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RESEARCH PAPER

Assessment of Genetic Variability, Heritability and Correlation among Growth Traits in *Toona ciliata* M.Roem

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ABSTRACT

The study was conducted to evaluate the growth performance of half sib progenies of thirty genotypes of *Toona ciliata* M. Roem under field conditions. Among genotypes TC2260, TC2234, TC2234 and TC2255 were found to be most promising for growth traits. The phenotypic coefficient of variation values were observed higher for all the parameters than genotypic coefficient of variation. High heritability and moderate genetic gain were observed for collar diameter. Highly significant and positive genotypic and phenotypic correlations were observed for primary branches and collar diameter. Due to significant genotypic association, between primary branches and collar diameter need to be properly prioritized during the selection process.

HIGHLIGHTS

- Analysis of variance revealed significant variations among different genotypes for all the traits.
- Genotypic and phenotypic coefficients variation observed as high for primary branches.
- Heritability (bs) was high for collar diameter, clear bole height, primary branches and height whereas the genetic gain was recoded high for Primary branches and collar diameter.
- Collar diameter has a strong correlation with primary branches and height with clear bole height and primary branches.

Keywords: *Toona ciliata*, genotype, variability, heritability, correlation

The genus Toona comprises five species namely, *T. calantas, T. ciliata, T. fargesii, T. sinensis*, and *T. sureni* and belong to the family Meliaceae. The genus mainly distributed southern and eastern Asia, with some species also occurring in New Guinea and Australia (Edmonds 1995). Toona species are one of the most important timbers in the tropics due to its high quality and ease of cultivation on plantations (Bahadur 1988). *T. ciliata* is a large deciduous tree that grows quickly, reaching heights of up to 20–30 meters with a clear bole of up to 9–12 meters. It is indigenous to Australia and can be found in India, Burma, Laos, Pakistan, and Thailand Malaysia, Indonesia and china. The species is found in a wide range of forest types in India, including the sub-Himalayan tract, the outer-Himalayan valleys, the plains of Assam, Madhya Pradesh, Tamil Nadu, and Karnataka, the Eastern and Western Ghats, and the Western Peninsula, Khasi Hills, and Manipur, up to an elevation of 1200 meters (Singh 1982). In the Western Ghats, it is primarily found in wet evergreen forests with sporadic occurrences in moist deciduous forests (Rai 1985). In the western sub-Himalayan tract, it is primarily found in damp locales (Troup 1921) sheltered ravines, along streams, and even swamp woods. Toona wood is more valuable due to its color, durability, and timber quality (Zhan *et al.* 2019). The versatile wood of *T. ciliata* is used for

