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Variability and association studies in pod and seed traits in half-sibs progenies of *Thespesia populnea* in Tamil Nadu

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Abstract

The present study was carried out to identify superior candidate plus trees of *Thespesia populnea* across its natural distribution in Tamil Nadu and pods were collected for tree improvement work. The pod and seed physical parameters viz., 100 pod weight, number of seeds per pod, 100 seed weight, seed length, seed breadth and germination per cent were studied. The seeds collected from Bhavanisagar (FCRI TP 12), Periyampatti (FCRI TP15) and T. Nagar (FCRI TP 16) region were superior in all traits studied compared to other regions of Tamil Nadu. These progenies can be utilized for quality seedling production in nursery.

Keywords: *Thespesia populnea*, half-sib progeny, variability, GCV, PCV, correlation, path analysis

Introduction

Thespesia populnea is one of the fast growing and multipurpose trees and the wood is excellent for carving. It is widely used for making bowls and plates, clubs, paddles, agricultural implements, musical instruments, gunstocks, carts, wheels, boats, tool handles, furniture, cabinet work, utensils, jewellery and turnery. The wood can also be used as firewood. Friday and Okano (2006)^[7] reported that tree is suitable for dry locations because it develops a long taproot in porous soils; it may tolerate a dry season of up to 8 months. Well grown in 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. In Asian mangrove areas, it is planted to consolidate ridges and bunds in an aqua-silvicultural system for prawn production. Pokharkar *et al.* (2008)^[12] examines biodiesel production from nonedible oil extracted from *T. populnea* plant seeds. It was found that the yield of biodiesel made from the *T. populnea* seed oil under various conditions was found 50-92 per cent. Biodiesel produced from this non-edible oil was tested on a diesel engine to study the effect of biodiesel fatty acid composition on the engine exhaust emission.

Orwa *et al.* (2009)^[11] reported young shoots are used as fodder and as green manure. The tree can yield 2-3 kg of green fodder and this goes up to 10 kg in the 15 years. 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)^[8]. The bark contains high levels of tannins and has been used for tanning leather. *T. populnea* is valid for its timber is lacking in genetic improvement work. Genetic improvement of planting stock, both through the seed route and clonal route can play a very significant role in improving the yield, productivity, quality of the produce and profitability of plantations. Hence, the present study aims at genetic improvement of *T. populnea* through pod and seed traits.

Materials and methods

Survey was conducted in the six agro climatic zones of Tamil Nadu of North Eastern Zone, North Western Zone, Western Zone, Southern Zone, Cauvery Delta Zone and Hill Zone. Among the six zones, *T. populnea* was not found in hill zone. Therefore, the candidate plus trees (CPTs) were identified in 30 locations. Among them 20 locations which recorded seed set were included in the study. All the 21 locations were distributed in eight districts viz.,

Coimbatore, Tiruppur, Erode, Namakkal, Dharmapuri, Chennai, Theni and Ramanathapuram (Table 1).

The experiment was carried out at Forest College and Research Institute, Tamil Nadu Agricultural University, Mettupalayam 11°19' N, 76°56' E, 300 m above mean sea level, 800 mm rainfall, pH 7.1) during 2014 - 2015. The observations on pod and seed traits viz., 100 pod weight, number of seeds per pod, 100 seed weight, seed length, seed breadth and germination per cent were measured and also

subjected to genetic analysis. The parameters were recorded on twenty randomly selected pod and seed representing each replications. Completely Randomized Block Design (CRBD) was used. The observations used for analysis of variance (Sukhatme and Amble, 1989) [13] and coefficients of variation were estimated by Burton and Devane (1953) [4]. The heritability and genetic gain was calculated by the method of Lush (1940) [9] and Burton and Devane (1953) [4], respectively.

