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Correlation Studies for Morphological and Biomass Traits in Half-sib Progenies of *Peltophorum pterocarpum*

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The current research was conducted on twenty plus trees of *Peltophorum pterocarpum* from different locations in Bihar to study the association among different morphological and biomass traits. It was found that PPT_{12} (Rajgir Park) and PPT_4 (Muraura, Nalanda) performed better for germination metrics under open field and greenhouse conditions, respectively. PPT_6 (Nari, Nalanda) and PPT_{13} (Sathopur, Nalanda) outperformed all other superior tree progenies in terms of morphological and biomass attributes in green house and open field conditions, respectively. The phenotypic coefficient of variability was greater than the genotypic coefficient of variability for all morphological and biomass variables tested under green house and field conditions, showing that the environment played a greater role. Germination value heritability was found to be high in both environments. High heritability with high genetic advance was associated with shoot length in greenhouse condition, indicating additive gene action. Under greenhouse conditions, the phenotypic correlation coefficients among the seedling parameters evaluated varied from a non-

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significant 0.211 (P=0.01) between shoot root ratio and root dry weight and between shoot length and collar diameter to a very significant 0.967 (P=0.01).Accessions showing higher values for one or the other attributes could be selected as parents for further improvement.

Keywords: Peltophorum pterocarpum; heritability; phenotypic and genotypic correlation; growth variability; PPTs (Peltophorum plus tree).

1. INTRODUCTION

Peltophorum pterocarpum, often known as yellow-flamboyant, is a native plant of tropical, southeastern Asian nations such as Thailand, Laos, Vietnam, India, and Sri Lanka, as well as the Andaman, the Malay Peninsula, and North Australia. It belongs to the family Fabaceae (Sub-family:Caesalpiniaceae). The plant may also be found in several parts of India, notably Birbhum district in West Bengal. It is a very attractive tree with a spreading crown that is often used for decoration all over the world. In terms of biodiversity, it provides nectar for Hymenopteran insects such as honey bees, bumble bees, and various commercially significant vasps [1]. It is a deciduous tree that grows to 15–25 m (occasionally up to 50 m) tall and has a trunk diameter of up to 1 m. It is found all over the world, particularly in tropical Southeast Asia [2].

Peltophorum is a fast-growing tree with several applications. Because of its dense spreading crown, *Peltophorum* is a popular shade tree. It has reforestation potential, as well as the capacity to fix nitrogen and serve as a source of green manure. Despite the fact that it is not a commercial timber species, the wood is utilized locally for light building, cabinet-making, and as fuelwood. Various plant components are employed as feed, fuelwood, lumber, tannin, or dyestuff. In Java, the bark is an essential component of the dark or black 'soga' dye used for batik production. It is also used to preserve and dye fishing nets, as well as tanning leather. Copper pod is an excellent source of green manure [3]. Apart from these, it has a strong therapeutic value. Different portions of this tree are used to cure a variety of ailments, including stomatitis, sleeplessness, and skin problems, constipation, ringworm and its flower extract is known to be a good sleep inducer and used in insomnia treatment [4]. It is used as an astringent to treat or reduce intestinal diseases caused by childbirth pain, sprains, bruises, and swelling, or as a lotion to treat eye problems, muscular aches, and sores. It is used in tooth powders and gargles [5].

Ginwal discovered that there are significant disparities in the genotypic and phenotypic coefficients of variation for all of the traits, indicating that these features are susceptible to environmental changes. The level of diversity in the base population, which is evaluated by several population metrics like as genotypic and phenotypic variations and genotypic and phenotypic coefficient of variation, determines whether tree breeding succeeds or fails [6]. Adaptation to changing environmental conditions sustains genetic diversity among separate and overlapping tree populations. Understanding patterns of variation in adaptive qualities is critical when choosing seed sources for planting. As a result, selection based on component qualities with strong genetic advance may be more efficient in *Peltophorum pterocarpum* plant selection. The objective of the present investigation was to quantify the magnitude of genetic variability present in the existing base population (Twenty P. *pterocarpum* genotypes collected from different regions of Bihar) and to identify important morphological and biomass characters to provide useful information for developing improved genotypes for future breeding programs.

