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**Research article**

# Screening of promising clones of *Gmelina arborea* Roxb. at gene bank with higher productivity: a multipurpose tree species

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**Abstract:** To study the screening of clone, 25 clones of *Gmelina arborea* were selected based on height, collar diameter, DBH, straightness of the stem and insect susceptibility from total seventy (70) numbers of clones. Among them, 25 numbers of clones were selected considering the above parameters. Selected clones shows the performance for the clone number GA017and GA39 is in the same position (height 22.13±0.64 m) as best performing best and GA106 and (height 21.45±0.86 m) is in second position and collar diameter GA017 (67.07±0.57 cm) and GA106 (68.30±0.48 cm) respectively. Wood density parameters of different clones at gene bank were estimated as minimum range of clone number GA044as fresh weight 0.65 gm, total length 4.10 cm, fresh volume 0.59 gm, dry weight 0.24 gm and the maximum range resulted in GA008 as fresh weight 1.27 gm, total length 7.77 cm, fresh volume 1.13 gm, dry weight 0.48 gm.

**Keywords:** Selected clone, Diameter at breast height (DBH), Collar diameter (CD), Height (Ht).

## INTRODUCTION

*Gmelina arborea* Roxb. is a tropical medium-sized tree that reaches up to 30-35 m in height and 3-4 m girth. It is a deciduous forest tree species under the family Verbenaceae. The species is fast-growing commonly known as *'white teak'* grown extensively in India for timber, fodder and industrial purposes. Species is distributed in South-East Asia and occur naturally throughout India, Nepal, Sikkim, Bangladesh, Sri Lanka, Myanmar, Thailand, Laos, Cambodia, Vietnam and the southern provinces of China. In India, it is naturally distributed in Assam, West Bengal to Orissa. The species was introduced in large tropical areas due to its well-known silvicultural techniques and wood quality produced by fast-growing trees that were managed in short rotation systems (Dvorak, 2003). The species is considered as useful multi-purpose tree species. Wood is used as raw material for cellulose (Foelkel *et al*., 1978), firewood (Lugo *et al*., 1988), polewood (Moya, 2004), particle board (Chew & Ong, 1989), veneer (Sicad, 1987) and structural uses (Gonzalez *et al*., 2004). It is cultivated commercially for timber such as furniture, pellets boxes, veneers, industrial wood etc. Timber wood is excellent for its durability, lack of shrinkage and distortion, smooth finish and for general construction, in making furniture, for agriculture implements, paneling, carriages, carpentry, boxes, pulp and plywood industries. Due to the presence of high protein content leaves are also used as green fodder. Hence, this multipurpose uses of the species has gained the attention of farmers, industries and forest departments for commercial cultivation in farmlands. The species has also gained stable acceptance as a plantation species for the source of pulp and fiber production and various farm and agro-forestry schemes (Doat, 1976). It was planted in different ecological locations under a wide variety of management regimes approximately 65 thousand hectares (Moya, 2004). It grows rapidly and can be harvested under short rotation, and is thus progressively becoming an alternative to the species harvested from natural forests (Alfaro & De-carmino, 2002). This species is also includes agroforestry or small-scale planting where the combination of good growth and high durability of the wood is important and makes it is an important alternative to eucalypts. The species comprises high medicinal value of leaf, flower, root bark and fruit are used in many ayurvedic preparations. Poor germination of seeds in *G. arborea* was reported by many authors due to unknown regions (Omoyiola, 1974; Hartman & Koster, 1975; Okoro, 1983).

Several programmes for genetic improvement of *Gmelina* have been initiated in many countries in India (Tewari, 1995) and several other researchers. Their experiences on the species is that it is easy to breed owing to its fast growth, early flowering for short breeding generations and good response to selection due to large phenotypic variation combined with high heritability etc. Selection is always based on yield and attributed traits results in higher expected response (Baker, 1986). Kumar *et al*. (2017) selected 58 most divergent plus trees of *Melia composite* Willd. out of 230 CPTs based on height, collar diameter, diameter at breast height, clear bole height, straightness, incidence of pests and

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diseases. Along with selection, wood density study was also done, which varies within the plant and between individuals of the same species.

As the species has immense value, the study of genetic variation for the selection of elite families for tree improvement programs is a most important phenomenon. Hence, research work on genetic improvement has been initiated by the Indian Council of Forestry Research & Education (ICFRE) through assembling divergent populations in the gene banks from different parts of the country and Rain Forest Research Institute, Assam during 2003 assembled different divergent populations by using various conventional methods in and the gene bank of the species as clonal seed orchard (CSO) and was established at Naharoni, Golaghat, Assam. These orchards age is 11-12 years and the inter-clonal variations offered possibilities for selecting superior clones for further planting at different locations to evaluate their performance to the specific site. So, this essential study was targeted to screen promising genotypes of *G. arborea* with higher productivity.

