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ISSN: 2455-6521 (Online)

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Innovative Farming
-A Quarterly International Journal of Agriculture

Research Article

Article: SAAI/IF/513

Assessment of Growth Dynamics in Different Mulberry Genotypes at 12 and 15 Months after Plantation (MAP) for Pulp and Paper Production

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KEYWORDS:

Genotypes, Growth dynamics, Mulberry, Paper production, Pulp

ARTICLE INFO

Received on:
09.12.2022
Revised on:
08.04.2023
Published on:
15.04.2023

ABSTRACT

India has huge need for growing wood products, driven by urbanization and forest protectant act which is need for creation of domestic plantation system. The present study assesses the growth attributes of 21 mulberry genotypes at two different periods such as 12 and 15 months after plantation (MAP) to screen the superior genotype for pulp and paper industry. This research utilized a Randomized Block Design with five replications conducted at the Forest College and Research Institute, part of Tamil Nadu Agricultural University. Key growth traits measured by plant height, basal diameter, diameter at breast height (DBH) and volume. Among the genotypes significant variations were observed with plant height, basal diameter, diameter at breast height and volume from 2.15 to 5.67 m, 41.04 to 53.46 mm, 27.61 to 43.25 mm and 0.0007 to 0.0039 m^3, respectively at 15 MAP. Across the all the parameter the mulberry genotype MI-0845 has superior growth performance for pulp and paper production. This investigation highlights the potential of targeted genotype evaluation in enhancing mulberry wood productivity and quality, contributing to sustainable agro-forestry practices in India.

How to Cite:

Mithilasri, M., Parthiban, K.T., 2023. Assessment of growth dynamics in different mulberry genotypes at 12 and 15 months after plantation (MAP) for pulp and paper production. *Innovative Farming* 8(2), 47-53.

INTRODUCTION

India ranks among the top producers and consumers of wood products in the Asia-Pacific region. The growing population and urbanization coupled with changes in polices and legal issues have significantly increased the demand for wood and wood based products (Parthiban and Fernandaz, 2017). However, there is no concomitant increase in organized plantation development. The acting of Forest Conservation Act (1980) and the directives from Honourable Supreme Court on complete ban on felling in nature forests have restricted or totally stopped the availability of wood from natural forests. The increasing demands, combined with limited supply of natural forest resources, have resulted in a significant disparity between supply and demand (Parthiban and Seenivasan, 2017). It is

estimated that the country would need over 152 million m^3 woods to meet the raw material requirement of wood based industry and an equal amount of wood is needed to fulfil the raw material requirements of the unorganized wood-based industry. In addition, more than 380 million tonnes of wood is needed to meet the energy requirement of both domestic and industrial utility. All these wood requirements have necessitated development and promotion of organised plantation and agroforestry systems. To resolve these issues, Government of India has enunciated an exclusive National Agroforestry Policy in the year 2014 and extended directions and strategies to promote agroforestry. The policy advocates identifying potential new and alternate species amenable for incorporation in agroforestry and plantation forestry programme. Against this backdrop, mulberry has been identified as one of the potential and alternate species amenable for agroforestry due to its multiple utility. Accordingly, the current study has been designed to identify superior clones amenable for multifarious industrial utility.

The success of any species depends on organised tree improvement programme through suitable provenance/ seed sources/ progeny/ clone evaluation leading to productivity and wood quality improvement (Parthiban *et al.*, 2020; Mithilasri *et al.*, 2021). Mulberry, a fast-growing deciduous perennial plant with significant heterozygosity, is believed to have originated in the Northern Hemisphere and subsequently expanded to tropical areas of the Southern Hemisphere. The provision of superior leaves is essential for the long-term success and economic viability of the sericulture sector, as mulberry serves as a vital food source for silkworms (*Bombyx mori*) (Vijayan *et al.*, 2010). It is very well witnessed that increased production of silk depends on increased leaf yield of mulberry. A plethora of research workers recorded wide range of breeding programme which is including genotype selection, variability analysis and associated studies which screen the superior genotype and clone (Vijayan *et al.*, 2010; Biradar *et al.*, 2015; Suresh *et al.*, 2017). However, breeding study connected with wood quality and productivity was very less only few researches are done wood productivity and quality improvement programme. Therefore, it is important to initiate systematic tree improvement programme through genotype evaluation test which highlight the needs for current study.

