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Evaluation of *Melia dubia* Germplasm for Cultivation in Low Rainfall Region

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ABSTRACT

The present investigation was carried out to identify desirable genotypes under low rainfall conditions. Forty two genotypes of *Meliadubia* in two trails were evaluated for different growth parameters, total standing biomass and MAI at the Hoskote Research Station of Hoskote Range Forest Division, Bengaluru Rural District, Karnataka. Significant differences were observed for all the growth parameters among the germplasm lines. In trail I, germplasm line MD013 showed highest girth (34.67 cm), leaf area (5.41 cm2) and biomass (11.06 kg / tree) and line 159 and 115 for maximum plant height (2.95 m) while in trail II, germplasm line MD058 accounted for the maximum girth (29.6 cm), leaf area (4.28 cm2) and biomass (9.18 kg / tree) and line 257 showed plant height (3.69 m). The findings show that Genotypes MD058 and MD013 were found suitable for cultivation in the low rainfall regions.

Keywords: Low rainfall, genotype, growth, biomass

IT is a fact that the ever-expanding human population requires an enormous amount of wood, which in turn, puts intense pressure on the existing forest wealth of India. The production potential of trees for wood generation is restricted to about 0.7 cubic metre/ hectare / years in the country as compared to the world average of 2.1 cubic metre / ha / year. This results in a huge gap between demand and supply of wood. In the years to come, more food production with less land will be the situation due to rapid urbanization (Palsaniya *et al.,* 2009). More uncertainties in climatic conditions due to climate change will further complicate the food production scenario. However, enhancing the efficiency of farms by planting and integrating fast-growing trees under farm forestry and agroforestry is a reasonable and realistic alternative to meet the ever increasing demand for wood. In order to sustain livelihood under the above situations agroforestry is considered to be a potential option. The current approximate area under agroforestry is estimated to be 25.32 m ha, or 8.2 per cent of the total geographical area of the country (Dhyani *et al*., 2013).

Agroforestry is the study of incorporation of trees into farming systems which has enormous potential to mitigate the effects of climate change and to improve the wood production. Trees with better stress tolerance compared to annual crops can help in generating a subsistence income. With climate change, it is expected to cause many uncertainties in the future and placing greater pressure on agricultural systems, food production and food prices thus, agroforestry is a viable option to help buffer farmers against such impacts. It can help boost food and fodder production and also serve as alternative sources of income especially during lean periods (Parthiban and Govinda Rao, 2008). Agroforestry is a potential option which can provide economic, environmental and social benefits in a sustainable manner to the farmers. Cultivation of short rotation trees has helped to mitigate financial crisis leading to economic upliftment of farmers. As a result, *Meliadubia* plantation as an agro forestry option, on wastelands has become popular because of a variety of benefits like timber, fuelwood and fodder for goats, sheep and cattle. It is a promising tree highly suitable for farm forestry and agro forestry for generating higher income in the semi-arid regions. The wood from this tree is used in plywood industry and is also suitable for pulp industry (Parthiban *et al*., 2009).

Melia dubia is a large, fast-growing deciduous tree of the Meliaceae family, attains a height of 20-25 metres. It has a spreading crown and straight cylindrical bole (trunk) of around nine metres. It is an indigenous species of south-east Asia and Australia. It is found in Sikkim, Himalayas, North Bengal, Upper Assam, Khasi hills, Hills of Orissa, Deccan plateau, North Cirears, Nallamalai hills and Western Ghats from southwards of South Canara at an altitude of 1500 - 1800 m in India. It can be grown in area with an annual rainfall of 1,000 millimetres, minimum temperature of 0-15°C and maximum temperature of 30-43°C. It is growing in almost all districts of Karnataka. But in the districts of Chitradurga, Bellary, Tumkur, Kolar, Chikkaballapur, Bengaluru rural, Ramanagara, Mandya and Mysore districts it is cultivated for timber and fodder (Nuthan *et al.,* 2009).

