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Growth performance and variability studies in different half sib families of *Melia dubia* under greenhouse condition

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Abstract
The performance of twenty phenotypically superior trees in the natural distribution zones of Uttar Pradesh were studied for genetic divergence. Based on the relative magnitude of D^2 values, twenty superior trees progenies were grouped into eight clusters on the basis of morphological and biomass traits. Cluster V exhibited the highest number of five superior tree progenies. Cluster V exhibited maximum intra cluster distance (4.79) indicating that progenies in this cluster were more diverse than the other clusters. The maximum inter cluster D^2 value was obtained between cluster VI and VII (9.21). The clustering pattern in this study revealed that superior tree progenies from different geographic region were grouped together in a cluster and vice-versa suggesting that geographical diversity did not necessarily represent the genetic diversity. The contribution of different traits towards diversity revealed that seedling height contributed the maximum towards divergence. The study also showed that the phenotypic coefficient of variation (PCV) was higher than the corresponding genotypic coefficient of variation (GCV) for all the morphological and biomass traits which revealed that the traits were sensitive to environmental fluctuations. The traits with low genetic gain and high heritability indicate that the expression is possibly controlled by intra and inter allelic interactions. The hybridization between the more diverse genotypes of *Melia dubia* can produce genotypes with high heterotic vigor.

Keywords: Superior trees, D^2, euclidean cluster, *Melia dubia*, heritability

Introduction
Melia dubia Linn. Belongs to the family Meliaceae and is also known as bakayan tree. *Melia dubia* is an indigenous species of tree to India, South East Asia and Australia (Allen and Allen, 1981) [1] where it has been cultivated as a source of firewood. *Melia dubia* is commonly found in the hills at elevations ranging from 600-1800m and grows well in rainfall areas of 625mm to 875mm.

It is fastest growing tree and is used for reforestation purposes. The wood of this tree is used majorly in Plywood Industry and also paper, matches, packaging etc. The fruit of the plant is bitter. It is considered anthelmintic, antioxidant, immune modulatory, antiulcer and antitumor property. The wood is used for packing cases, match box sticks, photo frames, pencils (Nataraj pencil company using the *Melia dubia* wood) mini furniture like stools, benches, wooden tables, interior decoration, window doors, wooden racks & packing industries, musical instruments, tea powder boxes, cigar boxes, building purposes, ceiling planks agricultural implements etc. The seedlings production is very difficult because it’s germination percentage is as low as 10%. *Melia dubia* is a large tree, attaining a height of 20 meters with a spreading crown and a cylindrical straight trunk of 9 m (Length - Girth, 1.2-1.5 m). About 400 trees can be planted in an acre which fetches Rs. 10-12 lakhs in 6-8 years’ time.

Melia dubia is a promising tree highly suitable for agro forestry or farm forestry with a life cycle of 8 to 12 years is gaining economic importance both in domestic and global markets. It is getting popularized among farmers due to its characteristics such as fast growth, stem straightness without much of branches, less shade effect and for not susceptible to pest and insect attacks. The commercial importance for agro forestry plantations is increasing due to various reasons as explained above and certain tree varieties like *Melia dubia* is getting popularized because it fetches assured income with buyback arrangements and requires low maintenance. In addition, these trees also contribute in carbon sequestration and mitigation of climate change impacts (Thakur and Chauhan, 2008) [10].

But considering the general characteristics of the fast growing tree species generally planted by the farmers, technology input is very much essential to make quality products. Through effective research it is possible to broaden the market of *Melia dubia* plantation products into specialty products i.e. development of higher grade of plywood like Decorative/Marine/

Shuttering grade Plywood, MDF, Particle Board, Laminated Veneer Lumber (LVL), Compreg etc. *Melia dubia* will grow up to 40 feet within two years of planting and has the potential of yielding up to 40 tons of biomass on an average per acre per annum of 10 year old plantation. The minimum cultivation period is six years and it can be allowed up to 8 years for good economic value. In addition to the commercial importance these trees helps in preventing temperature rise and checking gas emission into the atmosphere as the trees are naturally endowed to absorb maximum CO_2. Its high calorific value makes it a viable source of feedstock for biomass power plants. In view of the ever increasing timber demand for various commercial purposes and shortage in natural resources the importance for the fast growing *Melia dubia* is gaining steadily.