MATERIALS AND METHODS

Study Area

The current study was conducted at Forest College and Research Institute, Mettupalayam (11°19' N, 76°56'E) during 2018-2021. The research field located at 300 AMSL having 800 mm rainfall and soil pH of 7.1. The present study twenty-one genotypes were planted at 2 m × 2 m spacing distance in Randomized Block Design with five replications. The morphological traits were recorded at different growth period such as 12 MAP and 15 MAP.

Growth Attributes

Growth attributes includes basal diameter, plant height and diameter breast height.

a) *Plant height*: The measurement of plant height was conducted by determining the distance from the ground level to the tip of the stem, expressed in meters.

b) *Basal diameter*: The basal diameter was recorded at the base of the stem, in close proximity to the ground level, and was denoted in centimeters.

c) *Diameter breast height*: The measurement of the stem's diameter should be taken at breast height and recorded in centimeters.

d) *Volume*: The volume was determined using the following formula:

$$V = \pi r^2 h \times form\ factor$$

Where, V = Volume (m^3); r = Diameter at breast height (m)/2; h = Height (m); Form factor = 0.47 (Krisnawati *et al.*, 2011)

Statistical Analysis

The data obtained from field experiments underwent statistical analysis and were organized into separate

tables. The mean, variance and standard error were calculated following the methods outlined by Panse and Sukhatme (1978). The significance of the results was tested using the standard 'F' table, as described by Snedecor (1956).

RESULTS AND DISCUSSION

In tree enhancement initiatives, the careful selection of superior genotypes is imperative as it lays the groundwork for all improvement endeavors. The efficacy of these programs hinges on the level of genetic diversity present within a given tree species, a factor that is paramount in devising successful enhancement strategies (Lebedev *et al.*, 2020). By utilizing suitable species and seed sources, substantial, efficient, and expeditious progress can be made in the majority of forestry tree improvement programs. Against this backdrop, the present investigation has been conducted to evaluate and assess 21 genotypes of mulberry in order to identify the superior genotype for higher productivity. The twenty-one mulberry genotypes were evaluated through organized morphological trait evaluation for varied growth attributes and the results are presented in table 1 and 2.

Table 1: Plant height (m) and basal diameter at various growth periods of different mulberry genetic resources

Clones	Plant height (m)		Basal diameter (mm)	
	12 MAP	15 MAP	12 MAP	15 MAP
ME-0025	5.20**	5.67**	46.35**	53.46**
MI-0211	5.18**	5.46**	45.76**	52.92**
ME-0001	2.33	2.98	36.38	42.67
ME-0109	3.42	3.86	40.08	45.76
MI-0013	4.71**	5.01**	41.68	50.02**
MI-0349	3.26	3.79	38.62	44.19
MI-0395	2.43	2.85	35.68	41.43
MI-0536	3.98	4.20	39.68	46.85
MI-0615	4.62**	4.89**	40.85	46.67
MI-0718	4.33**	4.95**	40.08	45.76
MI-0768	4.86**	5.20**	43.07**	50.13**
MI-0034	3.06	3.79	37.07	43.14
MI-0663	2.24	2.52	34.06	42.07
MI-0685	4.62**	4.91**	41.96	48.46
MI-0017	3.18	3.75	37.96	44.08
ME-0006	5.07**	5.39**	43.58**	51.62**
MI-0807	5.01**	5.42**	47.06**	52.07**
MI-0845	5.25**	5.51**	48.35**	53.46**
ME-0220	4.01	4.38	36.82	43.57
ME-0095	1.36	2.15	35.17	41.04
MI-0308	3.68	4.14	39.25	45.71
Mean	3.90	4.32	40.45	46.91
SEd	0.11	0.13	0.95	1.01
CD (0.05)	0.22	0.26	1.88	2.02
CD (0.01)	0.29	0.34	2.50	2.68