Table 1: Morphometric attributes of selected half-sibs of *Thespesia populnea*

Half-sib progenies	Location	Tree height (m)	GBH (m)	Clear bole height (m)
FCRI TP 1	FC&RI, Mettupalayam	5.9	0.44	2.3
FCRI TP 2	Umopalayam	6.6	0.52	3.8
FCRI TP 3	Gandhipuram	5.8	0.44	2.5
FCRI TP 4	GCT, Coimbatore	5.6	0.43	3.1
FCRI TP 5	TNAU, Coimbatore	5.2	0.43	2.2
FCRI TP 6	Karamadai	5.7	0.44	3.3
FCRI TP 7	Tiruppur-1	6.4	0.49	3.9
FCRI TP 8	Tiruppur-2	6.0	0.48	3.6
FCRI TP 9	Avinashi	6.3	0.49	3.9
FCRI TP 10	Rayapuram	6.5	0.50	3.9
FCRI TP 11	Erode	5.3	0.43	2.2
FCRI TP 12	Bhavanisagar	5.4	0.44	2.5
FCRI TP 13	Palapalayam	6.0	0.47	2.7
FCRI TP 14	Hogenakkal	6.6	0.51	4.0
FCRI TP 15	Periyampatti	5.1	0.43	2.4
FCRI TP 16	T. Nagar	6.7	0.52	3.6
FCRI TP 17	Ennore	6.2	0.47	3.9
FCRI TP 18	Jakkampatti	5.0	0.42	2.3
FCRI TP 19	Aundipatty	6.0	0.46	2.7
FCRI TP 20	Theni	5.2	0.42	2.2
FCRI TP 21	Aathikadu	6.6	0.51	4.0

Results

Variation in pod and seed traits

Hundred fruit weight was observed more significant difference between various half-sib progenies. The fruit weight was the highest in FCRI TP 21 (505.52 g) and the lowest in FCRI TP 5 (224.28 g) half-sibs. Nine half-sibs gained superiority over general mean. The number seeds per fruit ranged from 8.1 to 18.4 with an average of 12.62. The hundred seed weight was the highest in FCRI TP 21 and FCRI TP12 (18.44 g) whereas the lowest in FCRI TP 18

(12.83 g) half-sibs. Seed length exhibited significant difference between various half-sibs. The seed length was the highest in FCRI TP 6 and FCRI TP17 (1.06 cm) while the lowest in FCRI TP 2 and FCRI TP 4 (0.86 cm) half-sibs. The breadth of the seeds ranged from 4.22 cm to 5.41 cm with an average of 4.59 cm. Germination per cent varied from 12 per cent to 96 per cent with an average of 62.13 per cent. The germination per cent was the highest in FCRI TP 12, FCRI TP15 (96%) and the lowest in FCRI TP 21 (12%) half-sib progenies (Table 2).

Table 2: Effect of half-sibs on pod and seed physical parameters in *Thespesia populnea*

Half-sib	100 fruit weight (g)	No. of seeds per fruits	100 seed weight (g)	Seed length (cm)	Seed breadth (cm)	Germination per cent
FCRI TP 1	288.72	8.10	16.15*	0.88	4.97*	74*
FCRI TP 2	380.12*	12.30	13.97	0.86	4.27	62
FCRI TP 3	454.36*	14.60*	15.34	0.90	3.95	90*
FCRI TP 4	303.72	12.60	15.64	0.86	4.22	22
FCRI TP 5	224.28	10.10	13.56	0.94	4.60	22
FCRI TP 6	368.24	17.30*	13.18	1.06*	4.45	28
FCRI TP 7	305.76	9.30	14.53	0.90	4.50	90*
FCRI TP 8	341.89	10.10	13.45	0.90	4.25	84*
FCRI TP 9	410.12*	12.00	14.47	0.90	4.35	74*
FCRI TP 10	369.28	9.20	15.29	0.90	4.57	92*
FCRI TP 11	434.1*	13.60*	14.64	0.98*	4.49	60
FCRI TP 12	441.68*	15.90*	18.4*	0.90	4.50	96*
FCRI TP 13	302.76	11.10	15.49	1.00*	5.22*	76*
FCRI TP 14	321.2	11.20	14.16	0.98*	4.38	90*
FCRI TP 15	432.88*	13.80*	17.94*	0.94	5.00*	96*
FCRI TP 16	476.12*	18.40*	15.45	0.92	4.53	68*
FCRI TP 17	320.68	16.90*	17.4*	1.06*	5.41*	36
FCRI TP 18	316.68	12.30	12.83	0.98*	4.47	44
FCRI TP 19	390.96*	10.40	17.52*	1.04*	4.80*	48
FCRI TP 20	270.77	10.20	14.14	0.96	4.43	40

