Genetic Improvement Through Plus Tree Selection and Progeny Testing in Dek

ABSTRACT

Twenty five plus trees of *dek were* selected from agro-climatic regions of Haryana, Punjab and Uttrakhand. The plus trees were selected on the basis of the different characters of economic importance viz. straightness, clear bole height, self-pruning ability, acute branch angle etc. Among all the plus trees the maximum tree height was observed in MC21 (17.9 m) whereas the minimum in MC3 (6.5 m). Highly significant and positive correlation (r = 0.941) was found between the tree height and other morphological characters viz. clear bole height, girth at breast height, crown spread etc. with optimum amount of variability among different progenies for various characters. Further, the progeny performance exhibited a wide genetic variation which may be utilized for subsequent genetic improvement programme of this versatile tree species.

Keywords: Dek, plus trees, progenies, morphological characters, variability

1. INTRODUCTION

Low productivity (0.7 m^3/ha/year) of India's forests followed by increasing population and industries have created huge gap in demand and supply of wood and wood products (Parthiban *et al.*, 2021). Currently tree improvement programs are the most required need of hour to meet the growing domestic as well as global demands of wood and wood based products which are estimated to reach to 13.2 million tonnes till 2022 in India (Palsaniya *et al.*, 2009). Any breeding programme for the improvement of timber quality relies on the identification of the best parents. These will form the genetic base from which all subsequent improvements in form and vigour will be obtained. Such trees are usually found in forestconditions and may exhibit superior traits relative to neighbouring individuals of thesame species (Clark and Wilson, 2005). Selected trees arecommonly referred to as superior phenotypes or plus trees. These selected trees are referred to as the superior phenotypes of plus trees. Therefore, the plus tree selection is the first step for any tree improvement programme (Hooda *et al.*, 2009; Kaushik *et al.*, 2011 and Kumar, 2012). *Melia composita* commonly known as Dek, Burma Dek, White cedar , belonging to family Meliaceae a deciduous tree species, is native to Indian sub-continent but now is found growing in many different regions of the world (Murugesan *et al.*, 2013 and Johar *et al.*, 2016). The species bears a wide range of adaptability and can be easily propagated in areas with an average rainfall of 350-2000 mm up to an altitude 1800 msl with an average temperature range of 23-27 ^{o}C. *Melia composita* can be easily cultivated on a variety of soils, however, deep fertile sandy loam soils supports the best growth for this

Comment [WU1]: The author is advised to Modify the title as **mean performance evaluation and correlation coeffient analysis in dek tree** b/c genetic improvement of tree follows selection of above-average individuals from large populations, and subsequently breeding these individuals using a specified mating design. Following the breeding phase, the progeny must be tested on a variety of sites and climatic conditions. Progeny tests are specially designed genetic tests that expose hereditary differences among trees, by bringing different genotypes together under a common set of environmental conditions. When the progeny have developed sufficiently for a reliable assessment of their value, improved individuals or groups can be released for operational use and/or the breeding cycle can be repeated

Comment [WU2]: Add more it is written with few words versatile species (Orwa *et al.,* 2009). The wood of this species is highly resistant against fungus and termite (Swaminathan *et al.,* 2012). Being such an important versatile tree species with high values, required efforts have not been made for its genetic improvement. Therefore, in present study an attempt has been made to carry out the progeny testing of superior plus trees to boost the breeding activities of *Melia composita*.

Comment [WU3]: The author is advised to add more on introduction part like
Origin of dek tree, botanical description, mode of reproduction, productivity in the world, in Asia and then in India and causes of low productivity in India

2. MATERIALS AND METHODS

Based on intensive survey, 25 morphological superior trees were selected and sufficient amount of good quality ripened fruits was collected from different agro-climatic regions of Haryana, Punjab and Uttrakhand during January-March, 2019. The selection of the superior plus trees was made on the basis of the phenotypic assessment of desirable characters of economic interest such as tree height, clear bole height, girth at breast height etc. The sufficient amount of good quality physiologically ripened fruits was collected from individual selected tree. The collected fruits were depulped and seeds were properly washed with tap water and were further air dried at room temperature for 2-3 days and subsequently kept in cotton cloth bags and were stored at room temperature. The progenies of individual selected tree were raised in nursery by sowing of seeds (after soaking in normal water for 72 hrs) in poly bags (22.5 x 12.5 cm in size) filled with 1:2:1 proportion of FYM, dune sand and clay in the nursery of Forestry department, CCS Haryana Agricultural University, Hisar. For each progeny 60 poly bags (20 poly bags/replication) arranged randomly and one seeds per poly bag were sown in the month of July, 2019 and thereafter customary care was undertaken. Observations on germination (%), seedlings shoot length (cm), root length (cm), collar diameter (mm) and plant biomass (g) were recorded.

