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Genetic Variability and Relationship of Tree Characters and Oil Content of Calophyllam Inophyllum (L.) in South India

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Abstract: *Undi is a medium-sized to large evergreen tree that averages 8–20 m (25–65 ft) in height with a broad spreading crown of irregular branches. The tree supports a dense canopy of glossy, elliptical leaves, fragrant white flowers, and large round nuts. It grows along coastal areas and adjacent lowland forests, although it occasionally occurs inland at higher elevations. It is native to east Africa, India, Southeast Asia, Australia, and the South Pacific. It has been widely planted throughout the tropics and is naturalized in the main Hawaiian Islands. Oil from the nuts traditionally has been used for medicine and cosmetics and is today being produced commercially in the South Pacific. Seeds of undi have about 50-70 percent oil content. Thirty seed sources of Calophyllam inophyllum were collected from Different Region of south India (Tamilnadu, Karnataka, and Kerala). Tree height varied from 5.48 m to 7.19 m and DBH also varied significantly among all CPTs. Crown diameter varied from 3.50 m to 6.92 m. The seed oil content varied from 40.17 to 53.31 percent was recorded. These seed sources can be further screened for tree improvement traits considering their immense value in yielding bio diesel.*

1. INTRODUCTION

Calophyllam inophyllum linn is a species of family Guttifereae (Clusiaceae), native to India, East Africa, Southest Asia, Australia and South Pacific. Commonly it is called as 'Indian laurel', Alexandrian Laurel, Beach Calophyllam, Beauty leaf, Pannay tree, Sweet Scented Calophyllam (in English), Pongnyet, Burmese, Hawaii, Kokani, Nagachampa, (in Marathi), Sultan Champa, Surpan (in Hindi),Nagam, Pinmai, Punnagam, Punnai, Pinnay, Namere (in Tamil), along the beach crests, although sometimes occurring inland and adjacent lowland forest. It has been widely planted throughout the tropics and is naturalized in the main Hawaiian Islands. The tree is valued for its hardiness and beauty as an ornamental tree. Oil from the nuts has been traditionally used for medicine and cosmetics and is today being produced commercially in the South Pacific. The tree grows best in direct sunlight, but grows slowly. Annual yield of 20-100 kg/tree of whole fruits have been reported10, 11. Trees begin to bear significantly after 4-5 years. The nut kernel contains 50-70% oil and the mature tree may produce 1-10 kg of oil per year depending upon the productivity of the tree and the efficiency of extraction process. Although wildings occur, it can be moderately difficult to propagate. Its slow growth and large seeds make it unlikely that the tree will become an invasive weed if introduced into new areas. Tree grow to height of 8-20m (25-65ft), sometimes reaching up to 35cm (11ft). Canopy width is often greater than the tree's height when the tree is grown in open location. It has a broad spreading crown often with large, gnarled, horizontal branches. The light grey bark shows deep fissures alternating with flat ridges.

2. MATERIAL AND METHODS

The experiment was conducted at Forest College and Research Institute, Mettupalayam, located at 11°19'N latitude and 77°56'E longitudes and an altitude of 300 m above MSL. The average annual rainfall is 945mm, most of which is received between June to September. The temperature varies from 15 to 34.9 ^{0}C. The extensive survey was under taken across six different region of south India viz., Tamilnadu, Karnataka, Kerala and Puducherry. A distance of at least 20 km between two seed sources. The individual tree was identified based on their phenotypical characteristics and the individual tree identity was also maintained. Tree height, DBH and crown diameter were recorded for each CPTs. After record of growth traits, fruits were collected from the candidate trees subjected to analysis of oil content. The genetic estimates for the selected plus trees and oil content are furnished hereunder.

3. ESTIMATION OF OIL CONTENT USING SOXHLET METHOD

For estimating oil, the seeds were de-pulped, the kernels dried at 50°C for 16 hrs and allowed to cool in a desiccator. Five grams of seeds were pulverized to a fine powder in a porcelain mortar. Ground samples were placed in a filter paper and fastened in such a way to prevent escape of the meal and then carefully transferred to an extraction thimble. The thimble was then placed in a Soxhlet extractor to which sufficient quantity of solvent petroleum ether (40- 60°C) was added and heated until eleven siphoning were completed. The oil content was recorded by evaporating the petroleum ether at 60°C. The entire extraction process was carried out in Soxhlet extractor according to AOAC (1970). The percentage of oil content was then calculated by using the formula.