2. MATERIALS AND METHODS

The investigation was carried out in the nursery of College of Forestry, SHUATS, Prayagraj, U.P., during 2021-22 in greenhouse and open field conditions. The site is situated between the North latitude 25.41° and at the East longitude 81.84° with an altitude of 78 meters above mean sea level on the northern aspect. Mature pods were collected from different parts of the crown of an individual plus tree selected from twenty different locations in Bihar (Table 1). The pods were cleaned and dried at a similar temperature and humidity to reach constant weight. Observations on pod characters were taken. Healthy pods were counted and taken to make three replications containing fifty pods per replication. Ten pods were taken randomly from each a replication for observation. The average of ten pods measurements was recorded as pod length, width, and thickness. After taking

observations, seeds were extracted from pods and kept plus tree and replication-wise for taking observations on seed characters in the months of November- December 2021. All the seeds were weighed (digital electronic balance, Mx 7000 series) and the length (Digital Vernier calipers) of the seeds was also measured. The seeds were sown in a randomized block design (RBD) and completely randomized design (CRD) in three replications in poly bags of size 15x25 cm filled with a mixture of sand, soil and FYM (1:1:1) at a depth of 2 cm in the field environment and in the greenhouse environment with the same number of replications. Regular irrigation, weeding and hoeing were done as and when required. The data was recorded immediately after the seeds emerged outside the soil, i.e., after germination. Fifteen seedlings of each plus tree progeny were randomly selected and tagged, excluding the border ones. The data regarding germination parameters was worked out for all the genotypes from different locations. Peak value and germination value were calculated as per Czabator [7] while germination speed was estimated using method prescribed by Maguire [8]. The data on morphological and biomass characters viz., morphological and biomass characters, viz., seedling height, collar diameter, shoot length, root length, fresh shoot weight, dry shoot weight, fresh root weight, dry root weight, shoot/root ratio, and total biomass were recorded in each replicate and averaged after four months of sowing in the month of June-July, 2022.

The data were subjected to statistical analysis for the assessment of analysis of variance, variance components, heritability, genetic gain, correlation in both CRD and RBD design for germination, morphological and biomass traits. Heritability (Broad sense) was calculated as suggested by Burton and Devane [9]. Genetic gain was worked out by the following method suggested by Johnson et al. [10]. Karl Pearson's (simple) correlation coefficient was worked out whereas, phenotypic and genotypic correlation coefficients were estimated as per given by Searle [11].

3. RESULTS AND DISCUSSION

3.1 Germination Parameters

The analysis of variance revealed very significant variations in germination percent, peak value, mean daily germination, germination value, and germination speed, indicating a great degree of variability in the material under study (Table 2). Under open field conditions, the maximum germination percent, peak value, germination value, mean daily germination, and germination speed of PPT_{12} (Rajgir park, Nalanda) were measured. Under greenhouse conditions, however, maximum germination percent, peak value, mean daily germination, and germination value for PPT_4 (Muaura, Nalanda) and germination speed for PPT_{16} were reported. The current study's findings are consistent with those of Thakur et al. [12] in *Barberis aristata*, Singh and Wani [13] in pod and seed traits of *Pongamia pinnata.*

3.2 Growth Performance of Growth Traits

Observations on morphological and biomass traits viz. plant height, collar diameter, shoot weight and root weight and total biomass pertaining to 20 genotypes are presented in Table 3. ANOVA for morphological and biomass traits viz, seedling height, collar diameter, shoot fresh weight, root fresh weight, shoot dry weight, root dry weight, shoot/root ratio, and seedling biomass resulted highly significant differences. Data revealed that for morphological and biomass traits in the open field environment PPT_{13} (Sathopur, Nalanda) showed outstanding performance in comparison to all other plus tree progenies. PPT_9 (Giriyak, Nalanda) accompanied by PPT_{18} (Patna, Bihar) resulted in poor performance. Data showed that for morphological and biomass traits under greenhouse conditionsPPT_6 (Nari, Makanpur, and Nalanda) showed outstanding performance in comparison to all other plus tree progenies. PPT_{20} (Pawapuri, Nalanda) resulted in poor performance. A plethora of workers reported the existence of significant differences and superiority of few seed sources, progenies, and provenances in various tree species like *Eucalyptus camaldulensis* (Ginwal et al. [14]; Grewia oppositifolia (Uniyal et al. [15]; Pongamia pinnata [16]; and *Jatropha curcus* [17], which lend support to the current findings in *Peltophorum pterocarpum* genetic resources.

