Print : ISSN 0970-7662

Journal of Tree Sciences
online available at www.ists.in

Volume 31 No.1&2 June & December, 2012

Variability and Genotype Selection in *Callophyllum inophyllum* for Quality Fruit Yield in the Central West Coast of India

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ABSTRACT

Calophyllum inophyllum is one of the important commercially important multipurpose tree species of coastal tropics. Among the various uses, the seed of this tree yields crude oil, which is used as a preservative, home lamp and biofuel. Hence, an attempt was made to study the variation and identify superior genotypes for seed character along the Konkan Coasts of Maharashtra**.** Several expeditions were conducted among six base populations located along the Central West Coast of Peninsular India and a total of 21 Candidate Plus Trees (CPTs) were identified for high seed yield. Fruits were sampled from each tree and were evaluated for fruit and seed characters *viz*. fruit diameter, fruit length, fruit weight, fruit volume, seed diameter, seed length, seed weight, seed volume. It was observed that all the 21 identified CPTs varied significantly for various fruit and seed characteristics. Among them, CPT No. KKVCI – 13 performed better with respect to most of the characters, especially fruit size, fruit volume, seed size, while KKVCI-03 contained more oil content. Furthermore, seed parameters namely, oil content and fruit weight showed the highest heritability values of more than 90 percent. Hence, it is suggested to identify genotypes with more seed weight and oil content for further improvement programme.

Keywords:

Calophyllum inophyllum, candidate plus tree, fruit seed characters

INTRODUCTION

Callophyllum inophyllum L. Nonitalics (Clusiaceae) is commonly known as 'Indian laurel' and is a predominant mangrove associate. It is usually scattered along sandy beaches of sea coasts and sometimes form fragmented populations. It is indigenous to India and occurs along the East and West Coasts. This tree species is known for multiple uses namely, timber, fuel wood and seed oil. Among them, seed oil economically supplements the livelihood of local communities living along the coasts (Friday 2006).The seed kernels yield commercially important 50-73%Tamanu oil (Vanangamudi 1984) which is used as preservative for boats and burning home lamp. Moreover, this seed oil can be used in the conventional diesel engines (without any alterations) in its pure form or as a blend with mineral oil (Aggrawal 2006). The oil also possesses a medicinal property, employed for rheumatism, skin diseases, joint pains haemorrhage with recently discovered plant properties such as anti-HIV and anti-cancer active compounds. More recently, this species is recognized as of the biofuel yield in tree species of India. Efforts are being made to domesticate this species for commercial harvesting of seed oil as

biofuel in the country. Tropical trees are predominantly outcrossing (Zobel, and Talbert 1984), and it promoting heterogeneity and maintaining genetic diversity within population of species (Watson 1928). Morphological variations in pod and seed characters along with oil content among the natural population are useful in selection programme for genetic improvement of a species. (Bahadur and Hooda1995; Kaushik et al. 2007). Hence, an attempt was made to select few superior genotypes of *C. inophyllum* for better seed yield along the Coasts of Maharashtra.

MATERIALS ANDMETHODS

An extensive survey was conducted to screen the natural populations of *C. inophyllum* in South-Konkan region of Maharashtra during April-June, 2009. Six base populations of *C. inophyllum* such as, Harne, Ladghar, Bakale, Vijaydurg, Achara and Deobagh located in west coast ofSindhudurg and Ratnagiri districts of Maharashtra (Fig.1) were selected in these population phenotypically superior individuals (candidate plus Tree's, CPTs) were selected based on fruit, seed, and seed yield character. Mostly medium aged adult individuals bearing dbh range of 15-30 cm were related by following comparison tree method (Ledig 1974; Bagchi 1995).The seed yield was quantified by indirect estimation technique (Bhatt et al. 2003). The matured fruits were harvested from the selected trees and transferred to the college laboratory for further characterization. A total of 100 fruits and seeds were sampled from the seedlot for quantifying the variation. The sampled fruits were evaluated for fruit diameter, fruit length, fruit weight, fruit volume, seed diameter, seed length, seed weight and seed volume. The seeds were further assessed for oil content by Super Critical Fluid Extraction technique with carbon dioxide as the super critical liquid. The oil was extracted at pressure 520 bar with 70^{0}C vessel temperature for 3 hours. The raw data was compiled by taking the means of all the CPTs taken for different traits in the experiment. The means were subjected to further statistical and genetical analysis. All statistical parameters *viz*., mean, standard error, variance and coefficient of variation were analysed statistically using the software package SAS 9.2. Correlation analysis was done to determine the relationship between oil content, seed characteristics in seeds, growth and yield of the species. The variability and genetic estimates such as, phenotypic and genotypic variance, phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV) heritability genetic advance and genetic growth were worked out for seed traits, oil content and growth attributes as suggested (Burton 1952; Burton and Devane 1953; Lush 1949).