$$\text{Oil per cent} = \frac{\text{Oil weight (g)}}{\text{Sample weight (g).}} \times 100$$

4. VARIABILITY STUDIES

These parameters were estimated as per the method described by Johnson *et al.* (1955).

a) Heritability

Heritability in the broad sense (h^2) was calculated using the formula suggested by Lush (1940) and expressed in percentage.

h^2 (broad sense)=($\Box^2$g/ $\Box^2$p) x 100

b) Genetic advance

The genetic advance was worked after Johnson *et al*., (1955).

$$(GA) = \frac{\text{Genotypic Variance}}{(\text{Phenotypic variance})^{1/2}} \times K$$

Where,

K=Selection differential (2.06) at 5% level of significance.

C) Genetic advance as percentage of mean

This was calculated using the formula;

$$GA = \frac{GA}{X} \times 100$$

Where,

X= Grand mean

5. CORRELATION STUDIES

Genotypic and Phenotypic correlations coefficients were calculated according to the method suggested by Goulden (1952).

a) Genotypic correlation

$$R_g(XY) = \frac{\text{Genotypic covariance between X \& Y}}{[\text{GV of (X) x Genotypic variance of (Y)}]^{1/2}}$$

b) Phenotypic correlation

$$r_p(XY) = \frac{\text{Phenotypic covariance between X \& Y}}{[\text{Phenotypic variance of (X) x Phenotypic variance of (Y)}]^{1/2}}$$

The genetic estimates for biometric attributes
Were classified as detailed below.

Genetic parameter	Low	Moderate	High
GCV and PCV	<20	20-30	>30
Heritability	<30	30-60	>60
GA as % of mean	<30	30-60	>60

Path coefficient analysis

Path co-efficient analysis was estimated as suggested by Dewey and Lu (1959) to study the direct and indirect effects.

6. RESULT AND DISCUSSION

Variability studies

The present study revealed that significant amount of variability existed among different *Calophyllam inophyllum* in growth and oil content investigated viz., Tree height, DBH, Crown diameter and oil content. The heritability values were high with only marginal difference.

Table 2: Genetic parameters of growth traits and oil content

Characters	GCV	PCV	Heritability (%)	Genetic Advance (%) of mean
Tree Height	6.45	7.11	82.12	12.04
DBH	2.87	24.11	14.20	7.70
Crown Diameter	5.95	7.65	60.55	9.54
Oil Content	7.80	16.92	21.28	7.41

To understand the causes of variation, apportioning of total phenotypic variance has more utility. The genetic variance which is heritable could be exploited for future utility. In the current study, DBH moderate phenotypic and low genotypic variance in different identified *Calophyllam inophyllum* seed sources. The other traits Tree height, Crown diameter and oil content expressed low phenotypic and genotypic variances. Similar reports on moderate PCV and low GCV for DBH was observed in *Eucalyptus globulus* (Paramathma and Surendran, 1999); *E. grandis* (Pugazhendi *et al*., 1999) *Madhuca latifolia* (George Jenner *et al*., 1999); and *Casuarina equisetifolia* (Mohan Varghese *et al*., 1999). In the present study, the information obtained from the seed source of *Pongamia pinnata* showed that the phenotypic variance this indicates that the traits were influenced by non-additive gene action (Table 2). Among the growth and oil content, highest heritability was recorded by tree height (82.12) followed by crown diameter (69.82), oil content (61.39) and DBH (28.80). And Tree height (12.67), DBH (14.20), Crown diameter (60.55) and Oil content (21.28) showed that low genetic advance. It suggesting the role of additive gene action in the expression of these characters and could be considered as reliable indices for selection. Similarly, high heritability estimates for volume was earlier reported in Eucalyptus progeny trials (Balaji, 2000) in *C. equisetifolia* also reported high heritability for girth at breast height followed by girth at ground level. Jambulingam (1990) observed consistency in heritability and genetic gain for volume over growth stages in *C. equisetifolia*. Similarly, high heritability and genetic advance were reported for height in *Bambusa balcooa* at early stages of growth and Satheesh (2000) recorded high heritability for growth traits in *Bambusa bambos* and *Dendrocalamus strictus*, respectively.High heritability coupled with low genetic advance as percentage over mean indicates predominance of non-additive gene action (Paramathma *et al*., 1997). In the present study, such phenomenon was observed for tree height which recorded highest values for heritability and low genetic advance as percentage. Hence, selection based on this character will be advantageous for yield improvement and future breeding programme in *Calophyllam inophyllum* seed source.