In any tree breeding programme, there are series of activities for genetic improvement. One of the most important activities is choosing individual, which will serve as a parent for next generation (Roy, *et al*. 2004) [5]. This process is known as selection and it is based upon observed differences or variation among individuals of a population. The effectiveness of tree improvement programmes depends upon the nature and magnitude of existing genetic variability and also on the degree of transmission of traits, because genetic variation is the fundamental requirement for maintenance long term forest ecosystem (Zobel and Talbert, 1984) [16]. Hence, to make an improvement in any species, the breeder is constantly engaged in an effective choice of desirable parents of high genetic variability. Genetically, diverse parents are likely to produce high heterotic effect and desirable segregants (Wani, 2012) [14]. The occurrence of this species over a wide geographic range encompassing a great diversity of edapho-climatic conditions of its habitat is expected to be reflected in the genetic constitution of its diverse population (Searle, 1961) [7]. The species therefore offers an opportunity, for studying variation and also to select the superior seed sources for adaptability and growth. Due to longer rotation period of the tree, there is very less information available on its genetic improvement Therefore, an effort was made to study the genetic differentiation in superior tree progenies to identify the diverse genotype to use further in hybridization programme.

Materials and methods

The present study was carried out in the nursery of College of Forestry, SHUATS, Prayagraj (Uttar Pradesh, India). The area is situated at 28º 87' N latitude and 81º 15' E longitude at an elevation of 78 meters above mean sea level on Northern aspect. On an average the area receives an annual rainfall of 110cm, most of which happens during monsoon season.

Mature seeds from different parts of the crown for the present study was procured by selecting, the twenty phenotypically superior trees in the natural distribution zones of Uttar Pradesh on the basis of different morphological, fruit and seed character mentioned below a) Tree height, b) Tree diameter, c) Leaf area, d) seed length, e) seed width and f) 1000 Seed weight. Five phenotypically superior trees of same size and free from any disease and pest were selected and observations were made. Out of these, the best one was considered as plus tree. Uniform, healthy seeds from well mature pods of plus trees from twenty representing stands were collected to constitute the seed lot for each family. The details of the plus tree are given in Table 1. For experimental purpose, the seeds were sown in a randomized block design replicating thrice in poly-bags of size 10×25cm filled with a mixture of soil, sand and Farm Yard Manure (1:1:1) at a depth of 0.5 cm. The observations were made for 1 yr (12 month) old seedlings for different morphological and biomass traits viz., seedling height, seedling diameter, inter-nodal length, number of leaves, leaf area, shoot fresh weight, root fresh weight, shoot dry weight, root dry weight, shoot/root ratio and seedling biomass. The data were statistically analyzed for each character in a randomized block design. Analysis of variance was done as per Panse and Sukhatme (1978) [4] and genetic divergence by using non-hierarchical Euclidean cluster analysis (Spark, 1973) [9].

Table 1: Details of 20 superior tree of *Melia dubia* Linn.