3.3 Variability, Heritability and Genetic Advance Studies in Growth Attributes

The perusal of data revealed significant genetic variation among 20 genotypes of *Peltophorum pterocarpum* for growth attributes. The degree of heritability gives a framework for the elements influencing genetic improvement through selection, whereas genetic gain aids in the assessment of change caused by selection in the species' mean genetic level. The traits with the highest heritability and genetic gain should be

prioritised for future development efforts [18]. The extent of variability was measured by Genotypic coefficient of variation (GCV) and Phenotypic coefficient of variation (PCV) which provides information about relative amount of variation in different character [19]. In the current study, PCV were greater than GCV for all of the characters investigated in both open field and greenhouse conditions, demonstrating that the characters interacted with the local environmental factors to some extent as evidenced in *Bauhinia variagata* [20], *Leucaena leucocephala* [21], and also in the progenies of *Melia dubia* [22] which lend supports to the results of current investigation. The heritability states the magnitude of inheritance of quantitative traits while genetic advance provide needful information for formulating suitable selection procedure. Heritability (in the broad sense) was investigated for all of the characteristics. Greatest heritability was reported for germination value in open field conditions, whereas maximum heritability was observed for peak value in greenhouse conditions (Table 4). However, heritability for seedling biomass was found to be highest in open field conditions and lowest in green house conditions (Table 5). According to Johnson et al. [10], heritability estimates combined with genetic gain are more informative than heredity alone. In this situation, high heritability with strong genetic progress is related to shoot length under greenhouse conditions. This confirmed that additive gene effects are important in the determination of these characters and, as a result, selection would be effective for these traits, whereas traits with low genetic advance and high heritability suggest that expression is possibly controlled by intra and inter allelic interactions. These results support the findings of Kaushik et al. [23] in *Jatropha curcas,* Sunil and Kumar et al. [16] in *Pongamia pinnata* (L.)

3.4 Correlation Studies in Growth Attributes of *Peltophorum pterocarpum*

When selection is based on two or more features, the estimation of genotypic and phenotypic correlation between distinct traits may provide useful information in a breeding program. The significant and positive correlations among various morphological and biomass traits suggest and emphasize their utilization in indirect selection. Negative correlation suggests that selection made for one trait may prove contrary to the other one in *Dalbergia sissoo* [24]. In open field environment, out of 45 correlation coefficients of phenotypic correlation coefficient among morphological and biomass traits, 36 were found to be positive and highly significant (1% level of significance) and the remaining positive and non-significant (Table 6). In the genotypic correlation coefficient 42 were found to be positive and highly significant (1% level of significance) and the remaining were negative and non-significant. In greenhouse condition, out of 45correlation coefficients of phenotypic correlation coefficient among morphological and biomass traits, 39 were found positive and highly significant (1% level of significance) and remaining are positive and non- significant. In genotypic correlation coefficient, all characters are found positive and highly significant (1% level of significance) in greenhouse condition.

Seedling height showed positive and highly significant correlation at genotypic level with shoot length, root length, collar diameter, shoot fresh weight, root fresh weight, shoot dry weight, shoot root ratio and seedling biomass (Table 7). Collar diameter showed positive and highly significant with all the characters. Root dry weight showed positive and significant correlation with shoot length, collar diameter, shoot fresh weight, shoot dry weight, root fresh weight, shoot root ratio and seedling biomass. Shoot root ratio showed positive and highly significant correlation with all the characters except root dry weight. Seedling biomass showed highly positive and highly significant correlation for all the characters under open field condition. For green house condition, all the characters showed positive and highly significant correlation with each other.

Seedling height showed positive and highly significant correlation at phenotypic level with all the characters except root dry weight and shoot root ratio. Collar diameter showed positive and highly significant correlation with all the characters except shoot root ratio. Shoot fresh weight and root fresh weight showed positive and highly significant correlation with all the characters except shoot root ratio. Shoot dry weight and seedling biomass showed positive and significant correlation with all the characters. Root dry weight showed positive and significant correlation with all the characters except root length and seedling height. Shoot root ratio showed positive and significant correlation with seedling biomass and shoot dry weight under open field conditions. For greenhouse condition,

Table 1. Details of twenty plus trees of *Peltophorum pterocarpum* collected from different locations of Bihar