The wood is termite proof and used for packing cases, cigar boxes, ceiling planks, building purposes, agricultural implements, pencils, match boxes, splints and kattamarans. It is suitable for making musical instruments, tea boxes and most important for low grade plywoods. It is also suitable for the pulpwood and paper industry. It is used to treat skin diseases and diarrhoea, leaves used against stomach and liver troubles, fruit extract is used as anthelmentic and against skin disorders and the dried ripe fruit is not only used as an external parasiticide but also as a remedy for colic disorders amongst poor. It was reported that *Melia dubia* along with *Trichoder maviridae* has the capacity to degrade commonly occurring pesticide in soil residues of endosulpbon and acephate *in-vitro* conditions and therefore, it can be recommended for soil reclamation (wastelands) (Subashini *et al*., 2007). As far as productivity of *Melia dubia* is concerned, the species grows at the rate of 41.54 cubic metre / ha / yr (Saravanan *et al*., 2013), which is higher than Eucalyptus and Poplar. With such a wide utility it is a potential agroforestry species. Thus the present study is an attempt to assess the diversity of growth among the germplasm to make selection of a tree suitable for cultivation in low rainfall regions of Karnataka.

Material and Methods

The study was conducted in 42 genotypes of *Melia dubia* plantation established by Karnataka State Forest Department in December, 2013 at Hoskote Research Station of Hoskote Range Forest Division, Bengaluru Rural District, Karnataka, India, situated at 13°522 N, 77°502 E and at 891 m altitude, with an average annual rainfall of 620 mm. The experiment was conducted in two trails laid out in Randomized block design. The first trail consists of 21 germplasm planted at 4 x 4 m spacing with four replications and the second trail consisted of 21 genotypes planted at 4 x 5 m spacing with five replications. Growth parameters observations on girth at breast height (1.37 m above ground)measured using a measuring tape and mean annual increment (MAI) for girth at breast height were calculated. Girth at breast height measurements were made in June 2014 (6 months after plantation) and March, May and December 2016. Growth rate was assessed as increments in girth from the values measured in June 2014 and December 2016. Leaf of each germplam line is devised by measuring leaf area of 50 leaf lots of each germplam line and average is expressed as leaf area per leaf. Leaf area is measured using chlorophyll leaf area meter. Analysis of variance (ANOVA) was done according to Sukhatme and Amble (1989).

Results and Discussion

The growth performance of the lines grown under rainfed condition in low rainfall region under the field conditions assessed in three years old trees. Girth of the trees of 21 germplasm in trail I showed a significant difference among the clones. It varied from as high as 34.67 cm in the germplasm line MD013 to as low as 16.43 in germplasm line no. 69. In this trail the lines that recorded higher girth are the germplasm lines 262, 24, 32, and 265 (Table I). In the trail II girth of 21 lines varied significantly and ranged from as low as 9.2 cm in line MD126 to as high as 29.6 cm in line MD058. Few other lines recorded higher girth and in this trail are the lines 268 and 20, respectively. In girth recorded in number of lines of trail II was found to be less compared to tail I.

Leaf area of individual leaf varied significantly among the lines studied in both the trails. In trails I, it varied from 1.81 - 5.41 cm^2 in lines 69 and MD013, respectively. The germplasm lines that recorded higher leaf area are lines No. 262, 265 and 32 while the lines recorded the lower leaf area are 104, 159 and 270, respectively. Similarly, in the trail II leaf area varied from 0.99 – 4.28 cm^2 in the lines MD126 and MD058, respectively. The other lines that recorded higher leaf area are 268, MD111, 128 and MD122, respectively, while the lines MD123 and MD112 recorded low leaf area (Table II).