Notations	Location	District	State	Latitude*	Longitude*
S_1	Baripur	Deoria	U.P	27^0 74'N	79^0 95'E
S_2	Barhaj	Deoria	U.P	26^0 83'N	83^0 25'E
S_3	Majhgava	Deoria	U.P	24^0 37'N	74^0 86'E
S_4	Surypura	Deoria	U.P	25^0 89'N	84^0 22'E
S_5	Musaila	Deoria	U.P	26^0 09'N	83^0 12'E
S_6	Kesharpur	Deoria	U.P	22^0 61'N	86^0 63'E
S_7	Hetimpur	Deoria	U.P	26^0 74'N	83^0 30'E
S8	Salempur	Deoria	U.P	26^0 39 'N	83^0 24'E
S_9	Pakadi	Deoria	U.P	27^0 54'N	83^0 15'E
S_{10}	Majhailiraj	Deoria	U.P	26^0 50'N	83^0 77'E
S_{11}	Pathardeva	Deoria	U.P	26^0 50'N	83^0 78'E
S_{12}	Khukhundoo	Deoria	U.P	26^0 46'N	83^0 38'E
S_{13}	Surauli	Deoria	U.P	26^0 90'N	83^0 37'E
S_{14}	Sonughat	Deoria	U.P	26^0 57'N	83^0 06'E
S_{15}	Puraina	Deoria	U.P	26^0 05 'N	82^0 44'E
S_{16}	Belthara	Deoria	U.P	26^0 00'N	83^0 44'E
S_{17}	Ejarhi	Deoria	U.P	26^0 50'N	82^0 77'E
S_{18}	Phulwariya	Deoria	U.P	26^0 34'N	84^0 27'E
S_{19}	Katrari	Deoria	U.P	26^0 48'N	83^0 75'E
S_{20}	Kalinagar	Deoria	U.P	28^0 61'N	80^0 08'E

*Encarta U.S. geological survey

Results and discussion

Seedling characteristic can be used as a quantitative character defining genotype in measuring genetic distance between populations and differentiating population at early stages in variability studies. As tree characters measured in natural population are amenable to geographical and environmental interactions, seedling characters measured in different environment are useful in differentiating population at preliminary stage (Singh and Wani, 2016) [8].

The analysis of variance revealed the existence of significant difference among the superior tree progenies for all the traits studied, indicating the existence of genetic variability. Based on the relative magnitude of D^2 values twenty superior trees progenies were grouped into eight clusters on the basis of morphological and biomass traits (Table 2). Cluster V and VII and exhibited the highest number of four superior tree progenies. The minimum number of progenies occurred in cluster VIII.

Table 2: Distribution of twenty superior tree progenies in different clusters based on D^2 statistics of *Melia dubia* Linn.

Cluster No.	No. of superior trees in each cluster	Notation of superior trees	Notation of sites
I	2	S_5, S_{13}	Musaila, Surauli
II	2	S_7, S_{15}	Hetimpur, Puraina
III	2	S_6, S_{17}	Kesharpur, Ejarhi
IV	2	S_{18}, S_{20}	Phulwariya, Kalinagar
V	5	S_1, S_2, S_3, S_8 and S_{10}	Baripur, Barhaj, Majhgava, Salempur and Majhailiraj
VI	2	S_9, S_{19}	Pakadi, Katrari
VII	4	S_4, S_{11}, S_{12} and S_{14}	Surypura, Pathardeva, Khukhundoo and Sonughat
VIII	1	S_{16}	Belthara

The genotypes (parents) were selected from different eco-geographic areas, the genetic make-up along with breeding system, heterogeneity, natural and unidirectional selection pressure may be the cause of genetic diversity among different families of plus tree besides geographic variation to some extent. The cluster pattern proved that geographical variation need not necessarily be related genetic diversity. Therefore, selection of genotypes for hybridization may be made on the basis of genetic diversity rather than geographic diversity. The present result supports the findings in *Gliricidia sepium* and *Sorbus torminalis* (Salazar, 1986; Bednorz *et al*., 2006) [6, 2].

Inter crossing of divergent groups would lead to greater opportunity for crossing over, which releases hidden variability by breaking linkage (Wani and Marak, 2018) [13]. Progeny derived from such diverse crosses are expected to show wide spectrum of genetic variability provided a greater scope for isolating transgressive segregant in the advance generation. Hence, these genotypes might be used in multiple crossing programme to recover transgressive segregants.

