIDSC 4, FCRIDSC 7, FCRIDSC 8 and FCRIDSC 16 performed significantly (P=0.05) superior than other clones by recording collar diameter of 18.82, 19.84, 17.79, 22.25 and 19.01 mm respectively. These five clones showed superior performance with respect to volume index by recording significant values of 494.54, 537.18, 430.17, 652.41 and 546.10 cm^3 respectively. In terms of height nine clones namely FCRIDSC 1, FCRIDSC 2, FCRIDSC 3, FCRIDSC 4, FCRIDSC 5, FCRIDSC 7, FCRIDSC 8, FCRIDSC 16 and FCRIDSC 19 had recorded significant height of 132.18, 127.38, 139.39, 135.78, 131.04, 135.78, 131.70, 151.10 and 143.68 cm respectively.

Trees have long gestation period hence the study of growth traits at juvenile age is imperative to determine the relative performance of different clones (Chaturvedi and Pandey, 2005). If there exist a good correlations between the measured traits of clones at young ages of tree development, prediction of growth at an advanced age may be possible (Burley and Wood, 1976). In the present study five clones which were collected from Idayamelur, Kyathadevara Gudi, Othakadai, Coimbatore and Thentirupati were proved to be significantly different from other clones for all the examined traits at the age of six months. It speculates the superiority of selection from these five locations. Kumar (2007) recorded similar findings in two year old *Gmelina arborea* clones. On the basis of mean height performance 38 per cent of the clones collected from Lanka origin were found to be superior. To witness the elite genotype in a clonal trial, testing has to be carried out for a longer duration. Hence it can be concluded that long term growth assessment of sissoo clones is necessary.

The analysis of variance proved that the values of all the traits were highly significant. Among the traits investigated, the volume index recorded higher genotypic (49.95%) and phenotypic coefficient of variation (52.16%) (Table 3). The other two traits registered intermediate values of GCV and PCV. For all the observed traits the GCV was found to be slightly lower than the PCV. The GCV of the probed traits were slightly lower than the PCV and indicated the lesser effect of environmental variation. Among the traits studied height registered maximum heritability of 98 percent followed by volume index with 91 percent (Table 3). The genetic gain of volume index, collar diameter and height and was 98.55%, 34.61% and 30.01% respectively. Heritability and genetic gain of all investigated traits were found to be high.

In the current study maximum heritability was recorded for height (98%) and maximum genetic gain was recorded for volume index (98.55%). Gera *et al*. (2000) while examining *Dalbergia sissoo* clones found low heritability for collar diameter and high heritability for height and number of branches. Since all the three traits of the present investigation showed high heritability and genetic gain, it can be concluded that selection based on these traits would be effective.

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Table 1. Locational details of *Dalbergia sissoo* plus trees (PTs) selection and biometric observations

