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Research Article

Genetic variability and association studies in half-sib progenies of Puvarasu (*Thespesia populnea L.* Sol. ex. Correa) in coastal regions of Thiruvarur District, Tamil Nadu

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Abstract
Twelve-month-old superior 20 half-sib progenies of *Thespesiapopulnea* were evaluated nine months after planting for genetic variability, heritability, genetic gain, correlation and path analysis at Perugavalthan, Thiruvarur District, Tamil Nadu during 2014. Among the 20 half-sibs, progenies collected fromAathikadu recorded higher growth characters followed by Periyampatti and T. Nagar. Volume index registered highest phenotypic and genotypic coefficient of variation followed by height. Maximum heritability was observed for volume index followed by height and basal diameter. Volume index was found to be associated with higher genetic gain while it was low for height and basal diameter. Volume index had high and significant positive phenotypic and genotypic correlation with height and basal diameter. Path analysis showed that basal diameter and height contributed directly to the volume index. The half-sib progenies of *Thespesiapopulnea* collected from Aathikadu, Periyampatti and T. Nagar were proved to be superior on the basis of characters under study in coastal saline soil.

Key words
Variability, Genetic gain, Correlation, Path analysis, Saline soil, *Thespesiapopulnea*.

Introduction

Globally, soil salinization is more common problem in arid and semi-arid regions than in humid regions.High concentrations of salts have detrimental effects on seed germination and plant growth (Taiz and Zeiger, 2006; Ramoliya*et al.,* 2006) and eventually kill growing plants (Garg and Gupta, 1997). However, plant species differ in their sensitivity or tolerance to salts. Soil salinity is a major abiotic stress affecting approximately 7 per cent of the world's total land area (Shabala and Cuin, 2007). It has been reported that salinization of arable land may result in 30 per cent land loss in the whole world within next 25 years and up to 50 per cent by the middle of 21st century (Wang *et al.,* 2003). In India, the total geographical area is about 329 m. ha, among which the area under cultivation is only 160 m. ha. The sizable fertile areas are becoming unfit for cultivation due to increase in salinity and sodicity. In India, 6.73 m. ha area is reported to be salt affected (Singh *et al.,* 2013), where cultivation of salt tolerant multipurpose tree species could be the best suited alternatives.*Thespesiapopulnea*is one of the fast growing, multipurpose trees and itthrives on sandy coastal soils as well as volcanic, limestone and rocky soils with a pH of 6.0-7.4. It tolerates heavier soils, soil salinity and occasional inundation, but does not grow on permanently inundated soils. Trees should be pruned to develop clear boles for timber production (Friday and Okano, 2006). It is widely used for carving, making bowls, plates, cups, paddles, agricultural implements, musical instruments, gunstocks, carts, wheels, boats, tool handles, furniture, cabinet work, utensils, jewellery and turnery. It is also considered suitable for light construction, flooring, wall panelling, interior trim, precision equipment, toys, novelties and pattern making. The wood can also be used as firewood. Pokharkar*et al*. (2008)examines biodiesel production from non-edible oil extracted from *T. populnea* plant.

Orwa*et al.* (2009) reported that young shoots are used as fodder as well as green manure. The tree can yield 2-3 kg of green fodder and this goes up to 10 kg in the 15 years. Friday and Okano (2006) also reported in South-East Asia and India the young leaves, flowers and unripe fruits are eaten raw, boiled or fried as a vegetable and also it has medicinal properties. The leaves are applied to inflamed and swollen joints. When cut, the young fruit secretes a yellow sticky sap used to treat ringworm and other skin diseases. The bark yields a tough fibre used for cordage, fishing lines, basketry, coffee bags and for

caulking boats. The outer bark may be used for rope and the inner bark for finer cordage. The flowers and fruits yield a water-soluble yellowish dye, while the wood soaked in water gives a solution that is used in Asia to dye wool deep brown (Krauss, 1993). The wood may produce a yellow dye which is used to dye wool in East and South-East Asia, and the leaves are used to make a black dye (Clark and Thaman, 1993). The bark contains high levels of tannins and has been used for tanning leather. However, such multiple utility trees have not been studied intensively for its natural variability and its exploitation for commercial application leading to establishment of *Thespesiapopulnea*plantations in salinity areas. Hence, the current study is a pioneering attempt to evaluate the genetic variability and association studies for salt tolerance in *Thespesiapopulnea*to identify the superior genetic resources.