The intra and inter cluster distance among the superior tree progenies was of varying magnitude (Table 3). Cluster V exhibited maximum intra cluster distance (4.79) indicating that progenies in this cluster were more diverse than the other clusters. Minimum intra cluster distance (0.00) was shown by cluster VIII. The maximum inter cluster D^2 value was obtained between cluster VIII and VI (9.12) which was followed by Cluster II and VI (8.66). The minimum distance (3.79) between cluster II and III revealed that the trees belonging to these cluster were relatively closer. The clustering pattern in this study revealed that superior tree progenies from different geographic region were grouped together in a cluster and vice-versa suggesting that geographical diversity did not necessarily represent the genetic diversity. Wani *et al.*, (2010) [15] reported that the factors other than geographical diversity might be responsible for their genetic uniformity. The trees/provenances that originated in one region had been distributed into different clusters indicated the trees with same geographic origin could have undergone change for different characters under selection. The present result also supports the findings in *Bauhinia variegata* and *Morus alba* that the no eco-geographical link with cluster pattern of the genotypes and their progenies (Wani and Chauhan 2007; Thakur and Chauhan, 2008) [12, 10].

Table 3: Average inter and intra cluster distances (D^2 values) among twenty superior tree progenies

Clusters	I	II	III	VI	V	VI	VII	VIII
I	1.66	4.75	4.11	4.12	4.39	5.51	4.19	5.27
II		2.01	3.79	6.28	6.70	8.66	4.75	4.85
III			2.09	5.16	5.98	7.46	3.57	4.58
IV				2.12	4.63	4.81	5.03	5.88
V					4.79	5.26	5.41	7.05
VI						3.42	6.75	9.12
VII							4.71	5.76
VIII								0.00

Underlined figures represent intra cluster distance

Comparison of cluster means for eleven characters (Table 4) indicated that different characters showed considerable difference between the clusters. Germination per cent (64.83) was observed highest in cluster VIII. However, seedling height recorded maximum (67.65) in cluster VI whereas, collar diameter (4.36), intermodal length (4.36), shoot dry weight (4.10), root dry weight (2.68) recorded maximum in cluster II. Shoot fresh weight (4.130), and shoot/root ratio (1.098) recorded maximum value for cluster V. The present result substantiates the findings in *Prosopis cineraria* (Manga and Sen, 2000) [3].

Conclusion

Twenty superior trees progenies were grouped into eight clusters on the basis of morphological and biomass traits in which Cluster V and VII exhibited the highest number and maximum intra cluster distance indicating that progenies in this cluster were more diverse than the other clusters. The maximum inter cluster D^2 value was obtained between cluster VI and VIII. The clustering pattern in this study revealed that geographical diversity did not necessarily represent the genetic diversity. Hybridization between the more diverse genotypes of *Melia dubia* can produce genotypes with high heterotic vigor.

Table 4: Mean value for various traits in different cluster for 20 Superior trees progenies of *Melia dubia* Linn.

Clusters Traits	I	II	III	IV	V	VI	VII	VII
Germination Per cent	56.78	61.83	62.67	62.00	50.92	52.08	62.33	64.83
Seedling Height	54.87	54.87	54.87	54.87	54.87	54.87	54.87	54.87
Collar Diameter	3.57	135.72	3.57	8.60	3.55	2.82	1.83	1.62
Internodal Length	4.36	124.10	4.36	10.27	3.05	4.10	2.68	1.58
Shoot Fresh Weight	3.34	132.22	3.42	11.00	2.45	2.37	1.55	1.46
Root Fresh Weight	2.54	122.67	2.21	6.72	2.60	2.75	1.67	1.70
Shoot Dry Weight	4.02	128.97	4.02	11.29	3.39	4.01	1.79	2.31
Root Dry Weight	3.03	126.82	3.35	8.82	1.45	2.72	1.50	1.82
Shoot/Root Ratio	3.78	130.55	3.78	11.22	2.67	2.91	1.55	1.90
Seedling Biomass	1.97	135.00	1.97	6.90	3.10	3.57	1.77	2.12

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