FCRI TP 21	505.52*	15.70*	18.44*	1.00*	5.04*	12
Grand mean	364.75	12.62	15.33	0.94	4.59	62.13
SEd	5.768	0.203	0.254	0.016	0.078	1.325
CD	11.994	0.423	0.528	0.032	0.162	2.755

* - Significant at 5 per cent level

Genetic parameters of pod and seed traits

Hundred pod weight recorded moderate phenotypic and genotypic coefficient of variation expressed of 20.41 and 20.38 respectively. Heritability for this trait was high and genetic advance as percentage of mean was moderate with 99.68 per cent and 41.92 respectively for hundred pod weight (Table 3). The phenotypic and genotypic coefficients of variation expressed by number of seeds per fruit were moderate (23.23 and 23.19). The heritability estimate was

high (99.65 per cent) whereas genetic advance as percentage of mean was moderate (47.69) for number of seeds per fruit. The heritability estimates was high (98.99 per cent) whereas genetic advance as percentage of mean was low (22.96) for hundred seed weight. The phenotypic and genotypic coefficients of variation expressed by seed length were low (6.99 and 6.33). The heritability and genetic advance as percentage of mean was high (99.81 per cent and 90.17 per cent) for seed germination.

Table 3: Genetic estimates for pod and seed physical parameters in half-sib progenies of *Thespesia populnea*

Characters	Phenotypic coefficient of variation (%)	Genotypic coefficient of variation (%)	Heritability (%)	Genetic advance as per cent of mean
100 pod weight	20.42	20.38	99.68	41.92
No. of seeds per pod	23.23	23.19	99.65	47.69
100 seed weight	11.26	11.20	98.99	22.96
Seed length	6.99	6.33	81.93	11.79
Seed breadth	7.97	7.82	96.16	15.80
Germination per cent	43.85	43.81	99.81	90.17

Association studies

Correlation studies

The estimates of phenotypic and genotypic correlations among pod and seed parameters in half-sibs of *Thespesia populnea* are presented in Table 4. Hundred pod weight exhibited positive phenotypic (0.189) and genotypic (0.190) correlation with germination per cent (Table 4). The phenotypic inter correlation with number of seeds per pod (0.626) and hundred seed weight (0.485) were positive and significant whereas seed length (-0.090) and seed breadth (-0.061) showed negative inter correlation with hundred pod weight. The hundred pod weight shows a positive and significant genotypic inter correlation with number of seeds per pod (0.625) and hundred seed weight (0.483). Whereas seed length (-0.108) and seed breadth (-0.072) showed

negative inter correlation with hundred pod weight. Number of seeds per pod exhibited negative phenotypic (-0.234) and genotypic (-0.235) correlation with germination per cent. The number of seeds per pod exhibited a positive genotypic inter correlation with hundred seed weight (0.305), seed length (0.279) and seed breadth (0.080). Hundred seed weight exhibited positive phenotypic (0.063) and genotypic (0.063) correlation with germination per cent. The hundred seed weight exhibited a positive and significant genotypic inter correlation with seed breadth (0.573) whereas seed length (-0.003) showed negative inter correlation with hundred seed weight. Seed length exhibited negative phenotypic (-0.499) and genotypic (-0.553) correlation with germination per cent. Seed breadth exhibited negative phenotypic (-0.178) and genotypic (-0.182) correlation with germination per cent.