Seed source (No.)	Location	Latitude	Longitude	Tree height (m)	Tree girth (m)	Pod length (cm)	Pod breadth (cm)	Pod thickness (mm)	Seed length (cm)	100- seed weight (g)
PPT_1	Akhara par talaab, Bihar Sharif	25.1859^{0}N	85.5251^{0}E	7.62	0.30	5.78	1.89	2.91	1.0	6
PPT_2	Praranchak, Nalanda	25.3456^{0}N	85.4229^{0}E	8.53	0.38	6.69	1.74	3.48	0.6	6
PPT_3	Araut, Nalanda	25.3302^{0}N	85.5245^{0}E	9.14	1.38	6.05	2.41	4.53	1.0	6
PPT_4	Muraura, Nalanda	25.2027^{0}N	85.5491^{0}E	9.82	0.91	6.93	2.34	3.69	1.0	7
PPT_5	Kisanbag, Nalanda	25.1811^{0}N	85.5104^{0}E	10.66	1.09	6.40	2.10	3.59	1.0	6
PPT_6	Nari (Makanpur), Nalanda	25.2099^{0}N	85.4613^{0}E	8.12	0.45	7.56	2.06	3.17	0.7	6
PPT_7	Rajgirkund, Nalanda	25.0187^{0}N	85.4250^{0}E	15.24	1.82	6.55	1.91	3.65	0.9	5
PPT_8	Bakrabihar, Nalanda	25.1151^{0}N	85.5237^{0}E	13.71	1.21	5.67	2.26	4.28	0.9	4
PPT_9	Giriyak, Nalanda	25.0344^{0}N	85.5097^{0}E	12.12	0.55	5.92	2.03	2.82	0.9	7
PPT_{10}	Kalyanbigah, Nalanda	25.3731^{0}N	85.5170^{0}E	10.28	1.23	6.85	2.48	4.25	1.0	7
PPT_{11}	Tulsigarh, Nalanda	25.3596^{0}N	85.4383^{0}E	8.36	0.68	6.73	2.22	3.23	0.9	6
PPT_{12}	Rajgir Park, Nalanda	25.0026^{0}N	85.4228^{0}E	18.89	1.92	5.87	2.12	3.82	1.1	7
PPT_{13}	Sathopur, Nalanda	25.1944^{0}N	85.4993^{0}E	17.67	1.37	6.91	1.84	4.12	1.0	5
PPT_{14}	Chandi, Nalanda	25.3190^{0}N	85.4069^{0}E	12.23	1.82	6.53	1.93	3.91	0.6	5
PPT_{15}	Ramdiha, Nalanda	25.2754^{0}N	85.5184^{0}E	11.58	1.39	6.82	2.10	3.99	0.8	3
PPT_{16}	Bihar sharif, Nalanda	25.2052^{0}N	85.5004^{0}E	12.92	1.56	7.01	2.53	4.23	0.9	5
PPT_{17}	Madhopur, Nalanda	25.3609^{0}N	85.3738^{0}E	15.57	1.30	6.66	2.76	2.69	0.8	6
PPT_{18}	BudhVihar, Patna	25.6065^{0}N	85.1376^{0}E	11.88	1.10	6.50	1.87	2.86	0.8	6
PPT_{19}	Sarmera, Nalanda	25.2604^{0}N	85.7996^{0}E	14.12	1.13	5.62	2.69	3.22	0.9	6
PPT_{20}	Sharifganj, Katihar,	25.5218^{0}N	87.5660^{0}E	18.28	1.82	6.29	2.82	3.58	0.8	7

all the characters showed positive and significant correlation with each other. The above findings support the result of Thakur et al. [25] in *Alnus nitida*, and Wani and Chauhan [20] in *Bauhinia variagata* half-sib progeny,and Nasir and Wani [26] in Poplar [27-29].

Table 2. Germination characters of twenty plus tree progenies of *Peltophorum pterocarpum* under open field and greenhouse conditions