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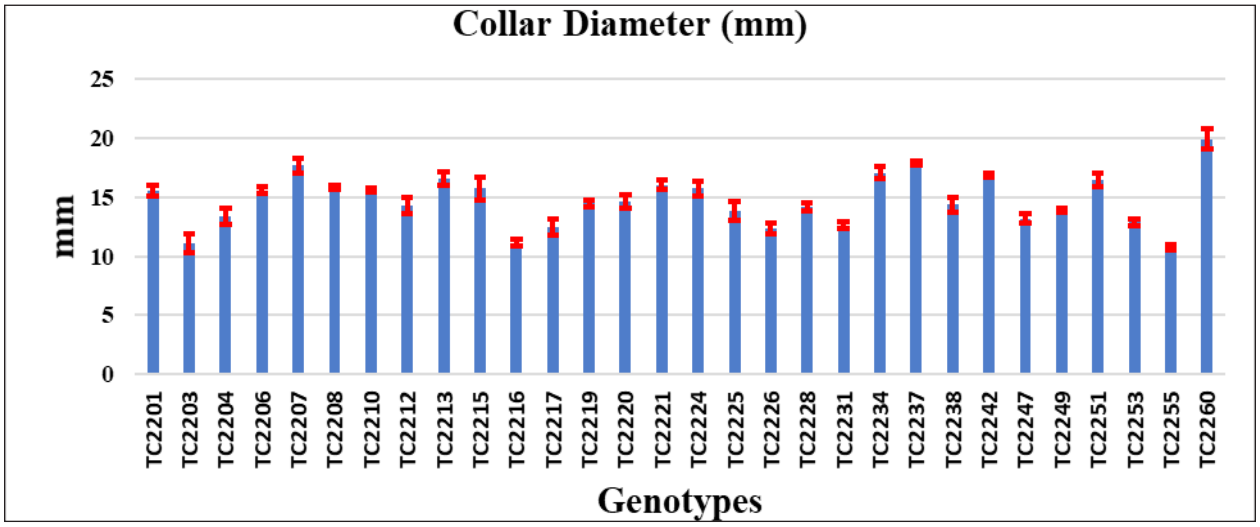
building and boat construction, furniture, musical instruments, carving, and various other purposes. Its wood is considered moderately durable, as it possesses moderate weight, strength, and hardness. Given the continuous rise in timber imports, it is essential to identify and evaluate fast-growing and multi-purpose tree species to meet the growing demand for wood. *T. ciliata* is one such important alternative species; due to its rapid growth and versatility, it can serve as a potential source of raw material for wood-based industries (Edmonds 1993; Edmonds 1995). To ensure its sustainable and high-quality utilization, it is essential to study its genetic diversity and the genetic parameters associated with various growth. Knowledge of such genetic parameters can facilitate the identification, selection, and evaluation of superior genotypes, thereby enabling the selection and breeding of plants with improved growth, productivity for future generations. Genetic analysis holds special significance in tree improvement programs, as it enables the assessment of genetic diversity across various genotypes, thereby facilitating the identification and selection of superior ones (Zobel and Talbert 1984). Despite the availability of substantial genetic diversity in *T. ciliata* a fast-growing and highly versatile species relatively little work has been undertaken regarding its systematic tree breeding and genetic improvement. Therefore, given the rising demand for quality raw materials in wood-based industries, it is essential to develop an effective and systematic tree improvement program for *T. ciliata* by identifying and selecting genotypes that exhibit superior growth quality. The present study has been conducted with this objective in mind.