Table 4: Phenotypic and genotypic correlation among pod and seed physical parameters in half-sib progenies of *Thespesia populnea*

Characters		100 pod weight	No. of seeds per pod	100 seed weight	Seed length	Seed breadth	Germination per cent
100 pod weight	P	1.000	0.626**	0.485*	-0.090	-0.061	0.189
	G	1.000	0.625**	0.483*	-0.108	-0.072	0.190
No. of seeds per pod	P		1.000	0.308	0.263	0.088	-0.234
	G		1.000	0.305	0.279	0.080	-0.235
100 seed weight	P			1.000	0.016	0.576**	0.063
	G			1.000	-0.003	0.573**	0.063
Seed length	P				1.000	0.416**	-0.499
	G				1.000	0.416**	-0.553
Seed breadth	P					1.000	-0.178
	G					1.000	-0.182
Germination per cent	P						1.000
	G						1.000

* - Significant at 5 per cent level

** - Significant at 1 per cent level

Path Coefficient Analysis

The genetic correlation coefficients of pod and seed parameters with germination in half-sib progenies of *Thespesia populnea* were partitioned in to direct and indirect by path coefficient analysis and the results are presented in Table 5. Among the pod and seed attributes for germination,

seed length showed the maximum direct positive effect 0.469 followed by hundred pod weight (0.417), number of seeds per pod (0.340), seed breadth (0.136) and hundred seed weight (0.114) on germination per cent and the residual effect was 0.7830 (Table 5).

Table 5: Path coefficient analysis of pod and seed physical parameters on seed germination per cent in half-sib progenies of *Thespesia populnea*

Characters	100 pod weight	Number of seeds per pod	100 seed weight	Seed length	Seed breadth	Germination per cent
100 pod weight	0.417	0.212	0.055	0.050	0.009	0.190
Number of seeds per pod	0.260	0.340	0.034	0.131	0.010	-0.235
100 seed weight	0.201	0.103	0.114	0.002	0.078	0.063
Seed length	0.044	0.095	0.001	0.469	0.056	-0.553
Seed breadth	0.030	0.027	0.065	0.195	0.136	-0.182

Residual Effect = 0.7830

Hundred fruit weight exhibited the maximum positive indirect effect through number of seeds per pod (0.212) followed by hundred seed weight (0.055), seed length (0.050) and seed breadth (0.009) on seed germination per cent. Hundred seed weight exhibited the maximum positive indirect effect through hundred pod weight (0.201) followed by number of seeds per pod (0.103), seed breadth (0.078) and seed length (0.002) on germination per cent. Seed length recorded maximum positive indirect effect through number of seeds per pod (0.095) followed by seed breadth (0.056), hundred pod weight (0.044) and hundred seed weight (0.001) on seed germination per cent. Seed breadth exhibited maximum positive indirect effect through seed length (0.195) followed by hundred seed weight (0.065), hundred pod weight (0.030) and number of seeds per pod (0.027) on seed germination per cent.