RESULTS AND DISCUSSION

Survey was made in six different populations of *Calophyllum inophyllum* in the Konkan region of Maharashtra in which total 153 adult healthy individuals were marked for their performance with respect to fruit yield, seed trait and oil content. Among 153 individuals only 21 trees were evaluated as candidate plus trees through comparison tree method. Result showed a great degree of variation among the 21 identified CPTs for various morphological characters (Table 1). The diameter at breast height of selected CPTs ranged from 10.5 (KKVCI-13) to 95.54 cm (KKVCI-14) where as crown diameter of selected CPTs ranged between 2 (KKVCI-19) and 7.43 m (KKVCI-14). Great range of variation was recorded for Seed yield (4.22 to 51.25 Kg tree^{-1}) with an average seed yield of 22.90 Kg tree^{-1} (Fig. 2). There was a significant variation ($P<0.05$) among all the 21CPTsof *C. inophyllum* for fruit and seed characters and oil content (Table 2).CPT bearing no. KKVCI-13 has had superiority over other CPTs for fruit and seed characters. The fruit weight of KKVCI-13 weighed 24.82 g and it was 2.5 times bigger than the average fruit weight of all CPTs (10.94 g). Furthermore, seed weight of this CPT was 12.33 g i.e. two times more than mean seed weight of all CPTs (5.92 g). The seed oil percentage ranged from 61.81 to 79.73 percent with an average of 68.27 percent among all CPTs (Table. 2).Similarly, the fruit size parameters namely, fruit diameter (39.36 mm), fruit length (44.05 mm), fruit volume (31.55 cc) and seed size parameters namely, seed volume (13.80 cc), seed diameter (31.47 mm) and seed length (40.58 mm) was found to be highest in KKVCI-13. Among other 20 CPTs, CPTs like KKVCI-19 and 21 showed best performance in most of fruit and seed traits (Table 2).The maximum seed oil content was observed in KKVCI-

Table 1: Population details and Biometric parameters of selected 21 CPTs of *Calophyllum inophyllum*

CPTs	Population	Tree Height (m)	DBH (cm)	Crown Diameter(m)	Crown Length (m)	Crown Height (m)	No. Primary Branches	No. Secondary Branches	Branch Angle
KKVCI -01	Ladghar	6.9	31.84	4.78	5.1	1.8	3	8	50^0
KKVCI -02	Dande	4.0	14.17	2.05	3.0	1.0	4	10	60^0
KKVCI -03	Dande	8.0	28.98	5.35	7.0	1.0	11	17	50^0
KKVCI -04	Dande	7.5	27.07	4.15	5.5	1.0	15	22	30^0
KKVCI -05	Dande	5.5	49.36	4.40	3.5	2.0	4	7	60^0
KKVCI -06	Achra Pirawadi	8.0	60.50	6.50	7.0	1.0	9	12	70^0
KKVCI -07	Achra Pirawadi	9.0	27.71	3.78	8.0	1.0	8	12	45^0
KKVCI -08	Achra Pirawadi	5.5	17.67	4.83	5.0	5.0	10	15	80^0
KKVCI -09	Achra Pirawadi	9.0	27.86	4.50	7.5	1.5	11	22	60^0
KKVCI -10	Achra Pirawadi	12.0	28.66	3.50	10.5	1.5	8	10	70^0
KKVCI -11	Devbag	11.0	22.29	7.65	9.0	2.0	5	9	60^0
KKVCI -12	Devbag	12.0	34.07	3.38	9.5	2.5	7	12	70^0
KKVCI -13	Devbag	4.0	10.50	4.13	3.0	1.0	5	10	40^0
KKVCI -14	Devbag	8.5	95.54	7.43	7.5	1.0	12	17	90^0
KKVCI -15	Devbag	8.0	55.73	7.13	6.5	1.5	8	13	60^0
KKVCI -16	Vijadurg	5.0	14.80	2.93	3.0	2.0	8	13	75^0
KKVCI -17	Vijadurg	10.5	53.34	6.28	4.5	1.5	14	18	60^0
KKVCI -18	Vijadurg	6.5	25.16	4.95	4.0	1.5	10	14	30^0
KKVCI -19	Palende/Harne	5.0	13.37	2.00	3.5	1.5	4	8	45^0
KKVCI -20	Palende/Harne	6.0	23.88	3.55	4.5	1.5	9	10	60^0
KKVCI -21	Devbag	9.0	27.23	5.10	7.5	1.5	12	26	70^0
Range		4-12	10.5-95.54	2-7.65	3-10.5	1-5	3-15	7-26	30^0-90^0
Mean		7.7	32.8	4.7	5.9	1.6	8.4	13.6	58.8^0