MATERIALS AND METHODS

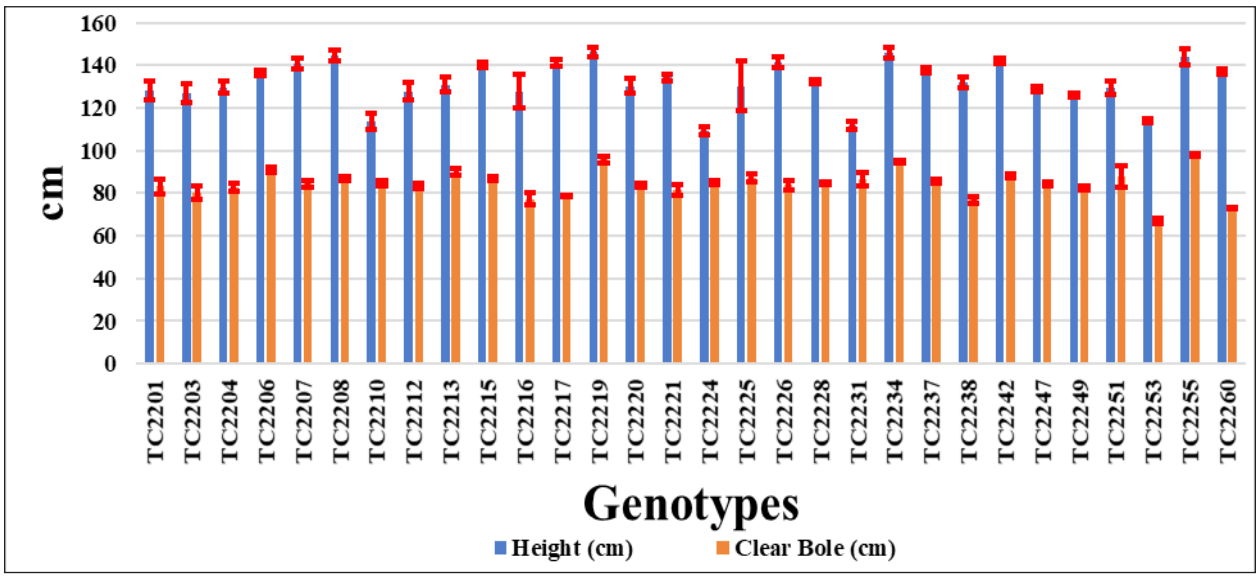
Thirty genotypes have been selected from different forest divisions of Uttarakhand (Table 1) and nursey was raised in the Division of Genetics and Tree Improvement, ICFRE – Forest research Institute Dehradun. A field trials consisting of half sib progenies of the selected 30 genotypes have been established at Jachh, Nurpur. Himachal Pradesh. The field trial was laid out after attaining the age of one year of sapling in the randomize block design with replications and each replication consisted of 4 half-sibs at spacing of 3×3 m apart. Observations were recorded, after 1 year of plantation individually on height, clear bole height, collar diameter and number of branches. The data thus obtained were subjected to analysis of variance as suggested by Panse and Sukhatme (1978). The phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) were determined by formula as suggested by Burton and De Vane (1953). Heritability (broad sense), genetic advance (GA) and genetic gain were worked out as per the procedure given by Burton and De Vane (1953) and Johnson *et al.* (1955). Simple correlation coefficients were computed to determine the correlation among various traits as per the method given by Panse and Sukhatme (1978).