TABLE I

Performance of Melia dubia *germplasm trail I for growth parameters*

Germplasms	Girth (cm)	Plant Height(m)	Leaf area (cm^2)	Biomass (kg / tree)	MAI for GBH (cm / yr)
267	26.51	2.57	3.04	5.75	6.45
159	17.85	2.95	2.53	2.99	6.52
115	21.96	2.95	3.30	4.53	6.75
268	26.09	1.97	3.36	4.27	7.32
260	25.85	2.81	3.81	5.98	7.14
261	26.48	1.98	2.81	4.42	6.7
24	29.48	1.76	3.73	4.87	7.55
259	27.58	2.41	3.60	5.93	6.14
69	16.43	2.63	1.81	2.26	4.67
32	27.59	2.36	4.23	5.72	8.16
75	24.42	2.41	3.22	4.49	6.7
28	22.57	2.73	2.92	4.43	5.81
76	25.01	2.75	4.18	5.48	6.92
195	25.62	2.72	2.56	5.69	6.76
104	21.18	2.98	2.18	4.51	5.91
265	27.28	2.53	4.25	6.00	6.45
262	30.53	2.41	5.24	7.15	8.95
270	17.25	2.81	2.7	2.74	6.08
114	22.52	2.17	2.70	3.50	5.64
233	26.34	1.92	3.18	4.24	6.76
MD013	34.67	2.89	5.41	11.06	5.53
S.Em.±	1.38	0.18	0.04	0.67	0.33
CD at 5%	3.95	0.51	0.12	1.90	0.95

Growth rate of the germplasm lines in both the trails was assessed in terms of mean annual increment (MAI) (Table I and II). It varied significantly among the lines in both the trails. The increment rates were worked out for three different growth periods of the four years of the total growth (Fig.1 & 2). From this it was found that the growth rates from the time of planting to two and a half years of growth it was maximum in all the lines in both the trials. In the next three summer months between March, 2016 to May, 2016 the growth rates were least in all the lines. In the subsequent seven months it was more than the previous summer months but was almost on par with the initial growth rates. However, there were variations in growth rates in all the lines during the three stages of growth.

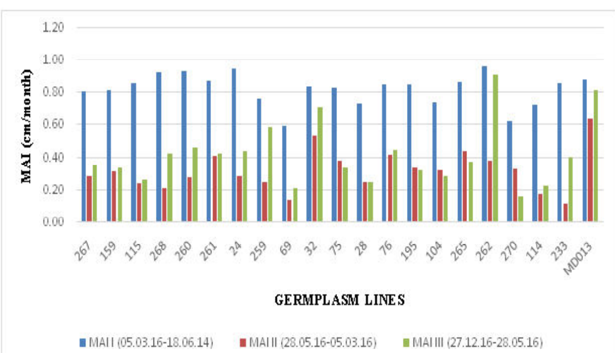

Fig. 1: Girth increment rates at different growth stages of germplasm lines ofa trail I

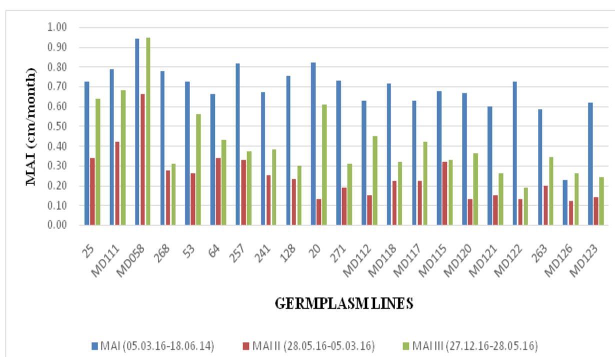

Fig. 2: Girth increment rates at different growth stages of germplasm lines of trail I

TABLE II
Performance of Melia dubia *germplasm trail II for growth parameters*

Germplasms	Girth (cm)	Plant Height (m)	Leaf area (cm^2)	Biomass (kg/tree)	MAI for GBH (cm /yr)
25	21.17	2.83	2.4	4.04	6.05
MD111	24.8	3.57	3.41	6.99	6.53
MD058	29.6	3.29	4.28	9.18	7.13
268	29.5	3.18	3.97	8.81	6.12
53	18.77	3.26	2.84	3.66	5.93
64	23.67	3.19	2.46	5.69	5.43
257	20.57	3.69	2.30	4.97	6.51
241	21.97	3.05	3.07	4.69	5.37
128	23.73	2.77	3.23	4.97	5.91
20	28.69	3.15	2.44	8.26	6.83
271	19.8	3.23	2.35	4.03	5.70
MD112	16.7	2.75	1.81	2.44	5.34
MD118	21.53	3.35	2.84	4.95	5.97
MD117	17.43	3.01	2.59	2.91	4.98
MD115	18.7	2.84	2.42	3.16	5.31
MD120	17.7	2.71	2.34	2.70	5.44
MD121	20.13	2.63	2.81	3.39	4.63
MD122	21.3	2.65	3.11	3.83	5.51
263	17.83	3.14	2.78	3.18	4.71
MD126	9.2	1.82	0.99	0.49	1.92
MD123	21.1	2.85	1.28	4.04	4.74
S.Em. ±	1.05	2.02	0.03	0.66	0.26
CD at 5%	3.00	0.56	0.10	1.91	0.74