Discussion

In forestry, selection of superior genotypes is very important as it forms the basis for tree improvement. The success of any tree improvement programme depends upon the amount of genetic variability in a tree species and it is of significant importance for developing effective tree improvement strategies (Vakshasya *et al.*, 1992) [15]. In the present investigation significant difference were observed among the half-sibs of *T. populnea* for their physical characteristics *viz.*, hundred fruit weight, number seeds per fruits, hundred seed weight, seed length and seed breadth and germination percent. The highest value for hundred fruit weight (505.52 g) and hundred seed weight (18.44 g) were recorded in FCRI TP 21. For seed length (1.06 cm) two half-sibs shows maximum value *viz.*, FCRI TP 6 and FCRI TP 17. For seed breadth (5.41 cm) FCRI TP 17 and number of seeds per fruit exhibited maximum in FCRI TP 16 (Table 2) half-sibs. This result is in accordance with earlier findings of variation evident in seed parameters of *Albizia lebbek* among the seed sources of Tamil Nadu (Natarajan, 1999) [10] and in *Acacia catechu*, (Bhat and Chauhan, 2003) [3]. Significant variation was noticed for seed germination among the half-sibs. The maximum germination per cent was observed in FCRITP 12 and FCRITP 15 (96% each) followed by FCRITP 10 (92%), FCRITP 3, and FCRITP 7 and FCRITP 14 (90% each) half-sibs and a minimum in FCRITP 21 (12%) half-sibs. This implies that genetic (Vakshaya *et al.*, 1992) [15] and geographic (Salazar, 1986) conditions influence an important role in deciding germination, survival and establishment of seeds.

Among the pod and seed parameters studied in half-sibs of *T. populnea*, germination percent had an edge over others with high phenotypic (PCV) (43.85) and genotypic (43.81) coefficient of variation (GCV). Heritability (99.81) and genetic advance as per cent of mean (90.17) were also high for germination per cent followed by number of seeds per fruits and hundred pod weight, whereas other seed parameter recorded low to medium PCV and GCV, high heritability and low genetic advance. (Table 3) The findings agree with the

result in *Tectona grandis* (Arun Prasad, 1996) [1] and *Caesalpinia sappan* (Arthanari, 2008) [1] was observed high heritability and genetic advance as per cent of mean for germination per cent.

Correlation and path analysis established the extent and cause of association between yield and its attributes so that these yield components may form additional criteria for selection in breeding programme. Yield is a complex entity associated with many characters which are themselves interrelated. Such interrelationship of various yield components is very essential to understand the relative importance of each factor involved (Dhillon *et al.*, 1992) [6]. Two characters *viz.*, hundred pod weight and hundred seed weight were positively correlated with germination per cent, however other three parameters expressed negative correlations both at phenotypic and genotypic level (Table 4). The results agree with the findings in *Grewia optiva* (Tyagi *et al.*, 1999) [14]. In contrary negative correlation between germination and seed characters were reported in *Acacia nilotica* (Vanangamudi *et al.*, 1998) [16]. Path coefficient analysis which apportions the correlation coefficient in to direct and indirect effects and measuring the relative importance of the casual factors involved and is being extensively utilized for understanding the complex traits in breeding programmes (Dewey and Lu, 1959) [5]. All parameters exhibited positive direct effect on germination. The maximum positive direct effect was expressed by seed length (0.469) followed by hundred pod weight (0.417) on seed germination per cent (Table 5).

Conclusion

The highest value for 100 fruit weight and 100 seed weight were recorded maximum in Aathikadu (FCRI TP 21) half-sibs while half-sib progenies Karamadai (FCRI TP 6) and T. Nagar (FCRI TP 17) recorded higher seed length. Half-sib from T. Nagar (FCRI TP 17) observed maximum seed breadth whereas number of seeds per fruit was recorded maximum in Ennore (FCRI TP 16). The progenies Bhavanisagar (FCRI TP 12), Periyampatti (FCRI TP 15) recorded maximum germination per cent. The germination per cent recorded the highest phenotypic and genotypic coefficient of variation. Heritability and genetic advance as per cent mean were also high for germination per cent followed by number of seeds per fruit and hundred pod weights. Hundred pod weight and hundred seed weight were positively correlated with germination per cent. Seed length exerted maximum direct positive effect on germination followed by hundred pod weight, number of seeds per pod, seed breadth and hundred seed weight. Indirect positive effect was also observed in number of seeds per pod and hundred seed weight through hundred pod weight on seed germination. The progenies selected from Bhavanisagar (FCRI TP 12), Periyampatti (FCRI TP 15) and T. Nagar (FCRI TP 16) can be used for production of quality seedlings in nursery.

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