Table 1: Details for genotypes of *Toona ciliata* used in the study

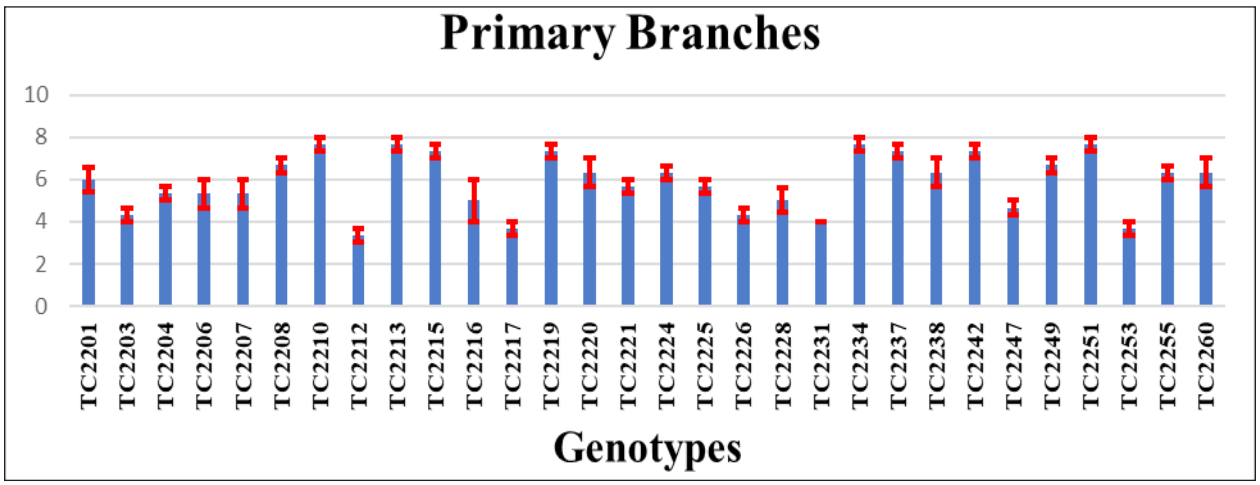
Genotypes	Latitude	Longitude	Altitude
TC 2201	31°03′10.1″	77°49′19.2″	1227
TC 2203	31°00′28.4″	77°50′00.4″	1161
TC 2204	31°57′50.5″	77°55′11.8″	1132
TC 2206	30°58′47.5″	77°59′34.3″	1080
TC 2207	30°59′22.2″	78°00′38.4″	1092
TC 2208	30°43′19.6″	78°21′37.4″	1147
TC 2210	30°44′38.6″	78°27′11.7″	1227
TC 2212	30°45′45.9″	78°34′69.4″	1385
TC 2213	30°45′20.6″	78°34′22.8″	1410
TC 2215	30°45′20.6″	78°34′22.8″	1410
TC 2216	30°25′10.9″	78°24′42.4″	1566
TC 2217	30°23′37.1″	78°25′40.7″	1115
TC 2219	30°22′13.2″	78°25′42.1″	743
TC 2220	30°18′36.1″	78°40′02.5″	905
TC 2221	30°15′57.9″	78°42′54.2″	690
TC 2224	30°19′32.1″	78°23′11.1″	1391
TC 2225	30°18′37.7″	78°20′41.0″	1320
TC 2226	30°09′45.5″	78°17′37.3″	1130
TC 2228	30°13′16.3″	78°15′08.7″	650
TC 2231	30°24′26.1″	78°05′16.04″	1023
TC 2234	29°49′24.62″	78°43′05.25″	1052
TC 2237	29°48′02.16″	78°36′02.48″	704
TC 2238	30°12′50.09″	78°53′18.75″	1326
TC 2242	30°30′17.78″	79°05′14.24″	998
TC 2247	30°12′14.71″	79°16′38.87″	880
TC 2249	30°11′00.15″	79°19′38.51″	937
TC 2251	29°55′19.12″	79°21′00.73″	1039
TC 2253	29°36′11.92″	79°39′54.53″	1625
TC 2255	29°36′52.58″	79°39′55.04″	1597
TC 2260	29°46′39.50″	79°46′21.09″	1430



Graph 1: Variation in collar diameter in different gynotypes of *Toona ciliata*



Graph 2: Relationship between height and clear bole height among genotypes of *Toona ciliata*



Graph 3: Variation in primary branches among genotypes of *Toona ciliata*

Table 2: Variation in growth characters among different genotypes of *Toona ciliata*