7. CORRELATION STUDIES

The correlation study was employed using the data collected from the plus trees to throw light on the association of traits for oil content. This correlation studies will also provide information about the relatedness of association in the parental population to that of the progenies viz., clonal population performance. A knowledge of the interrelationship existing among different growth, form and wood attributes is of crucial value to the tree breeder. If these were not known to the breeder, selection for one trait may cause an inadvertent change in the other (Zobel and Van Buijtenen, 1989). Some wood property traits are related but many are not (Zobel, 1971). In the current study, the magnitude of genotypic correlation coefficients between all growth and oil content studied were found to be higher than the corresponding phenotypic correlation coefficients. In phenotypic and genotypic correlation coefficient, oil content showed a positive correlation with tree height, DBH and crown diameter which are obviously the contributing characters to oil content (Tables 3 and 4).

Table 3: Genotypic correlation coefficient of growth

Characters	Tree Height	DBH	Crown Diameter	Oil Content
Tree Height	1.000	1.034	1.064	1.064
DBH		1.000	1.292	1.151
Crown Diameter			1.000	1.054
Oil Content				1.000

Table 4: Phenotypic correlation coefficient of growth

Characters	Tree Height	DBH	Crown Diameter	Oil Content
Tree Height	1.000	0.277	0.738	0.481
DBH		1.000	0.300	0.062
Crown Diameter			1.000	0.320
Oil Content				1.000

Positive phenotypic and genotypic correlations betweengrowth and oil content have been reported in several genera like Pinus (Squilance *et al*.1997) and *Eucalyptus camaldulensis*.

Path coefficients for growth

The path analysis permits the separation of direct effects from indirect effects through other related traits by partitioning the genotypic correlation coefficients (Dewey and Lu, 1959). The maximum positive direct effect was exerted by DBH (0.1092) on oil content followed by Tree height (-0.0529) (Table 5; Figure. 1).

Table 5: Path coefficient analysis for growth

Characters	Tree Height	DBH	Crown Diameter
Tree Height	-0.0529	-0.3315	-0.6799
DBH	-0.1607	0.1092	-0.0990
Crown Diameter	-0.0565	-0.3597	-0.6376

Residual effects=0.1913 (Diagonal values are direct effect)

The present investigation envisaged that high and positive association coupled with intensive direct effect of crown diameter on oil content indicated that the crown diameter could be the selection criterion in *Calophyllam inophyllam* improvement programmes and also for utilization in the industrial plantation programmes. From a comprehensive perspective, all growth traits were contributing directly to oil content. The crown diameter exercised its influence directly the available reports relate to path analysis of growth traits (Rathinam et al., 1981; Surendran, 1982). Therefore the growth attributes crown diameter may be considered important in the improvement in oil content per tree.

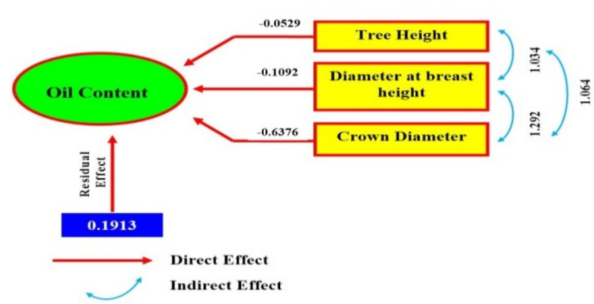

Fig. 1: Pathway co-efficient analysis in *Calophyllam inophyllam* genetic resource

8. CONCLUSION

In the current study, among the growth, oil content and DBH moderate phenotypic and low genotypic variance in different identified *Calophyllam inophyllam* seed sources. Highest heritability was recorded by tree height (82.12). Tree height was recorded highest values for heritability and low genetic advance as percentage. In phenotypic and genotypic correlation coefficient, oil content showed a positive correlation with tree height, DBH and crown diameter which are obviously the contributing characters to oil content. The maximum positive direct effect was exerted by DBH (0.1092) on oil content followed by Tree height (-0.0529). Hence, selection based on growth character will be advantageous for yield improvement and future breeding programme in *Calophyllam inophyllam* seed source. Therefore the growth attributes crown diameter may be considered important in the improvement in oil content per tree.

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