Comment [WU4]: Write detail methodology
1.Study area description
2.Experimental design and trial management
3.Sampling method used
4.Data collected
5.Data analysis methodology and models used for the data analysis

3. RESULTS AND DISCUSSION

The morphological data of the selected plus trees is depicted in Table-1. The height of the selected plus trees varied from 6.5 (MC3) to 17.9 m (MC21) with an average height of 11.1 m. The maximum clear bole height was recorded from MC-21 plus tree closely followed by MC-13. The girth at breast height (gbh) of the selected plus trees varied from 60.9 to 180.8 cm. Therefore, the selected plus trees in present study had a fairly good clear bole length, gbh and straightness which is one of the desirable character for the good economic returns and marketability of timber. Earlier, Chauhan *et al.* (2012) and Meena *et al.* (2014;2016) also reported that the straightness, total height , girth at breast height and the clear bole height of the tree coupled with the lower values of crown spread are desirable for an ideal tree species for agroforestry plantation. The correlation studies of morphological characters of plus trees in present investigation (Table 2) showed that the clear bole height had positive and highly significant association with the tree height (r = 0.941) closely followed by crown spread (N-S direction) (r = 0.910). Likewise, Johar *et al.* (2016) also reported highly significant and positive correlation (r = 0.522) among the different progenies of *Melia composita* for different morphological characters viz. height, clear bole height, GBH etc . Fruit length (18.94 mm), fruit thickness (16.02 mm) and test weight (1365.81g) were recorded significantly higher in plus tree MC-15 whereas the minimum fruit length (11.38 mm), fruit thickness (8.22 mm) and test weight (1125.56 g) were recorded in MC5 (Table 3) indicating a wide range of genetic variation in the selected sexual planting material. The germination studies are important tool to assess the variation present in the species as well as selecting the promising genotype that can be helpful to boost the efforts of mass afforestation programmes. In the present investigation, significant variation in germination was observed among selected candidate plus trees of *M. composita*. Since, the experiment was conducted in nursery by providing the same environment, the probable reason for the variation in seed germination and its attributes may be the arousal of parental genetic effect in the offspring (Rix *et al*., 2012). In angiosperms, the primary control of germination and dormancy is known to govern through maternal tissue immediately surrounding the embryo (Mayer and Poljakoff-Mayber 1982), maternally derived seed coat and additional genetic contribution to the endosperm (Donohue 2009). Variability in seed germination may also be attributed owing to other maternal provisioning during seed development like hormones, proteins and nutrients. Significant variation in terms of seed germination attributes have been documented in other woody perennials also. Chavan and Anand (2013) reported significant variation in half-sib progenies of *Azaditrachta indica*. Similarly, significant variation in germination was found in *Tecomella undulata* by Kant and Kumari (2016), in *Faidherbia albida* by Fredrick *et al.*, (2015), in *Pongamia pinnata* by Gupta *et al.,* (2016). Genetic variability in tree species is a gift to mankind, as it forms the basis for selection and further improvement of species. The information on the genetic structure and diversity relationship of a candidate plus tree provides a basis for planning future efficient utilization of genetic resources to realize the potentiality for maximizing growth and yield. Significant differences were found between progeny with respect to all growth characters in nursery under study at the 5% level of significance (Table 3). The progenies from MC-18 exhibited maximum shoot length (98.59 cm) followed by the progenies from MC-16 and MC- 17 plus trees, respectively. However, the maximum root length was observed in the progenies from MC12 (20.84 cm) closely followed by the progenies from MC-22 (20.46 cm) and MC13 (20.06 cm). The highest collar diameter was observed in progeny MC17 (13.73 mm) followed by MC19 and MC18 and lowest in MC5 (4.89 mm) at the age of six months. Meena *et al.*, (2014) also reported similar findings in *Melia azaderach* . The results of present study clearly indicate that considerable differences exist among the progenies of selected plus tress for growth attributes in *Melia composita* and appreciable improvement in growth parameters can be achieved by collecting seeds from selected plus trees and may be exploited further for tree improvement programme.