Materials and Methods

The study was conducted *at* in Perugavalnthan (Latitude 10º47'19''N, Longitude 79º50'80''E), Thiruvarur District, Tamil Nadu during 2014-15. The soil characteristics of experimental plot are presented in Table 1. Twenty half-sib progenies of *Thespesiapopulnea* were collected from various locations of Tamil Nadu. One-year old seedlings of 20 half-sib progenies were planted in a Randomized Block Design (RBD) with 3 replications of nine seedlings each and the spacing adopted was 1.5 m x 1.5 m.The field was irrigated once in 10 days. The plants were maintained in the field and observations on plant height (cm), basal diameter (cm) and volume index (cm^3) were taken at 9 months after planting in all the seedlings of each replication.

Volume index was calculated using the formula (Hatchell, 1985; Manavalan, 1990)

$$V.I. = (\text{Collar diameter})^2 \times \text{Height (cm)}$$

Phenotypic and Genotypic coefficient of variability (PCV and GCV) was worked out by formula suggested by Burton (1952). Heritability and genetic advance were calculated by the formula used by Lush (1940) and Johnson *et al.* (1955). Genetic gain was calculated by the method suggested by Johnson *et al.* (1955). Genotypic and phenotypic correlations were determined as per the methods suggested by Goulden (1952), while path coefficients, also at genotypic and phenotypic levels, were estimated according to Dewey and Lu (1959).

Results and Discussion

Plant height, basal diameter and volume indexare the important biometric attributes which decide the growth and development of plants. Significant variations in plant characters like height, basal diameter and volume index were observed under coastal soil conditions among half-sib progenies of *T. populnea* at 9 months after planting.

Among half-sib progenies, the progenies collected from Aathikadu possessed maximum height (167.78 cm), basal diameter (2.71 cm) and volume index (1229.96 cm^3), followed by the progenies collected from Periyampatti for height (150.96 cm), basal diameter (2.61 cm) and volume index (1030.87 cm^3) and T. Nagar for height (147.15 cm), basal diameter (2.48 cm) and volume index (907.38 cm^3) (Table 2).

The findings of the current study are also in accordance with the workers who reported the existence of significant differences and superiority of few seed sources, progenies and provenances in various tree species like *Dalbergiasissoo* (Rawat and Nautiyal, 2007), *Acacia catechu* (Nautiyal*et al.,* 2006)and *Leucaenaleucocephala* (ChavanSangaram and Keerthika, 2013), which confirms the current findings in *Thespesiapopulnea*.

The extent of variability is also assessed by genotypic and phenotypic coefficient of variation. In the present study (Table 3), volume index registered maximum phenotypic and genotypic coefficient of variation (45.47 %, 43.96 %) followed by height (16.87 %, 14.06 %)which indicates presence of sufficient amount of variability for characters under study. Similar results of higher phenotypic and genotypic coefficient of variation reported in *Azadirachtaindica (*Dhillon*et al.,* 2003*)* and *E. tereticornis* (Kumar *et al.*, 2010).

Among the three character under study higher heritability was reported for volume index (93.44%) followed by height (90.64%) and basal diameter (81.41%) (Table 3). Similar results had been reported earlier in *Tectonagrandis* (Anmol Kumar, *et al.,* 1997), *Simaroubaglauca* (Kumaran*et al*., 2010) andin *Leucaenaleucocephala* (Chavansangaram and Keerthika, 2013).

Genetic gain for the trait under study revealed that higher genetic gain was recorded for volume index (87.54 %) which indicating a wide scope of genetic improvement in this particular trait, while it was low for height (31.50%) and basal diameter (23.04%) (Table 3). These results are conformity with the findings of Anmol Kumar *et al.* (1997) in *T. grandis* and in *Eucalyptus grandis* (Subramanian *et al.*, 1995)

In the present investigation, volume index registered a higher magnitude of phenotypic and genotypic

association with plant height and basal diameter. These traits also had positive and significant correlation with volume index (Table 4). Similar observations of higher magnitude of genotypic correlation coefficient than phenotypic correlation values were reported in *Eucalyptus tereticornis* (Gokul, 1997) and in *Meliadubia* (Saravanan, 2012).

Results obtained in path co-efficient analysis of half-sib progenies of *Thespesiapopulnea* revealed that basal diameter and height showed positive direct effect on volume index. Basal diameter showed maximum positive direct effect (0.613) followed by height (0.332) on volume index. The basal diameter had maximum direct effect on volume in *Santalum album* suggesting that a better scope for improvement of volume by selecting this trait (Manoj Kumar and Subramanian, 1998). The contribution of the direct effect of plant height and diameter on volume index in the current study also confirmed the results of earlier finding indicating the contribution of both factors on growth and development. Similarly, basal diameter recorded maximum indirect effect via plant height on volume index. Hence, from the current study, high and positive association with intensive direct effect of plant height and basal diameter could be used as a valuable, reliable and relevant measure for *Thespesiapopulnea* tree improvement programme. Wide range of research findings in different tree species *viz*., *Eucalyptus tereticornis* (Rathinam*et al*., 1982), *Simaroubaglauca*(Kumaran*et al*., 2010) and*Meliadubia* (Saravanan, 2012) also lend support to the findings of current study.