[**Significant at 1% level; *Significant at 5% level]

The mulberry genotypes differed significantly due to plant height and basal diameter at varied growth periods. At 12 and 15 MAP the plant height varied

between 1.36 m (ME-0095) to 5.25 m (MI-0845) and 2.15 m (ME-0095) and 5.67 m (ME-0025), respectively. The analysis also indicated that 10 genotypes at 12 MAP and 15 MAP proved superior at 1% significant level. Considering all the growth periods into accounts five clones namely, MI-0025, MI-0211, ME-0006, MI-0807 and MI-0845 exhibited significantly higher basal diameter at 1% level of significant. Basal diameter differed significantly due to clones at varied growth periods. At 12 and 15 MAP the basal diameter varied between 34.06 mm (MI-0663) to 48.35 mm (MI-0845) and 41.04 mm (ME-0095) to 53.46 (MI-0845) mm, respectively. Comparison of genotypes for this parameter at different growth periods indicated six genotypes namely, ME-0025, MI-0211, MI-0768, ME-0006, MI-0807 and MI-0845 proved superior at 1% level of significant.

Table 2: Diameter at breast height (DBH) (mm) and volume (m^3) at various growth periods of different mulberry genetic resources

Clones	Diameter Breast height (DBH) (mm)		Volume (m^3)	
	12 MAP	15 MAP	12 MAP	15 MAP
ME-0025	35.61**	42.93**	0.0024**	0.0039**
MI-0211	31.28**	38.26**	0.0019**	0.0029**
ME-0001	22.51	33.24	0.0004	0.0012
ME-0109	27.18	33.41	0.0009	0.0016
MI-0013	36.49**	43.03**	0.0023**	0.0034**
MI-0349	21.80	31.78	0.0006	0.0014
MI-0395	20.85	31.67	0.0004	0.0011
MI-0536	29.74*	36.28	0.0013	0.0020
MI-0615	27.79	35.02	0.0013	0.0022
MI-0718	33.14**	40.46**	0.0018**	0.0030**
MI-0768	34.82**	41.36**	0.0022**	0.0033**
MI-0034	26.08	32.31	0.0008	0.0015
MI-0663	20.13	30.85	0.0003	0.0009
MI-0685	35.36**	42.34**	0.0021**	0.0032**
MI-0017	25.49	32.72	0.0008	0.0015
ME-0006	26.62	33.16	0.0013	0.0022
MI-0807	36.02**	43.25**	0.0024**	0.0037**
MI-0845	36.53**	42.76**	0.0026**	0.0037**
ME-0220	25.65	32.97	0.0010	0.0018
ME-0095	19.05	30.53	0.0002	0.0007
MI-0308	25.47	27.61	0.0008	0.0012
Mean	28.56	35.89	0.0013	0.0022
SEd	0.58	0.74	0.0001	0.0001
CD (0.05)	1.15	1.47	0.0002	0.0002
CD (0.01)	1.52	2.25	0.0002	0.0002

[**Significant at 1% level; *Significant at 5% level]

The diameter at breast height (DBH) significantly varied due to mulberry genotype at various growth periods. At 12 MAP, the maximum DBH registered in MI-0845 (336.53 mm), while the minimum DBH observed in the genotype, ME-0095 (19.05 mm). At 15 MAP the DBH significantly varied from 27.61 mm to 43.25 mm. Among the genotype MI-0807 (43.25 mm) recorded the highest DBH followed by MI-0013 (43.03 mm), ME-0025 (42.93 mm), MI-0845 (42.76), MI-0685 (42.34), MI-0768 (41.36), MI-0718 (40.46) and MI-0211 (38.26) at 1% significant level.