## MATERIALS AND METHODS

In the present investigation for screening of promising clones, clonal gene bank was evaluated. These clones were raised from selected candidate plus tree (CPT) of four (04) different geographical regions of the northeastern region and including West Bengal. They belong to different clusters and demonstrate that enough diversity within the region of selection. Total of seventy (70) numbers of clones were established under uniform conditions in the gene bank Naharani, Golaghat, Assam. The selection procedure involves several traits in the screening of progenies range of diversity to carry out through the index method of as described by Cotterill & Dean (1990). During this study, different traits of their growth parameters were studied height, collar diameter, diameter at breast height, straightness of the stem, insect susceptibility and resistance. At the time of study, the age of the trees is 10-11 years. Collected growth data were analysed for the average growth of different traits with the lowest and highest growth range among the clones and 25 numbers of clones were selected. Hence, the clones considered for the study were a huge number of seventy (70) recorded growth data arranged in descending order for further analysis. Two numbers of growth traits such as height (Ht) and collar diameter (CD) were considered for the selected 25 clones. Based on the above data evaluation those are performing well in terms of both traits, ten (10) best-performing clones were selected and the next selection was made among them and best seven (07) clones were calculated. Now, these data were considered for analyzing one-way Analysis of variance (ANOVA) as per Sukhmate & Amble (1989) and compared with respective CD value at 5% to find out the significant difference of different clones in different traits followed by the (Duncun, 1955) multiple range test ($p<0.05$) to find out the most superior clones. All the statistical analysis was performed by SPSS version 16.0.

To estimate the average specific gravity of different genotypes, wood samples were taken from clones of Naharani, Golaghat district, Assam (Fig. 1A). Samples were collected with an increment borer 16$^{//}$ Suuntoto extract a small cylindrical piece of wood of known diameter and the length of this piece is measured to calculate the volume of the sample. First mosses, aroids, and the outer bark of the tree were removed where the trunk will be covered at tree breast height.

Then unscrew the knob at the end of the handle and this is the extractor that holds the bit inside the handle. A rope was tied around the tree (Fig. 1B) and the threads have engaged then turn the handle and the bit will then proceed into the tree and try to core the tree slightly past the pith (center) of the stem. When the proper depth has been achieved then the bit out one full turn back and then insert the extractor into the hollow increment corer bit then the extractor to its full length has been inserted. Slowly withdraw the extractor from the increment handle to get beck an intact core (Fig. 1C). Then immediately placed the core into a plastic bag and seal the ends and marked it (Fig. 1D). The full wood core was placed into the water for ½ an hour to ensure adequate swelling. The water displacement method has been followed to measure the green volume of the wood core. The length of core has been measured with scale (Fig. 1E). A container capable of holding the sample is filled with water and placed on a digital balance of precision at least 0.01 g. The sample is then carefully sunk in the water, such that it is completely underwater. It is placed underwater with a thin needle (Fig. 1F). The measured weight of displaced water is equal to the sample’s volume. After 48 to 72 hours at regular intervals, these samples were weighed immediately after being taken out of the drying oven. Oven dry weight is measured from the same sample by drying it in a well-ventilated oven until it achieves constant weight. Collected data were analyzed for the lowest and highest range of mean among the different clones.

## RESULTS

Success of genetic improvement program depends on the existence of variability in the base population. By selecting superior performers with proper selection methodology, significant improvement in various traits was achieved in several forest tree species (Gurumurthi *et al.*, 1991). Clones were considered for this study, minimum and maximum ranges of growth data are presented in table 1. Data were one way ANOVA (Table 2) followed by the


**Figure 1.** Collection and measurement of wood core from selected clones of *Gmelina arborea* Roxb.: **A**, A view of clonal plantation at Naharoni, Golaghat, Assam; **B**, Rope tied around the tree; **C**, Wood core on the extractor; **D**, Wood core kept into the plastic bag and seal the ends; **E**, Length measurement of wood core sample; **F**, Density measurement of wood core sample.

**Table 1.** Average ranges ± SD for different growth traits of *Gmelina arborea* Roxb. clones.

| Range | Height (m) | CD (cm) | DBH (cm) | Straightness |
|---|---|---|---|---|
| Minimum | 5.33±0.13 (GA115)* | 31.67±0.74 (GA115) | 22.44±0.47 (GA115) | 1.44±0.12 (GA115) |
| Maximum | 22.13±0.57 (GA17) | 68.30±0.44 (GA106) | 59.77±0.26 (GA106) | 3.62±0.23 (GA006) |

**Note:** * Parenthesis indicated the clone number

**Table 2.** One-way ANOVA analysis of selected seven (07) numbers of clones of *Gmelina arborea* Roxb. on the basis of growth data of height and collar diameter.

| | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| Height | Between Groups | 96.813 | 6 | 16.135 | 30.372 | 0.000 |
| | Within Groups | 14.875 | 28 | 0.531 | | |
| | Total | 111.688 | 34 | | | |
| CD | Between Groups | 180.856 | 6 | 30.143 | 50.385 | 0.000 |
| | Within Groups | 16.153 | 27 | 0.598 | | |
| | Total | 197.009 | 33 | | | |

(Duncun, 1955) multiple range test ($p<0.05$) to find out the most superior clones (Table 3). Results shows at this age, taller height and the largest collar diameter in the clone number.