Comment [WU5]: The author is Re inter prêt the whole part of your result
Put it separately for
1. Mean performance evaluation
2. Correlation coefficient analysis
3.do analysis for both phenotypic and genotpic correlation separately

REFERENCES

1. Chauhan S, Gera M.. Selection of candidate plus trees of commercially important agroforestry species in Punjab. Indian Journal of Forestry, 2012; 35: 135-142.
2. Chavan RL, Anand B. Assessment of half -sib progenies of *Azadirachta indica* (A. Juss.) in North East dry zone of Karnataka. Progressive Research, 2013; 8(2): 273-275.
3. Clark J, Wilson T. The importance of plus-tree selection in the improvement of hardwoods. Quaterly Journal of Forestry, 2005; 99(1): 45-50.
4. Donohue K. Completing the cycle: maternal effects as the missing link in plant life histories. Philosophical Transactions of Royal Society of London series, 2009; B364:1059-1074.
5. Fredrick C, Muthuri C, Ngamau K. Sinclair F. Provenance variation in seed morphological characteristics, germination and early seedling growth of *Faidherbia albida*. Agroforestry Systems, 2015; 91:1007-1017.
6. Gupta G, Handa AK, Ajit , Maurya D. Variation in seed and seedling traits of *Pongamia pinnata*. The Indian Forester, 2016; 149(9): 852-857.
7. Hooda MS, Dhillon RS, Dhanda S, Kumari S, Dalal V, Jattan M. Genetic divergence studies in plus trees of *Pongamia pinnata* (Karanj). Indian Forester, 2009; 135: 1069-1079.
8. Johar V, Sharma KB, Rachana, Kumar P. Plus tree selection and progeny testing of Burma Dek (*Melia composita* Wild.). Indian Journal of Ecology, 2016; 43: 364-367.
9. Kant R, Kumari B. Effect of seed source variation on field emergence and seedling characters of different seed sources of Rohida (*Tecomella undulata* (Sm.) Seem). Journal of Tree Sciences, 2016; 35(1): 34-38.
10. Kaushik N, Mann, Suman, Kumar K. Variability in growth characters among progenies of *Pongamia pinnata* (L.) Pierre. Range Management and Agroforestry, 2011; 32:131-134.
11. Kumar R. Genetic variability and association studies in *Pongamia pinnata* (L.) Pierre. Range Management and Agroforestry, 2012; 33:129-132.
12. Mayer AM, Poljakoff-Mayber A. The germination of seeds. 3 edition. Pergamon ress, Oxford, England.1982.
13. Meena H, Ashok Kumar, Sharma R, Chauhan SK, Bhargava KM . Genetic variation for growth and yield parameters in half-sib progenies of *Melia azedarach* (Linn.). Turkish Journal of Agriculture and Forestry, 2014; 38(4): 531-539.
14. Meena H, Sharma R, Chauhan SK, Kumar A. Progeny evaluation in *Melia azedarach* (Linn.) for growth characteristics. Journal of Forestry Research, 2016; 27: 249-258.
15. Murugesan S, Senthikumar N, Rajesh Kannan, Vijayalakshmi KB. Phytochemical characterization of *Melia dubia* for their biological properties. Der Chemica Sinica, 2013; 4:36-40.
16. Orwa C, Matua A, Kindt R, Jamanadass R, Anthony S. Agroforestry database: a tree reference and selection guide version 4.0 (http//www.worldagroforestry.org/sites/treesbs/treedatabase.asp),2009.
17. Palsaniya DR, Dhyani SK, Tewari RK, Singh R, Yadav RS. Marketing issues and constraints in agroforestry. In: agroforestry, natural resource sustainability, livelihood and climate moderation. (Eds., O.P. Chaturvedi, A. Venkatesh, R.S. Yadav, B. Alam, R.P. Dwevedi, R. Singh and S.K. Dhyani), Serial Publishing House, India,2009; pp: 563-577.
18. Parthiban KT, Fernandaz CC, Sudhagar RJ, Sekar I, Kanna SU, Rajendran P, Devanand PS, Vennila S, Kumar NK. Industrial Agroforestry - A sustainable value chain innovation through a consortium approach. Sustainability, 2021; (13): 1-14.
19. Rix K, Gracie A, Potts B, Brown P, Spurr C, Gore P. Paternal and maternal effects on the response of seed germination to high temperatures in *Eucalyptus globules*. Annals of Forest Science, 2012; 69: 673-679.