The volume of twenty one mulberry clones was significantly varied at different growth period. At 12 MAP, the maximum volume recorded in MI-0845 (0.0026 m^3), whereas the minimum volume recorded in ME-0095 (0.0002 m^3). The volume of genotypes differed from 0.0007 m^3 (ME-0095) to 0.0039 m^3 (ME-0025) at 15 MAP. Considering all the growth periods in account only one genotype namely, MI-0845 proved superior. This genotype is highly suitable for pulp and paper production based on the morphological screening. The desirable genetic enhancement can only be achieved through the use of variation. Consequently, the variation observed in this study expands the opportunities for identifying genotypes with enhanced growth traits. Among the 21 genotypes examined, MI-0845 clearly stood out, demonstrating significantly higher values for the majority of growth characteristics. A plethora of researchers have identified superiority of few genetic resources among the wider several genetic resources tested in various species like *Ailanthus excels* (Kanna *et al.*, 2019); *Dalbergia sissoo* (Rajendran *et al.*, 2019); *Neolamarckia cadamba* (Selvan and Parthiban, 2018); *Santalum album* (Krishnakumar *et al.*, 2017); Eucalyptus (Vennila, 2009; Behera *et al.*, 2016) and *Albizia lebbeck* (Thakur *et al.*, 2014). Genotypic evaluation aims to obtained superior genotypes according to desired characters. In particular tree growth characters such as diameter, height, survival rate (Zhang *et al.*, 2003). Similarly genotype screening also conducted to desired a genotype amenable for varied industrial utility such as pulp and paper, plywood and energy utility (Parthiban *et al.*, 2020). Hence, the current study was also conducted to screen the superior mulberry clone for increased productivity which identified superiority of clone MI-0845.

Similar studies on genotype evaluation of poplar identified superiority of four genotypes (Sidhu and Dhillon, 2007) and found this superiority may be attributable to the difference in genetic potential of various genotypes. Hence, these superiority of mulberry genotype MI-0845 identified the current study may be attributed due to its genetic potential. Similar superiority of one or few genotypes in Eucalyptus was also reported (Lal *et al.*, 2006; Luna and Singh, 2009; Vennila, 2009), which thus lend support to the superior genotypes identified current study. It is also indicated that the variations identified among the genotypes for growth attributes may be due to genetic factors which facilitate selection of superior genotype (Behera *et al.*, 2016). All the above assertions are extending support to the findings made in the current study. In holistic analysis, the evaluation of mulberry genotypes conducted in the current study has identified the genotype MI-0845 has an earlier superior genotype which came into limelight for immediate adaption to deploy them in all future evaluation programme.

CONCLUSION

This study effectively evaluated the growth dynamics of 21 mulberry genotypes, revealing significant variability in key growth attributes crucial for pulp and paper production. The findings demonstrated that genotype MI-0845 exhibited superior growth performance across multiple parameters, including plant height, basal diameter, diameter at breast height (DBH) and volume, indicating its high potential for wood-based industries. These results underscore the importance of systematic clonal evaluation in the selection of superior genotypes for improved wood productivity and quality. The successful identification of promising mulberry clones paves the way for the implementation of organized plantation and agroforestry systems in India, addressing the growing demand for wood products while promoting sustainable practices. Future scope of this study should focus on the crop improvement of mulberry through plant breeding programme and their main aimed to improving the wood quality and productivity for sustainability of the pulp and paper industry.

Acknowledgement

The authors would like to thank the Central Sericultural Germplasm and Resources Centre (CSGRC), Hosur, TN, for providing the Morus genotypes and express their gratitude to Department of Sericulture, Forest College and Research Institute, Mettupalayam for providing research field.

Conflict of Interest

The authors declare no conflict of interest.

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