Plant_ No.	Coller Diameter (mm)	Height (cm)	Clear Bole (cm)	Primary Branches
2201	15.51±0.46	128.4±4.41	83.33±3.44	6±0.58
2203	11.1±0.81	126.77±4.53	80.23±2.93	4.33±0.33
2204	13.39±0.7	129.55±2.85	82.77±1.85	5.33±0.33
2206	15.6±0.33	136.45±1.46	90.82±1.38	5.33±0.67
2207	17.68±0.66	140.88±2.64	84.34±1.61	5.33±0.67
2208	15.78±0.17	144.65±2.39	86.82±0.8	6.67±0.33
2210	15.6±0.19	113.64±3.62	84.54±1.09	7.67±0.33
2212	14.28±0.69	127.87±4.13	83.33±1.3	3.33±0.33
2213	16.54±0.57	130.98±3.56	89.96±1.77	7.67±0.33
2215	15.75±0.98	139.99±1.24	87.08±1.01	7.33±0.33
2216	11.14±0.32	127.67±7.9	77.2±2.95	5±1
2217	12.46±0.63	141.12±1.3	78.89±0.31	3.67±0.33
2219	14.5±0.28	146.32±2.31	95.78±1.71	7.33±0.33
2220	14.6±0.59	130.4±3.76	83.9±0.87	6.33±0.67
2221	16.01±0.4	134.32±1.55	81.34±2.57	5.67±0.33
2224	15.76±0.62	109.27±1.89	85.15±0.95	6.33±0.33
2225	13.84±0.82	130.27±11.72	87.13±1.68	5.67±0.33
2226	12.32±0.47	141.5±2.26	83.73±2.48	4.33±0.33
2228	14.16±0.33	132.32±1.11	84.9±0.65	5±0.58
2231	12.63±0.3	111.68±1.91	86.57±3.18	4±0
2234	17.08±0.51	145.85±2.36	94.72±0.74	7.67±0.33
2237	17.9±0.13	137.54±1.17	85.68±0.73	7.33±0.33
2238	14.39±0.62	132.03±2.71	76.83±1.69	6.33±0.67
2242	16.89±0.19	141.93±1.23	87.8±0.95	7.33±0.33
2247	13.16±0.4	128.8±1.16	84.38±0.7	4.67±0.33
2249	13.87±0.19	125.97±0.74	82.26±0.84	6.67±0.33
2251	16.46±0.6	129.33±3.15	87.97±5.02	7.67±0.33
2253	12.89±0.28	113.84±0.95	66.98±1.21	3.67±0.33
2255	10.79±0.24	143.89±3.66	97.93±0.71	6.33±0.33
2260	19.92±0.89	137.03±1.43	72.93±0.32	6.33±0.67
Mean	14.58	131.62	84.28	5.72
Max	19.92	146.32	97.93	7.67
Min	10.79	109.27	66.98	3.33
SD	2.17	10.06	6.31	1.34
SE	0.40	1.84	1.15	0.24

RESULTS AND DISCUSSION

Analysis of variance revealed that there were significant variations among different genotypes with respect to various characters. The maximum Collar Diameter was noted for genotype TC2260 (19.92) followed by genotype TC2237 (17.9) while minimum Collar Diameter was recorded in genotype TC2255 (10.79). The maximum height was noted for genotype TC2219 (146.32) followed by genotype TC2234(145.85) while minimum height was recorded in genotype TC2224 (109.27). The highest Clear bole height was recorded in genotype TC2255 (97.93) followed by genotype TC2219 (95.78) where is lowest was found in genotype TC2260 (72.93). The number of branches was highest for genotype TC2210, TC2213, TC2234 and TC2251 (7.67) was observed for genotype and followed by genotype TC2215, TC2219, TC2237 and TC2242 (7.33) while lowest for genotype TC2212 (33.3). Significant variations work was observed among different genotypes in respect of different morphometric traits in this work. The variation found could possibly be the attributed to the genetic makeup of these genotypes as their seeds have been from various places, though grown in the similar field with same micro-climate, and supposed to be genetical different. The results of the study are in line with earlier founding of who have also observe significant variation of different characteristics in different genotypes.

Estimates of Genetic Parameter

Heritability provide a measure of genetic variation upon which all the possibilities of changing the genetic composition of species depend. In other words, knowledge of its magnitude gives an idea about the scope of affecting genetic improvement through selection whereas genetic gain gave relative measure of change produced by selection in mean genetic level of the species. Estimates of genetic parameters (Table 3) showed that primary branches had highest PCV (25.23%) followed by collar diameter (15.55%), height (7.13%) and clear bole height (7.13%). Highest GCV was exhibited by primary branches (21.49%) followed by collar diameter (15.55%), height (8.47%) and clear bole height (8.10%). Estimates of heritability (broad sense) were maximum in collar diameter (83.95%) followed by clear bole height (77.49%), primary branches (72.53%) and height (71.25%). Genetic gain was highest in respect of Primary branches (37.70%) followed by collar diameter (26.90%), height (16.42%) and clear bole height (10.92%). For all traits, the phenotypic coefficient of variation values were found greater than the genotypic

coefficient of variation (GCV), indicating that the environment had a great influence on the traits. The study's estimates of variability parameters are quite near to the findings of genetic parameters in *Pongamia pinnata* (Kumaran 1991), *Santalum album* (Krishnakumar 2017), *Neolamarkcia cadamba* (Thirunirai Selvan *et al.* 2018), *Ailanthus excelsa* (Kanna *et al.* 2019). As indicated by previous investigations of poplars (Tiwari *et al.* 1993), the traits with a high heritability and a substantial genetic gain could be utilized as reliable markers. Because of this, the current study's high heritability and substantial genetic gain for volume indicated that genetics plays a major role in this characteristic.