**Table 3.** Critical difference/LSD of top selected clones of total clones of *Gmelina arborea* Roxb.

| Clone No. | Height (Mean ± SD) | Collar Diameter (Mean ± SD) |
|---|---|---|
| GA011 | 18.80 ± 0.74[a] | 60.80 ± 0.67[a] |
| **GA017** | **22.13 ± 0.64[b]** | **67.07 ± 0.57[d]** |
| GA027 | 18.33 ± 0.40[a] | 65.33 ± 0.89[c] |
| GA039 | 22.13 ± 0.94[b] | 63.93 ± 0.56[b] |
| GA096 | 18.20 ± 0.69[a] | 65.61 ± 0.50[c] |
| GA099 | 19.15 ± 0.67[a] | 66.67 ± 1.30[d] |
| **GA106** | **21.45 ± 0.86[b]** | **68.30 ± 0.48[e]** |

**Note:** Mean ±SD; Duncun multiple range test.

GA106 and GA017 are performing best among the total clone. Due to the homogenous environment at the site, there were no large differences among the means. As well as the result of the wood density of the selected clones was recorded with fresh weight (FW) ranges from lowest 0.65 gm in (GA44) and highest 1.27 gm in (GA27 and GA008) comparing the mean fresh weight 1.01. Total length (TL) ranges from lowest 4.1 cm in highest 7.77 cm comparing the mean length 6.17 cm. Fresh volume (FV) was recorded minimum 0.59 gm to maximum 1.13 gm. The mean volume was 0.90 gm. Dry weight (DW) ranges from the lowest 0.24 gm to the highest 0.48 gm higher than the grand mean value 0.37. Data is represented in table 4.

**Table 4.** Wood density parameters of different clones of *Gmelina arborea* Roxb. at Gene bank, Naharani, Golaghat, Assam.

| Range | Fresh weight (gm) | Total length (cm) | Fresh volume (gm) | Dry weight (gm) |
|---|---|---|---|---|
| Minimum (GA044)* | 0.65 | 4.10 | 0.59 | 0.24 |
| Maximum (GA008) | 1.27 | 7.77 | 1.13 | 0.48 |

**Note:*** Parenthesis indicated the clone number

## DISCUSSION

Estimated variations in the attributes for the present study are height growth, collar diameter, DBH, and branching behavior which are used to calculate genetic control for a particular character. Information on the genetic structure and diversity of candidate plus trees provide the basis for planning efficient utilization of genetic resources to realize potentiality for maximizing growth and yield. In the present study, variations was observed in all the growth parameters at the age of 10-11 years the clones where, GA017 and GA039 were recorded with the same height in first position and GA106 was recorded performing second position. A similar result was reported also by Kumar, 2007 where, in his study, he placed clone GA106 in the 1$^{st}$ rank at the age of 24 months and the experiment was conducted under the same environment. In the case of collar diameter of different clone GA106 performed best and the second is GA017. Results are in comparison to mean value representing high degree of variation. Similar study was reported by Kumar *et al*. (2017) where, he selected 58 most divergent plus trees of *Melia composita* Benth. out of 230 CPTs based on height, collar diameter, diameter at breast height, straightness, the incidence of pests and diseases. Lambeth *et al.* (1994) was also reported a similar type of study of plus tree *Eucalyptus grandis* W.Hill on different growth character and select superior 65 numbers of clones out of 460 clones. In *Eucalyptus* and *Quercus*, the environmental variations appear to be overshadowed by genetic diversity (Purkaystha *et al*., 1973). The diversity of different forest tree species has been studied by several researchers such as Bruschi *et al*. (2003) in Italian populations of *Quercus petraea* (Matt.) Liebl., Anand *et al.* (2005) and Kaushik *et al*. (2007) etc. In the case of wood density of *Gmelina* varies from 350 to 535 kg $m^{-3}$ (Kasmudjo, 1990), which puts it in the right weight category for very many uses. Unlike pines, fast growth has not been thought to change the density of *Gmelina* wood appreciably with the inference that the species is ideal for rapid production of large quantities of stable utility timber (Hughes &Esan, 1969). Several studies have reported the variability of wood density and fibre dimensions in *Gmelina arborea* within and between the tree (Hughes & Esan, 1969; Zeeuw & Gray, 1972; Tang & Seng, 1982; Akachuku, 1985; Ohbayashi & Shiokura, 1989; Alipon, 1991; Akachuku & Burley, 1997; Moya, 2004).

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