From the present investigation, it is clear that considerable variations in plant height, basal diameter and volume index exist among half-sib progenies of *Thespesiapopulnea*in coastal soil. The heritability and genetic gain were high for volume index, which strengthens the probable reason that they are more under genetic control. The study suggests that judicious selection on the basis of these growth parameters can be an effective technique in selecting trees for maintaining good quality plantation. At this stage, half-sib progenies from Aathikadu, Periyampatti and T. Nagarmay be recommended to meet the immediate planting programmes in the coastal regions of Tamil Nadu for enhancement of growth and productivity of *T. populnea.* High positive genotypic correlation coefficient in growth traits reveals that the traits are genetically controlled and selection can be very effective in tree improvement programme of these species.

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Table 1.Initial soil characteristics of progeny evaluation trial of *Thespesiapopulnea* at Perugavalnthan, Thiruvarur district.

Sl. No.	Properties	Value	Method	Author
1.	Soil Texture	Clay	International pipette method	Piper (1966)
2.	pH	8.1	1:2.5 soil water suspension	Richards (1954)
3.	EC (d Sm^{-1})	5.9	1:2.5 soil water suspension	Jackson (1973)
4.	ESP	11.0	Neutral normal ammonium acetate method	Hesse (1973)
5.	Available N (kg ha^{-1})	240	Alkaline permanganate method	Subbiah and Asija (1956)
6.	Available P (kg ha^{-1})	10.5	Olsen's method, Colorimetry	Olsen *et al.* (1954)
7.	Available K (kg ha^{-1})	175	N.NH4OAC extract	Stanford and English (1949)

Table 2. Mean performance of *T. populnea* in progeny evaluation trial in coastal soil at nine months after planting.

Half-sib progeny details / Treatments	Height (cm)	Basal diameter (cm)	Volume index (cm^3)
Mettupalayam	92.49	2.07	396.46
Umapalayam	142.02	2.39	809.35
Gandhipuram	124.86	1.96	481.07
Coimbatore (GCT)	128.78	2.12	576.54
Coimbatore (TNAU)	108.43	1.79	347.38
Karamadai	84.11	1.50	189.29
Tiruppur-1	141.88	2.17	669.64
Tiruppur-2	112.33	1.89	400.45
Avinashi	133.59	2.26	683.73
Rayapuram	137.44	2.39	784.87
Erode	124.07	2.30	658.17
Bhavanisagar	138.48	2.06	589.83
Palapalayam	134.33	2.31	719.92
Hogenakkal	100.72	2.39	575.17
Periyampatti	150.96*	2.61*	1030.87*
T. Nagar	147.15*	2.48*	907.38*
Ennore	129.26	2.26	660.03
Jakkampatti	121.74	2.27	628.68
Aundipatty	113.96	2.23	569.19
Aathikadu	167.78*	2.71*	1229.96*
Grand mean	**126.72**	**2.21**	**645.40**
SEd	**7.934**	**0.132**	**97.396**
CD (0.05)	**16.061**	**0.268**	**197.172**

*** Significant at 5 per cent level**

Table 3. Genetic estimates for field performance of half-sib progenies of*Thespesiapopulnea*in coastal soil

Characters	Phenotypic Coefficient of Variation (%)	Genotypic Coefficient of Variation (%)	Heritability (%)	Genetic advance as per cent of mean
Height	16.87	14.06	90.64	31.50

Basal Diameter	13.74	10.39	81.41	23.04
Volume Index	45.47	43.96	93.44	87.54

Table 4.Correlation coefficient of biometric attributes in half-sib progenies of *Thespesiapopulnea*as influenced by coastal soil

Characters		Height	Basal Diameter	Volume Index
Height	P	1.000	0.760**	0.879**
	G	1.000	0.912**	0.929**
Basal Diameter	P		1.000	0.956**
	G		1.000	0.990**
Volume Index	P			1.000
	G			1.000

**** Significant at 1 per cent level**

Table 5. Path coefficient analysis of biometric attributes in half-sib progenies of *Thespesiapopulnea* on Volume index as influenced by coastal soil

Characters	Height	Basal Diameter	Volume index
Height	0.332	0.503	0.835
Basal Diameter	0.303	0.613	0.916

Residual Effect = 0.029