Height of the trees varied significantly among the lines in both the trails (Table I and II). The trends of the tree height were almost similar to that of the girth of the trees. Tree height varied from 1.76 – 2.98 m in the lines 24 and 104, respectively in trail I. Other lines that recorded higher tree height are 159, 115 and MD013 while those lines with least height were 233, 268 and 261. In the trail II, height varied from 1.82 – 3.57 m in lines MD126 and 257, respectively. Others lines that recorded higher height are MD111, MD118 and MD058 while the least height was seen in lines MD121, MD122 and 128.

The biomass accumulated in the above ground position of the lines varied significantly among the lines in both the trails (Table 1 and 2). In the trail I, biomass varied from 2.26 – 11.06 kg/tree in lines 69 and MD013 respectively. While the line 262 and 260 also recorded relatively higher biomass. On the other hand, lower biomass was also recorded in line 270 and 159. In trail II biomass of atree ranged from 0.49 – 9.18 kg/tree. Higher biomass was also recorded in lines 268, 0 and MD111 and lower biomass seen in other lines are MD112 and MD120.

The main purpose of this field study is to evaluate 42 lines of *Melia dubia* for their field performance and to identify suitable lines that can perform best under low rainfall conditions. Thus the trial was conducted in one of the low rainfall regions of Karnataka where the mean rainfall was found to be 620 mm. The major emphasis therefore is to assess the growth performance in field conditions. Growth of trees is best indicated in the girth increment of stem and tree height. From these two primary parameters biomass can be derived that reflect the cumulative growth performance. A total of forty two lines evaluated in this study were grown in the same piece of land but laid out in two trials with 21 lines in each of the trial. Since the two trials followed two different spacing these two sets of lines were analyzed and interpreted separately.

Trees with higher girth did not necessarily show higher tree height indicating diameter growth and the tree height are independent in their behavior. However, most of the lines which had higher girth resulted in producing higher biomass. Therefore, girth is in general considered to be a better indicator of growth and most allometeric equations used for biomass estimation prefer to use girth and height or girth alone but not the tree height (Henry *et al.,* 2010). For growth to take place substrate for growth in the form of sugars is a basic requirement.Therefore, carbon assimilation by the leaves through the efficient interception of light is the driving force of growth (Niinemetes, 2007). In this process the photosynthesizing leaf surface area and the photosynthetic rates play very important role. In order to assess such a relationship among the lines individual leaf surface area was measured. It is interesting to note that lines with least individual leaf area were also found to be ones with lowest girth as well as with lowest total biomass and with lowest girth increment rates.This is not to undermine the importance of photosynthetic rates and the canopy architecture of the plant. Individual leaf area can be a good indicator while screening large germplasm lines and also in tree species where photosynthetic measure-ments are not feasible (Okogbenin *et al.,* 2013).

Under low rainfall regions plants are invariably exposed to intermittent moisture stress because of low amount of total rainfall as well as its distribution. Therefore, the performance of lines during this period of intermittent stress period would be a best indicator of their moisture stress tolerance. In order to capture this, rate of growth was assessed in terms of girth increment during the different stages of growth and specifically for the three dry months of the year between March and May (Fig. 1 & 2).

The results found that the line MD013 and 32 showed relatively good growth rates during this period in trial I and similarly line MD 058 from the trial II. These lines also showed highest cumulative growth in terms of girth and biomass accumulation. Thus from the initial three years of growth where trees have experienced four summer seasons it is possible to say that these three lines have the potential to perform well under low rainfall conditions.

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