Traits / Sites		Germination percent	Mean daily germination	Peak value	Germination value	Germination Speed
PPT_1	OF	50.67	1.75	1.49	2.61	2.65
	GH	64.67	3.42	2.52	5.79	3.91
PPT_2	OF	53.33	1.98	1.57	3.11	5.64
	GH	64.66	3.42	2.54	6.12	3.95
PPT_3	OF	72.68	4.54	2.13	10.05	8.03
	GH	64.33	3.57	2.21	4.80	3.39
PPT_4	OF	72.67	3.46	2.14	7.40	7.02
	GH	93.00	2.70	3.06	18.37	11.46
PPT_5	OF	66.67	2.38	1.96	4.68	11.44
	GH	61.66	6.95	2.13	4.28	4.06
PPT_6	OF	61.33	2.92	1.80	5.26	3.12
	GH	73.66	2.52	2.49	8.25	9.72
PPT_7	OF	62.00	2.95	1.82	5.38	4.56
	GH	55.00	4.00	1.94	4.97	3.45
PPT_8	OF	60.67	3.03	1.78	5.40	3.82
	GH	51.00	3.21	1.82	2.94	3.98
PPT_9	OF	59.33	2.12	1.74	3.69	3.21
	GH	57.66	2.08	2.02	4.74	3.67
PPT_{10}	OF	54.67	1.95	1.61	3.14	3.15
	GH	55.00	2.94	1.94	347	3.48
PPT_{11}	OF	61.33	2.19	1.80	3.95	3.73
	GH	73.00	2.28	2.45	10.05	8.36
PPT_{12}	OF	78.67	6.56	2.31	15.15	26.97
	GH	57.00	4.87	2.02	5.43	3.07
PPT_{13}	OF	46.33	1.78	1.36	2.43	2.08
	GH	46.00	3.35	1.69	2.76	2.41
PPT_{14}	OF	60.00	2.73	1.76	4.83	2.95
	GH	59.00	2.11	2.07	4.02	3.54
PPT_{15}	OF	66.67	2.47	1.96	4.84	4.89
	GH	61.66	2.45	2.13	5.59	3.45
PPT_{16}	OF	78.00	6.50	2.29	14.91	11.41
	GH	78.33	3.25	2.62	15.24	11.74
PPT_{17}	OF	73.33	3.67	2.16	7.92	9.39
	GH	60.33	6.83	2.09	5.16	3.28
PPT_{18}	OF	57.33	3.02	1.69	5.10	2.74
	GH	61.00	3.06	2.11	5.73	4.15
PPT_{19}	OF	54.67	2.88	1.61	4.64	3.12
	GH	67.00	3.36	2.29	5.01	11.44
PPT_{20}	OF	57.33	2.61	1.69	4.41	3.34
	GH	64.33	2.71	2.21	5.79	3.62
Mean	OF	62.38	3.07	1.83	5.95	6.16
	GH	63.51	3.24	2.22	6.43	5.25
SE	OF	1.04	0.08	1.04	0.32	0.38
	GH	1.71	0.40	0.25	0.48	0.50
CD5%	OF	2.10	0.15	2.10	0.64	0.77
	GH	3.46	0.81	0.52	0.98	1.02

Table 3. Progeny mean for morphological and biomass traits of twenty plus tree progenies of *Peltophorum pterocarpum* under open field and greenhouse conditions

Traits / Sites		Shoot Length (cm)	Root Length (cm)	Collar Diameter (mm)	Seedling Height (cm)	Shoot Fresh Weight (g)	Root Fresh Weight (g)	Shoot Dry Weight (g)	Root Dry Weight (g)	Shoot Root Ratio	Seedling Biomass (g)
PPT_1	OF	17.39	17.69	2.24	35.08	2.59	0.62	1.54	0.34	4.53	1.88
	GH	54.16	33.11	2.73	87.28	23.82	3.94	11.97	2.16	5.58	13.39
PPT_2	OF	17.51	18.26	1.84	35.77	2.19	0.61	1.22	0.38	3.21	1.60
	GH	50.82	33.26	3.01	84.08	6.13	1.03	3.67	0.56	6.94	4.23
PPT_3	OF	21.22	32.29	2.24	53.51	1.55	0.57	0.88	0.34	2.59	1.22
	GH	47.87	30.38	2.68	78.25	31.49	7.10	18.36	3.68	4.78	22.04
PPT_4	OF	30.22	25.91	3.28	56.23	4.62	1.20	2.45	0.60	4.08	3.05
	GH	49.53	31.46	2.88	80.99	26.81	3.89	13.99	2.00	6.87	16.00
PPT_5	OF	21.19	22.67	2.64	43.96	3.63	0.94	2.03	0.60	3.38	2.63
	GH	43.12	34.43	2.68	81.71	11.85	2.71	6.41	1.21	5.25	7.62
PPT_6	OF	27.58	28.05	3.03	55.67	5.24	1.57	3.49	0.78	4.47	4.27
	GH	83.53	45.61	4.50	129.15	81.46	14.87	50.83	9.74	6.21	60.57
PPT_7	OF	14.31	11.27	1.83	25.58	2.66	0.81	0.99	0.91	1.09	1.90
	GH	68.47	40.71	3.95	85.64	58.42	10.99	32.39	5.66	5.92	38.05
PPT_8	OF	4.95	6.38	0.61	13.97	0.17	0.09	0.95	0.46	2.07	1.41
	GH	40.15	30.23	2.27	92.63	13.46	2.57	6.55	1.30	3.87	7.84
PPT_9	OF	0.61	0.87	0.09	1.49	0.07	0.06	0.04	1.94	0.02	1.98
	GH	81.33	36.64	4.51	117.97	46.69	7.82	29.76	4.15	6.80	33.80
PPT_{10}	OF	15.06	20.65	1.67	35.71	1.18	0.45	0.52	0.27	1.93	0.79
	GH	77.60	36.33	4.11	113.96	61.01	10.15	33.05	5.50	6.13	38.55
PPT_{11}	OF	23.64	33.15	3.16	56.79	4.05	1.04	2.28	0.60	3.80	2.88
	GH	54.79	29.78	3.09	84.61	17.78	6.64	19.04	3.40	5.75	22.44
PPT_{12}	OF	12.49	16.78	1.54	34.15	2.14	0.56	0.86	0.28	3.07	1.14
	GH	46.95	30.73	2.03	77.67	8.03	1.75	3.96	0.91	3.83	4.87
PPT_{13}	OF	46.64	37.48	5.32	82.92	12.37	3.62	7.21	1.90	3.97	9.11
	GH	60.78	36.01	3.00	89.02	18.16	5.26	10.16	2.90	3.69	13.06
PPT_{14}	OF	9.25	15.48	1.24	24.73	1.26	0.37	0.42	0.21	2.56	0.64
	GH	65.16	33.97	2.99	99.13	21.92	2.88	11.22	1.41	6.85	12.63