03 (79.73 per cent) with an average of 68.27 per cent for all the CPTs. The overall result showed that great variation was recorded among studied CPTs for various fruit and seed characters and oil content in *C. inophyllum*. As most of the CPTs are scattered in different populations along the coasts, the out crossing between the individuals in a population may cause variation in trees. (Zobel and Talbert 1984). Furthermore, the variation may also be due to different environmental conditions like soil to detritus ratio, tidal inundation, salinity level and rate of fresh water influx (Watson 1928). Moreover, seed yield is greatly influenced by several intrinsic and extrinsic characteristics. However, plant

Table 2: Variation in fruit and seed characteristics among 21 CPTs of *C. inophyllum*

CPTs	Fruit Diameter (mm)	Fruit Length (mm)	Fruit Weight (g)	Fruit Volume (cc)	Seed Diameter (mm)	Seed Length (mm)	Seed Weight (g)	Seed Volume (cc)	Oil Content (%)
KKVCI -01	29.24	33.56	11.97	11.47	24.31	28.50	7.21	5.01	64.15
KKVCI -02	30.20	34.59	13.03	14.71	23.19	27.48	5.87	5.51	68.68
KKVCI -03	28.11	33.96	10.65	9.19	22.81	27.99	5.53	4.04	79.73
KKVCI -04	26.34	30.34	8.30	7.35	21.30	25.42	4.32	3.35	70.42
KKVCI -05	26.43	29.52	8.41	6.46	21.62	24.62	4.39	5.08	72.99
KKVCI -06	23.77	27.23	8.06	8.57	21.74	25.08	5.01	5.08	62.65
KKVCI -07	23.33	27.48	8.66	7.47	21.45	25.24	5.19	4.72	67.73
KKVCI -08	23.33	26.50	7.92	7.00	21.35	24.12	4.67	4.05	63.73
KKVCI -09	26.69	30.40	10.20	8.99	21.24	25.19	4.97	5.12	65.57
KKVCI -10	28.80	31.39	9.38	8.28	20.88	25.52	4.70	4.82	69.44
KKVCI -11	27.04	30.52	10.47	6.87	24.01	27.04	6.24	4.37	67.54
KKVCI -12	26.32	29.59	9.45	7.67	20.86	23.67	4.75	4.37	69.46
KKVCI -13	39.36	44.05	24.82	31.55	31.47	40.58	12.33	13.80	66.39
KKVCI -14	26.28	30.90	9.04	9.07	21.18	25.52	4.59	4.52	67.43
KKVCI -15	27.03	31.83	9.41	10.67	22.36	25.84	5.55	6.41	71.80
KKVCI -16	27.77	33.50	10.29	9.45	23.29	27.69	5.62	5.40	62.92
KKVCI -17	27.09	29.81	9.19	8.98	23.05	25.88	5.51	5.23	70.37
KKVCI -18	26.58	31.19	10.24	9.39	23.63	26.98	6.07	5.77	70.76
KKVCI -19	34.62	40.20	18.24	16.42	28.14	32.22	9.21	7.45	69.51
KKVCI -20	25.80	30.18	8.26	6.76	21.13	25.51	4.79	2.96	72.35
KKVCI -21	32.28	37.10	13.78	11.84	31.09	26.94	7.84	6.67	61.81
Mean	27.92	32.09	10.94	10.39	23.34	27.00	5.92	5.42	68.27
S.E.m(±)	0.32	0.38	0.29	0.51	0.21	0.84	0.16	0.30	0.75
C.D. $_{0.05}$	0.9	1.1	0.8	1.4	0.6	2.4	0.4	0.8	1.51
C.V.=	12.09	13.46	17.70	31.58	8.64	32.27	12.85	25.31	1.34