20. Swaminathan C, Rao, V. Shashikala S. Preliminary evaluation of variations in anatomical properties of *Melia dubia* CAV. Woods. International Research Journal of Biological Sciences, 2012; 1: 1-6.

Table: 1 Morphological characters of selected plus trees of *Melia composita*

Accession No.	Latitude & Longitude	Tree height (m)	Clear bole height (m)	GBH (cm)	Clear bole height: Total height ratio	Height : GBH ratio	Crown	
							N-S	E-W
MC1	29.5050° N & 75.3070° E	8.2	3.9	60.9	0.48	0.13	4.8	4.7
MC2	29.5050° N & 75.3070° E	8.6	4.2	68.4	0.49	0.13	5.2	4.8
MC3	29.5460° N & 75.9318° E	6.5	3.0	65.3	0.46	0.10	4.5	4.4
MC4	29.5460° N & 75.9318° E	6.7	3.2	70.4	0.48	0.10	4.8	4.8
MC5	30.0343° N & 76.8079° E	8.8	4.6	90.4	0.52	0.10	5.3	4.9
MC6	30.5271° N & 75.5684° E	8.5	3.7	75.7	0.44	0.11	5.1	4.7
MC7	30.3819° N & 75.5468° E	11.2	4.5	88.4	0.40	0.13	5.4	4.9
MC8	30.7614° N & 75.6499° E	9.9	4.5	85.6	0.45	0.12	5.4	5.2
MC9	30.8028° N & 75.6310° E	12.5	4.7	90.1	0.38	0.14	5.9	5.7
MC10	30.9010° N & 75.8071° E	10.9	4.9	85.4	0.45	0.13	4.8	4.6
MC11	30.9010° N & 75.8071° E	8.6	4.2	71.5	0.49	0.12	5.2	5.1
MC12	30.9010° N & 75.8071° E	9.5	4.4	76.8	0.46	0.12	4.7	4.9
MC13	30.3518° N & 78.0095° E	17.2	8.4	175.7	0.49	0.10	8.2	7.1
MC14	30.71769 °N& 77.8674 °E	10.5	4.5	126.1	0.43	0.08	4.9	4.8
MC15	30.3340° N & 77.9602° E	10.7	5.0	137.6	0.47	0.08	4.8	4.6
MC16	30.3450° N & 78.0894° E	13.5	6.5	144.7	0.48	0.09	7.4	7.2
MC17	30.2497° N & 77.9810° E	14.7	6.9	145.8	0.47	0.10	7.5	7.1
MC18	30.2662° N & 78.1062° E	10.6	4.2	110.5	0.40	0.10	5.2	5.0
MC19	30.2662° N & 78.1062° E	11.5	5.1	99.8	0.44	0.12	6.3	6.0
MC20	30.3898° N & 78.1058° E	10.6	4.8	92.8	0.45	0.11	4.8	4.6
MC21	30.3579° N & 78.1066° E	17.9	8.6	180.8	0.48	0.10	8.3	7.4
MC22	30.3579° N & 78.1066° E	11.9	5.4	165.2	0.45	0.07	6.7	6.4
MC23	30.3579° N & 78.1066° E	15.6	7.4	160.7	0.47	0.10	7.9	7.5
MC24	30.3220° N & 78.0866° E	11.8	3.7	99.9	0.31	0.12	6.4	6.1
MC25	30.3220° N & 78.0866° E	12.9	5.8	132.5	0.45	0.10	6.8	6.7
Range		6.5-17.9	3.0-8.6	60.9-180.8	0.31 - 0.52	0.07 - 0.14	4.5-8.3	4.4-7.5
Mean		11.1	5.0	108.0	0.45	0.11	5.8	5.5

Table: 2 Correlation coefficient among different traits of plus tees of *Melia composita*