PTs	Location of PTs	District	State	Latitude	Longitude	Clonal Identity	Tree height (m)	Basal girth (cm)	Girth at BH (cm)	Age	Type of Selection	Volume (m^3)
1.	Sivaganga	Sivaganga	Tamil Nadu	9.84° N	78.48° E	FCRIDSC 1	11.00	114.50	107.00	25	Single tree	1.00
2.	Pudupatti	Sivaganga	Tamil Nadu	9.85° N	78.52° E	FCRIDSC 2	10.50	83.50	77.00	7	Single tree	0.50
3.	Idayamelur	Sivaganga	Tamil Nadu	9.87° N	78.66° E	FCRIDSC 3	12.00	85.50	80.00	7	Single tree	0.61
4.	Kyathadevara Gudi	Chamraj Nagar	Karnataka	11.91° N	77.14° E	FCRIDSC 4	10.00	120.00	114.00	35	Single tree	1.03
5.	Karunanjupuram	Chamraj Nagar	Karnataka	11.91° N	77.14° E	FCRIDSC 5	7.50	103.00	99.50	30	Single tree	0.59
6.	Kagalavadi	Chamraj Nagar	Karnataka	11.96° N	77.02° E	FCRIDSC 6	11.00	108.00	101.00	25	Single tree	0.89
7.	Othakadai	Erode	Tamil Nadu	11.28° N	77.17° E	FCRIDSC 7	15.00	151.00	145.00	30	Single tree	2.51
8.	Coimbatore 1	Coimbatore	Tamil Nadu	11.02°N	76.59°E	FCRIDSC 8	12.50	178.00	171.50	25	Single tree	2.93
9.	Coimbatore 2	Coimbatore	Tamil Nadu	11.02°N	76.59°E	FCRIDSC 9	8.50	55.50	50.00	15	Single tree	0.17
10.	DS I, FC&RI	Thanjavur	Tamil Nadu	10.89° N	79.19° E	FCRIDSC 10	6.00	26.00	25.50	2	Single tree	0.03
11.	DS II, FC&RI	Thanjavur	Tamil Nadu	10.89° N	79.19° E	FCRIDSC 11	6.50	31.50	29.50	2	Single tree	0.05
12.	IARI	New Delhi	New Delhi	28.63° N	77.15°E	FCRIDSC 12	15.00	131.00	123.00	40	Single tree	1.81
13.	Thrissur	Thrissur	Kerala	10.52° N	76.21° E	FCRIDSC 13	18.00	107.00	101.00	35	Single tree	1.46
14.	Dhiddapuram	Chamraj Nagar	Karnataka	11.96° N	77.02° E	FCRIDSC 14	12.00	146.00	139.00	35	Single tree	1.85
15.	Aadanakottai	Pudukottai	Tamil Nadu	10.60° N	79.01° E	FCRIDSC 15	11.00	106.00	101.00	7	Single tree	0.89
16.	Thentirupati	Coimbatore	Tamil Nadu	11.30° N	76.95° E	FCRIDSC 16	10.00	78.50	72.00	25	Single tree	0.41
17.	Thalavady	Erode	Tamil Nadu	9.35° N	76.53° E	FCRIDSC 17	6.50	54.50	49.50	45	Single tree	0.13
18.	Solan	Solan	Himachal Pradesh	30.92° N	77.12° E	FCRIDSC 18	15.00	147.00	141.00	50	Single tree	2.37
19.	Etmadhpur	Agra	Utter Pradesh	27.23° N	78.20° E	FCRIDSC 19	12.00	108.00	100.50	45	Single tree	0.96
20.	DS III, FC&RI	Thanjavur	Tamil Nadu	10.97° N	79.38° E	FCRIDSC 20	6.80	46.00	38.50	2	Single tree	0.08

Table 2. Collar diameter (mm), height (cm) and volume index (cm^3) of *Dalbergia sissoo* clones at 6 MAP

Clones	Collar diameter (mm)	Height (cm)	Volume index(cm^3)
FCRIDSC 1	16.34	132.18*	354.54
FCRIDSC 2	13.57	127.38*	238.49
FCRIDSC 3	18.82*	139.39*	494.54*
FCRIDSC 4	19.84*	135.78*	537.18*
FCRIDSC 5	15.69	131.04*	322.71
FCRIDSC 6	14.55	111.76	236.51
FCRIDSC 7	17.79*	135.78*	430.17*
FCRIDSC 8	22.25*	131.70*	652.41*
FCRIDSC 9	13.01	120.28	204.36
FCRIDSC 10	10.42	94.84	103.09
FCRIDSC 11	13.81	100.20	193.84
FCRIDSC 12	13.11	115.83	201.91
FCRIDSC 13	13.82	95.90	183.58
FCRIDSC 14	13.70	100.20	190.89
FCRIDSC 15	15.27	108.56	253.65
FCRIDSC 16	19.01*	151.10*	546.10*
FCRIDSC 17	12.85	98.46	163.17
FCRIDSC 18	14.10	105.21	209.99
FCRIDSC 19	15.43	143.68*	343.24
FCRIDSC 20	13.00	107.93	182.69
Grand Mean	**15.32**	**119.36**	302.15
SEd	**1.01**	**2.04**	37.03
CD (0.05)	**2.04**	**4.12**	74.97
CD (0.01)	**2.73**	**5.52**	**100.42**

* Significant at 5% level

Table 3. Different genetic parameters estimated for sissoo clones at 6 MAP

Genetic parameters	Collar diameter	Height	Volume Index
Genetic variance ($\sigma^2 g$)	7.90	308.39	22782.20
Phenotypic variance ($\sigma^2 p$)	9.42	314.60	24839.33
Genotypic coefficient of variation (GCV) (%)	18.35	14.71	49.95
Phenotypic coefficient of variation (PCV) (%)	20.04	14.86	52.16
Broad sense heritability (h^2) (%)	83.82	98.03	91.72
Genetic advance	7.50	56.85	879.31
Genetic advance as a percent of mean (%)	34.61	30.01	98.55

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