Traits / Sites		Shoot Length (cm)	Root Length (cm)	Collar Diameter (mm)	Seedling Height (cm)	Shoot Fresh Weight (g)	Root Fresh Weight (g)	Shoot Dry Weight (g)	Root Dry Weight (g)	Shoot Root Ratio	Seedling Biomass (g)
PPT_{15}	OF	7.21	9.69	1.05	16.91	1.01	0.41	2.02	0.36	6.95	2.38
	GH	67.80	35.72	3.55	103.34	34.08	4.84	17.29	2.65	6.44	19.94
PPT_{16}	OF	12.19	15.93	1.50	30.11	1.03	0.43	0.65	0.26	2.50	0.91
	GH	49.50	29.09	2.84	78.59	15.89	2.41	8.06	1.25	5.65	9.31
PPT_{17}	OF	14.89	25.09	1.81	39.98	1.69	0.48	0.69	0.28	2.44	0.97
	GH	58.39	33.07	3.22	91.45	27.95	6.26	16.48	3.15	5.26	19.62
PPT_{18}	OF	9.47	16.19	1.32	24.32	0.63	0.24	0.38	0.14	2.74	0.52
	GH	50.08	27.35	2.29	77.23	8.66	1.92	5.04	0.97	4.53	6.01
PPT_{19}	OF	3.17	4.39	0.58	7.56	0.30	0.14	0.39	0.23	2.00	0.62
	GH	56.70	29.95	3.33	77.61	46.57	8.36	25.70	4.32	6.24	30.48
PPT_{20}	OF	17.24	22.85	2.13	40.42	1.51	0.60	1.09	0.33	3.11	1.42
	GH	15.99	8.92	0.96	24.91	1.78	1.71	0.93	0.92	0.70	1.85
Mean	OF	16.31	19.05	1.96	35.74	2.50	0.74	1.50	0.56	3.02	2.07
	GH	56.14	32.34	3.03	87.76	28.10	5.35	16.24	2.89	5.36	19.11
SE	OF	7.86	8.33	0.93	15.72	1.66	0.52	0.37	0.11	1.24	0.38
	GH	8.62	4.31	0.50	13.28	16.35	3.21	9.33	1.98	1.06	11.07
CD5%	OF	15.90	16.86	1.89	31.82	3.36	1.06	0.75	0.23	2.51	0.77
	GH	17.42	8.72	1.01	26.85	33.04	6.49	18.85	3.99	2.15	22.37

Table 4. Progeny variability for germination characters (Open field and greenhouse conditions)