growth traits such as age, crown width and number of branches are highly influenced on the fruit/seed yield in tree species (George 1986). Even though growth traits have paramount importance, environmental factors such as temperature, rainfall and humidity in combination with genetic and physiological factors play an important role in the determination of seed yield potential of plant (Bhatt et al. 2003).

The magnitude of PCV was higher than the corresponding GCV for all the studied characters though they were only small differences (Table 3). Phenotypic variance denoting total variance was found to be maximum for fruit diameter (58.99) as compared to other fruit and seed characters studied which was followed by fruit volume. On the other hand fruit weight and seed weight had the maximum values of the coefficient of phenotypic and genotypic variation. The heritability estimates ranged between 15.12 and 99.94 per cent. Oil content exhibited highest broad sense heritability (99.94 per cent) followed by fruit volume (99.77

Table 3: Estimation of genetic parameters for fruit, seed, oil, germination and seed yield.

Traits	Variance		Coefficient of variation		Heritability (%)	Genetic advance	Genetic gain (%)
	Genotypic	Phenotypic	Genotypic	Phenotypic			
Fruit diameter	14.00	58.99	13.40	27.51	23.73	3.75	13.44
Fruit length	17.69	11.70	13.11	33.71	15.12	3.37	10.79
Fruit weight	15.81	56.51	36.34	68.71	27.97	4.33	39.58
Fruit volume	29.77	29.84	52.53	52.59	99.77	11.23	10.80
Seed diameter	9.73	9.81	13.37	13.42	99.18	6.4	27.42
Seed length	12.42	12.45	13.05	13.07	99.76	7.25	26.85
Seed weight	3.60	3.63	77.98	32.18	99.18	38.93	65.74
Seed volume	4.68	4.71	39.95	40.05	99.53	44.46	82.10
Oil content	17.36	17.37	6.10	6.10	99.94	8.58	12.58
Seed yield	15.01	15.75	53.50	54.80	95.30	24.63	75.84