Table 3: Estimates of various Genetic parameters

Traits	Mean	GCV (%)	**PCV (%)**	**h^2(bs) %**	**GA (5%)**	**GG (%)**
Collar Diameter	14.73	14.25	15.55	83.95	3.96	26.90
Height	132.01	7.15	8.47	71.25	16.42	12.44
Clear Bole	84.51	7.13	8.10	77.49	10.92	12.93
Primary Branches	5.88	21.49	25.23	72.53	2.22	37.70

Where : GCV = Genotypic coefficient of variation, PCV= Phenotypic coefficient of variation, h^2= Heritability (broad sense), GA= Genetic advance and GG = genetic gain

Correlation studies

Collar diameter has a strong connection (Table 4) with primary branches (0.645), height (0.247) with clear bole height (0.470), primary branches (0.173) at genotypic level revealed existence of the interrelated features like linkage, pleiotropic, or both.

Table 4: Correlation coefficients for different traits

	Collar Diameter	**Height**	**Clear Bole**	**Primary Branches**
Collar Diameter	1.000			
Height (G)	0.247	**1.000**		
Height (P)	0.173			
Clear Bole(G)	0.068	0.470**	**1.000**	
Clear Bole (P)	0.090	0.353**		
Primary Branches(G)	0.645**	0.302	0.519**	**1.000**
Primary Branches (P)	0.505**	0.222**	0.447**	

*G denotes genotypic correlation; P denotes phenotype correlation; ** denotes significant at 1% level of significance.*

The results of Parthiban (2019) and Deepanjli (2018) in various *T. ciliata* seed sources support the idea that these characters should be given appropriate emphasis during the selection program and can be used for indirect selection, particularly in traits requiring destructive sampling. *Melia azedarach* by Thakur and Thakur (2015)., *Populus deltoides* by Singh *et al.* (2015), *Ulmus villosa* by Thakur *et al.* (2014) and *Bauhinia variegata* by Wani *et al.* (2008) also supports our results.

CONCLUSION

The performance of the progenies showed notable variations across genotypes for *T. ciliata* growth characteristics, and further selection from experimental trials can lead to a noticeable improvement in growth parameters. For the growth qualities under examination, genotypes TC2260, TC2234, TC2234 and TC2255 did better. Collar diameter showed moderate genetic gain and high heritability. Due to their significant genotypic association, primary branches and collar diameter need to be properly prioritized during the selection process.

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GENERATIVE AI DECLARATION

The author(s) confirm that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript, and no images were manipulated using AI. The authors developed and verified all scientific content, data analysis, interpretation of results, and conclusions. The authors take full responsibility for the accuracy, integrity, and originality of the work presented, and no AI tool was listed as an author.

REFERENCES

Bahadur, K.N. 1988. Monograph on the genus Toona (Meliaceae). Bishan Singh Mahendra Pal Singh, International Book Distributors, Dehradun, India.

Burton, G.W. and DeVane, E.W. 1953. Estimating heritability in tall fescue (*Festuca arundinacea*) from replicated clonal material. *Agron. J.*, **45**: 478–481.

Deepanjli. 2018. Studies on variabilities and propagation techniques of *Toona ciliata* M. Roem. under Punjab conditions. M.Sc. Thesis, Punjab Agricultural University, Ludhiana, Punjab, India.

Edmonds, J.M. 1993. The potential value of Toona species (Meliaceae) as multipurpose and plantation trees in Southeast Asia. *Commonw. For. Rev.,* **72**: 181–186.