Parameters / Traits		Mean	Coefficient of Variability		Heritability (%)	Genetic Gain (GG)	Genetic Advance (GA)
			Phenotypic Coefficient of Variability (PCV)	Genotypic Coefficient of Variability (GCV)			
Germination Percent	OF	62.38	15.65	14.75	98.03	9.08	18.33
	GH	63.51	14.55	14.40	97.92	17.76	17.23
Mean Daily Germination	OF	3.07	46.52	44.69	92.36	1.40	2.67
	GH	2.22	45.56	43.79	90.23	2.74	0.04
Peak Value	OF	1.83	15.93	14.72	88.72	0.27	0.50
	GH	3.45	14.99	14.12	89.00	0.54	0.53
Germination Value	OF	5.95	59.93	59.42	98.35	3.62	7.34
	GH	6.43	60.91	60.40	99.41	7.09	0.22
Germination Speed	OF	6.16	94.13	92.81	97.36	5.74	11.50
	GH	5.25	93.11	91.87	97.00	11.22	11.65

Table 5. Progeny variability for morphological and biomass traits of twenty plus tree progenies under open field and greenhouse conditions

Arameters / Traits		Mean	Coefficient of Variability		Heritability (%)	Genetic Gain (GG)	Genetic Advance (GA)
			Phenotypic Coefficient of Variability (PCV)	Genotypic Coefficient of Variability (GCV)			
Shoot Length	OF	16.31	80.61	54.94	46.45	13.15	12.58
	GH	56.14	31.66	25.47	65.00	34.78	23.70
Root Length	OF	19.05	67.24	40.69	36.61	12.81	9.66
	GH	32.34	24.34	19.37	58.00	16.04	9.87
Collar Diameter	OF	1.96	76.30	49.05	41.33	1.49	1.27
	GH	3.03	32.41	25.35	61.00	1.92	0.04
Seedling Height	OF	35.74	69.69	44.23	40.28	24.91	20.67
	GH	87.76	28.19	21.23	57.00	48.41	9.83
Shoot Fresh Weight	OF	2.50	128.55	99.48	59.89	3.21	3.96
	GH	28.10	94.90	62.67	44.00	52.18	11.34
Root Fresh Weight	OF	0.74	126.30	91.86	52.90	0.94	1.02
	GH	5.5	91.18	53.95	35.00	9.55	3.52
Shoot Dry Weight	OF	1.50	108.85	104.58	92.31	1.64	3.11
	GH	16.24	96.72	66.41	47.00	30.74	15.26
Root Dry Weight	OF	0.56	92.23	88.84	92.80	0.52	0.99
	GH	2.89	103.06	60.17	34.00	5.84	2.09
Shoot Root Ratio	OF	3.02	62.88	37.96	36.46	1.90	1.43
	GH	5.36	34.34	24.32	50.00	3.60	0.98
Seedling Biomass	OF	2.07	94.68	91.94	94.28	1.96	3.80
	GH	19.11	96.91	66.03	46.00	36.25	17.72

Table 6. Phenotypic correlation coefficient of morphological and biomass traits of twenty plus tree progenies of *Peltophorum pterocarpum* under open field and greenhouse conditions

Characters		Shoot Length (cm)	Root Length (cm)	Collar Diameter (mm)	Seedling Height (cm)	Shoot Fresh Weight (g)	Root Fresh Weight (g)	Shoot Dry Weight (g)	Root Dry Weight (g)	Shoot Root Ratio	Seedling Biomass (g)
Shoot Length (cm)	OF	**1.00**	0.882**	0.986**	0.967**	0.914**	0.897**	0.680**	0.314**	0.188	0.652**
	GH	**1.00**	6.604**	0.457**	0.666**	0.347**	0.440**	0.553**	0.349**	0.343**	0.742**
Root Length (cm)	OF		**1.00**	0.892**	0.964**	0.688**	0.670**	0.479**	0.070	0.157	0.420**
	GH		**1.00**	0.513**	0.464**	0.595**	0.412**	0.299**	0.270**	0.323**	0.389**
Collar Diameter (mm)	OF			**1.00**	0.964**	0.904**	0.888**	0.662**	0.298**	0.183	0.633**
	GH			**1.00**	0.491**	0.510**	0.796**	0.259**	0.154	0.637**	0.313**
Seedling Height (cm)	OF				**1.00**	0.823**	0.805**	0.589**	0.189	0.172	0.543**
	GH				**1.00**	0.272**	0.396**	0.718**	0.130	0.357**	0.549**
Shoot Fresh Weight (g)	OF					**1.00**	0.983**	0.791**	0.516**	0.183	0.799**
	GH					**1.00**	0.382**	0.199	0.262**	0.358**	0.200
Root Fresh Weight (g)	OF						**1.00**	0.764**	0.524**	0.142	0.778**
	GH						**1.00**	0.262**	0.172	0.456**	0.445**
Shoot Dry Weight (g)	OF							**1.00**	0.516**	0.482**	0.974**
	GH							**1.00**	0.097	0.256**	0.500**
Root Dry Weight (g)	OF								**1.00**	-0.211	0.696**
	GH								**1.00**	0.412**	0.326**
Shoot Root Ratio	OF									**1.00**	0.348**
	GH									**1.00**	0.262**
Seedling Biomass (g)	OF										**1.00**
	GH										**1.00**