	Tree height	Clear bole height	GBH	Clear bole height: Total height ratio	Height : GBH ratio	Crown Spread (N-S)	Crown Spread (E-W)
Tree height		0.941**	0.876**	-0.037^{NS}	-0.212^{NS}	0.910**	0.876**
Clear bole height			0.875**	0.300^{NS}	-0.302^{NS}	0.890**	0.849**
GBH				0.107^{NS}	-0.643**	0.835**	0.815**
Clear bole height: Total height ratio					-0.267^{NS}	0.068^{NS}	0.045^{NS}
Height : GBH ratio						-0.268^{NS}	-0.287^{NS}
Crown Spread (N-S)							0.982**
Crown Spread (E-W)							

**** Significant at 5 per cent**

Table: 3 Fruit characters of selected plus tree of *Melia composita* from different locations

Accession No.	Fruit length (mm)	Fruit thickness (mm)	Test weight (g)
MC1	11.91	8.65	1145.82
MC2	14.79	10.35	1186.72
MC3	12.99	9.22	1156.92
MC4	14.45	10.22	1180.52
MC5	11.38	8.22	1125.56
MC6	12.65	8.72	1149.77
MC7	13.87	9.28	1160.87
MC8	14.98	10.39	1192.85
MC9	11.50	8.44	1130.85
MC10	15.64	10.63	1210.7
MC11	15.27	10.45	1205.87
MC12	15.97	10.94	1224.55
MC13	18.06	14.43	1295.75
MC14	16.79	13.92	1267.87
MC15	18.94	16.02	1365.81
MC16	17.22	14.28	1287.65
MC17	15.88	10.89	1218.68
MC18	16.51	13.93	1255.73
MC19	16.84	14.15	1275.95
MC20	16.39	12.48	1245.72
MC21	15.65	10.74	1212.71
MC22	14.14	10.15	1175.83
MC23	12.81	8.95	1151.91
MC24	16.39	13.87	1248.78
MC25	15.97	10.98	1225.91
Range	11.38-18.94	8.22-16.02	1125.56-1365.81
Mean	15.07	11.21	1211.97
CD at 5 %	1.14	0.86	91.45

Table:4 Mean performance of the progenies of *Melia composita* for emergence and seedling characters

Accession code	Germination (%)	Shoot length (cm)	Root length (cm)	Root : Shoot ratio	Collar diameter	Plant biomass
MC1	6.00	32.77	12.07	0.37	5.34	1.96
MC2	6.67	31.89	10.90	0.34	5.58	1.97
MC3	25.33	48.49	16.78	0.35	7.10	2.06
MC4	6.33	28.33	12.20	0.43	5.22	1.99
MC5	7.00	30.04	11.68	0.39	4.89	2.04
MC6	19.33	44.97	18.43	0.41	7.90	2.06
MC7	26.00	47.39	19.28	0.41	6.85	2.22
MC8	24.00	49.35	19.10	0.39	7.41	2.37
MC9	7.00	27.35	12.00	0.44	6.17	1.96
MC10	16.33	73.69	16.47	0.22	7.33	3.00
MC11	21.33	64.07	17.64	0.28	8.52	2.48
MC12	29.33	64.73	20.84	0.32	7.03	2.69
MC13	26.33	60.33	20.06	0.33	7.81	2.48
MC14	30.67	70.63	17.98	0.25	9.74	2.65
MC15	31.67	82.46	20.39	0.25	11.65	3.25
MC16	22.00	87.60	17.52	0.20	9.85	3.35
MC17	19.00	85.87	18.22	0.21	13.73	3.24
MC18	23.00	98.39	16.87	0.17	11.75	3.46
MC19	17.67	70.84	18.32	0.26	11.82	2.88
MC20	28.00	67.01	17.63	0.26	10.97	2.53
MC21	26.00	76.86	19.77	0.26	11.65	3.08
MC22	27.33	84.12	20.46	0.24	9.60	3.27
MC23	28.67	79.33	18.45	0.23	9.02	3.07
MC24	30.33	69.87	18.93	0.27	10.84	2.79
MC25	29.67	82.43	19.82	0.24	10.90	3.15
Mean	21.4	62.35	17.27	0.30	8.75	2.64
CD (p=0.5)	2.94	6.93	1.66	0.02	1.37	0.39