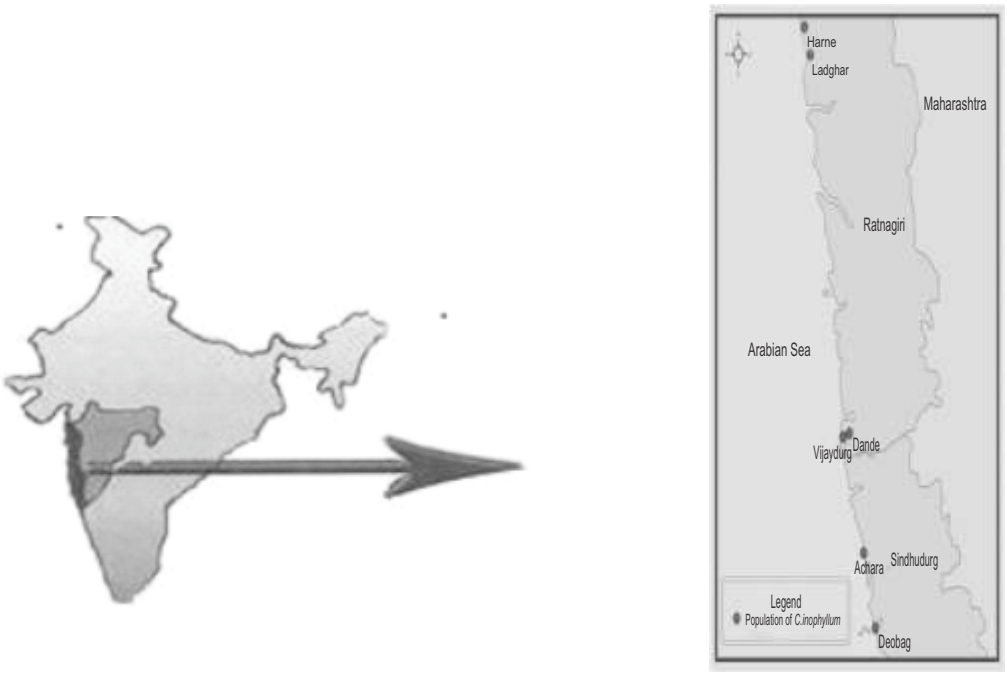

Fig. 1 : Geographical location map for six base populations of *C. inophyllum* in South Konkan region of Maharashtra

percent) and seed length (99.76 percent), while, it was least for fruit length trait. In contrast, seed weight showed the second highest genetic advance of 44.46 per cent followed by seed volume (38.93 percent).The expected genetic gain was found to be highest for seed volume (82.10per cent) followed by seed yield (75. 84 per cent) and seed weight (65.74 per cent).Variations among the CPTs are commonly used as an estimate of total genetic variation and to calculate degree of genetic control for particular trait (Foster and Shaw 1988.). Although heritability in broad sense may give useful

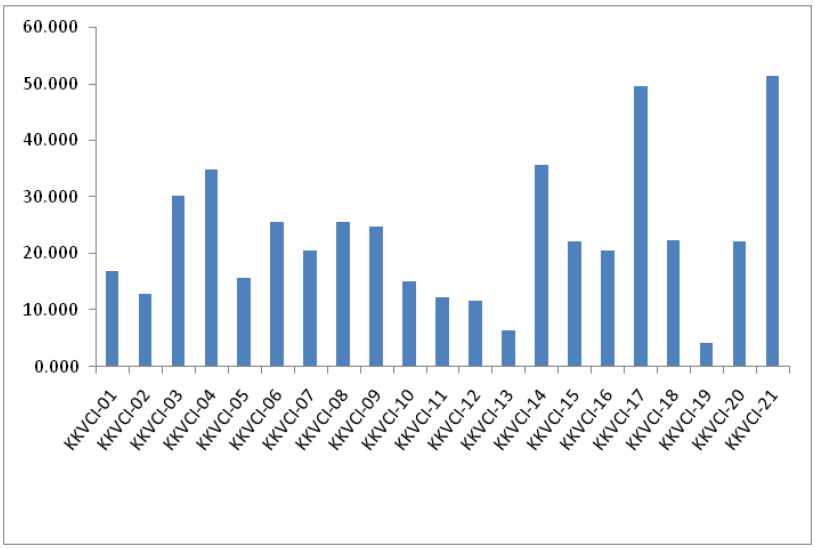

Fig. 2. Seed Yield of *C. inophyllum* genotypes

indication about the relative value of selection in the material at hand to arrive at a more reliable conclusion, heritability and expected genetic gain should be considered jointly. In the present study, all seed parameters, oil content and fruit weight showed the highest heritability values of more than 90 percent. Further, seed weight, seed volume and seed yield recorded maximum genetic gain as compared to other parameters. It has been proven that heritability estimates along with genetic is more useful than the heritability alone in predicting the resultant effect for selecting the best genotypes for given trait (Volker et al 1990). However, among fruit and seed characters studied, the estimate of genotypic coefficient of variation was less than that of the phenotypic coefficient of variation for all the characters, except seed weight and it could be due to influence of non-additive gene action (Kaushik et al. 2007). Moreover, seed weight is influenced by the nutrient availability at the time of seed setting and environmental factors (Allen 1960; Johnsen et al. 1989).

The above results indicate that among the various seed characters, seed oil content has had the highest heritability estimates among all and hence selection of CPTs having high seed oil content can lead to better gains in the breeding program. CPTs with high seed yield may be influenced by the tree age and crown characters. Hence the CPT KKVCI 03 having the high oil content can be recommended for further breeding program.

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