OF- Open Field Condition, GH- Greenhouse Condition
*** - Correlation is significant at the 1 percent level*

Table 7. Genotypic correlation coefficient of morphological and biomass traits of twenty superior tree progenies of *Peltophorum pterocarpum* under open field and greenhouse condition

Characters		Shoot Length (cm)	Root Length (cm)	Collar Diameter (mm)	Seedling Height (cm)	Shoot Fresh Weight (g)	Root Fresh Weight (g)	Shoot Dry Weight (g)	Root Dry Weight (g)	Shoot Root Ratio	Seedling Biomass (g)
Shoot Length (cm)	OF	**1.00**	0.887**	0.996**	0.973**	0.941**	0.940**	1.033**	0.391**	0.661**	0.958**
	GH	**1.00**	1.239**	1.404**	1.054**	2.226**	1.219**	1.087**	1.493**	1.331**	1.113**
Root Length (cm)	OF		**1.00**	0.874**	0.971**	0.732**	0.737**	0.797**	0.068	0.681**	0.678**
	GH		**1.00**	1.330**	1.399**	1.229**	1.643**	1.596**	1.322**	1.358**	1.517**
Collar Diameter (mm)	OF			**1.00**	0.963**	0.968**	0.956**	1.076**	0.379**	0.747**	0.991**
	GH			**1.00**	1.450**	1.588**	1.010**	1.411**	2.876**	1.317**	1.706**
Seedling Height (cm)	OF				**1.00**	0.865**	0.864**	0.952**	0.232	0.703**	0.850**
	GH				**1.00**	1.634**	1.432**	1.058**	2.512**	2.318**	1.229**
Shoot Fresh Weight (g)	OF					**1.00**	1.003**	1.085**	0.598**	0.550**	1.056**
	GH					**1.00**	1.562**	1.784**	2.474**	1.231**	2.413**
Root Fresh Weight (g)	OF						**1.00**	1.127**	0.612**	0.585**	1.095**
	GH						**1.00**	1.197**	2.190**	1.281**	1.282**
Shoot Dry Weight (g)	OF							**1.00**	0.562**	0.553**	0.976**
	GH							**1.00**	1.353**	1.899**	1.262**
Root Dry Weight (g)	OF								**1.00**	-0.220	0.728**
	GH								**1.00**	1.946**	1.605**
Shoot Root Ratio	OF									**1.00**	0.400**
	GH									**1.00**	1.725**
Seedling Biomass (g)	OF										**1.00**
	GH										**1.00**

OF- Open field condition, GH- greenhouse condition

*** - Correlation is significant at the 1 percent level*

4. CONCLUSION

In the current study, PPT_6 (Nari, Nalanda) outperformed all other superior tree progenies in greenhouse conditions, but PPT_{13} (Sathopur, Nalanda) excelled all other superior tree progenies in field conditions for morphological and biomass traits. These two genotypes can be used in future improvement programs. The key finding of this evaluation research is the significant variability within the species. The wide phenotypic diversity seen in this gene pool should be utilized in selection and breeding programs and to develop a core collection. Furthermore, the current study hypothesized a strong positive and highly significant phenotypic association between seedling height, collar diameter, and root fresh weight in open field conditions, which could be used as a beneficial, accurate, and relevant standard for *Peltophorum* breeding programs. The majority of the features tested had strong heritability values and could be effectively used to build *Peltophorum* descriptions. Heritability was highest for seedling biomass in the open field and shoot length in the greenhouse environment. Heritability with high genetic advance was associated with shoot length under greenhouse conditions. Using suitable, habitat-adapted reproductive material is essential for both the long-term stability of forests and the success of reforestation. Hopefully, the genetic information of tree species will aid geneticists, breeders, and tree improvement specialists in maximizing plantation quality and production to fulfill market demand over time.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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