Edmonds, J.M. 1995. Toona. *In:* Meliaceae. Mabberley, D.J., Pannell, C.M. and Sing, A.M. (Eds.), Flora Malesiana, Series I, **12**(1): 358–371.

Johnson, H.W., Robinson, H.F. and Comstock, R.E. 1955. Estimates of genetic and environmental variability in soybeans. *Agron. J.,* **47**(7): 314–318.

Kanna, S.U., Krishnakumar, N., Kather, M.M.A. and Jailani, K. 2019. Growth performance of *Ailanthus excelsa* through progeny test. *Pharma Innov. J.,* **8**: 204-210.

Krishnakumar, N., Parthiban, K.T., Jayamani, P., Revathi, R. and Umeshkanna, S. 2017. Genetic variability of growth parameters among different progenies of *Santalum album* L. *J. Indian Soc. Coastal Agric. Res.,* **35**(1): 56–63.

Kumaran, K. 1991. Genetic analysis of seed and juvenile seedling attributes in neem (*Azadirachta indica* A. Juss.) and pungam (*Pongamia pinnata* Linn. Pierre). M.Sc. (For.) Thesis, Forest College and Research Institute, Tamil Nadu Agricultural University, Coimbatore, India.

Panse, V.G. and Sukhatme, P.V. 1989. Statistical Methods for Agricultural Workers. Indian Council of Agricultural Research, New Delhi, India, pp. 360.

Parthiban, K.T., Krishnakumar, N., Karthick and Thirumurugan, M.M. 2019. Improvement of toon (*Toona ciliata* M. Roem.) genetic resources through growth and evaluation. *Indian J. Agrofor.,* **21**: 60–68.

Rai, S.N. 1985. Notes on nursery and regeneration technique of some species occurring in southern tropical wet evergreen and semi-evergreen forests of Karnataka (India). *Indian For.,* **111**: 644–657.

Singh, N.B., Singh, S.K. and Chaudhary, P. 2015. Correlation coefficients and path analysis of quantitative characters in full-sib progenies of *Populus deltoides* Bartr. *ndian J. Genet.*, **75**: 145–149.

Singh, R.V. 1982. Fodder Trees of India. Oxford and IBH Publishing Co., New Delhi, India.

Thakur, I.K., Thakur, S., Singh, N.B., Sharma, J.P. and Sankanur, M. 2014. Studies on progeny performance, variability, heritability, genetic gain and correlation in *Ulmus villosa. Indian For.,* **140**(5): 483–488.

Thakur, I.K. and Thakur, S. 2015. Variability, heritability, genetic gain, genetic advance and correlation in growth characteristics of progenies of *Melia azedarach. Indian For.,* **141**: 247–253.

Thirunirai, S.R. and Parthiban, K.T. 2018. Genetic variability, correlation and path analysis in *Neolamarckia cadamba* (Roxb.) Bosser. *Indian J. Agrofor.,* **20**(2): 20–24.

Tiwari, D.N. 1993. Poplar. Surya Publications, Dehradun, India.

Troup, R.S. 1921. The Silviculture of Indian Trees. Vols. I–III, Oxford University Press, London, UK.

Wani, A.F., Raj, A.J. and Chauhan, K.C. 2008. Association analysis for morphological and biomass traits in *Bauhinia variegata* seedlings. *Indian J. Trop. Biodiv.,* **16**: 119–127.

Zhan, X., Li, P., Hui, W., Deng, Y., Gan, S., Sun, Y. *et al.* 2019. Genetic diversity and population structure of *Toona ciliata* revealed by simple sequence repeat markers. *Biotechnol. Biotechnol. Equip.,* **33**(1): 214–222.

Zobel, B. and Talbert, J. 1984. Applied Forest Tree Improvement. John Wiley & Sons, New York, USA.