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# Provenance variation study in *Acacia mangium* Willd. In Odisha

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**Abstract**
A good provenance is needed for production of quality planting material for better establishment of plantation and to get higher return in short period. The identification of a good provenance is very important before raising any plantation. Genetic improvement of the planting stock through evaluation trial can play a very significant role in improving production, productivity, quality of produce and profitability. However very less work is done in Odisha for the production of genetically superior planting material in *Acacia mangium*. So the present experiment was conducted during 2017-2018 to screen superior provenance for seed production. For this purpose observation was taken on plantation of nine different provenances of India from which seeds were collected and laid out in RBD with 4 replications each. Observations on seven different characters *viz;* plant height, collar diameter, crown spread, no. of branches, leaf area, leaf length and leaf width were recorded after 21 months of planting. The results revealed significant differences among the nine provenances and among the characters studied. The provenance T-3 recorded maximum height (6.60 m) and collar diameter (8.08 cm) and minimum value was recorded for T-9 i.e. 4.09 m for plant height, 3.93 cm for collar diameter. The maximum crown spread was found in T1 (2.93 m) and minimum in T6 (1.77 m) for crown spread. In case of no. of branches T-3 had lowest no. of branches. Leaf area was recorded maximum for T-1 (84.95 cm2) and minimum for T-6 (66.58 cm2). Leaf length was maximum for T-9 (19.57 cm) but T-3 recorded maximum value for leaf width (6.22 cm). There was significant positive correlation of plant height with collar diameter, crown spread, no. of branches, leaf width; Collar diameter with crown spread, no. of branches and leaf area; Crown spread with no. of primary branches and leaf width; Leaf area with leaf length and leaf width. There was significant negative correlation between height with leaf length; No. of branches with leaf area, leaf length and leaf width; and Leaf length with leaf width. T3 was found to be a superior provenance with respect to morphological characters among all the provenances studied.

**Keywords:** Provenance, variation, morphological character, correlation, *Acacia mangium*

## Introduction
The original geographical region showing greater diversity from where seeds and plants are collected is known as a provenance. It may refer either to native or exotic trees growing at that place, but its common use is in reference to native trees. Provenances are genetically divergent populations in a species formed in a specific geographic area in response to environmental conditions. Provenance research has importance in planned breeding of hybrids between species, and must be directed towards breeding of a hybrid combination of provenances having the highest adaptation and productivity. Combining different provenances often combine desirable characters of different races and may result in hybrid vigour for many characters. Many genetically distinct populations are developed due to interaction with its local microclimate, so testing of these population for planting in a particular site is the essence of provenance testing.

*Acacia mangium* belongs to family "Fabaceae" and subfamily "Mimosoideae". It is a single-stemmed evergreen tree that grows to 25-35m in height and dbh of more than 60 cm. *Acacia mangium* is a species of the humid, tropical lowland zones. It tolerates pH level between 4.5 and 6.5. It occurs behind mangroves in seasonal swamps, along streams and on well-drained flats, low ridges and mountain foothills (Pinyopusarerk *et al.* 1993) [10].

*Acacia mangium* is well adapted to a wide range of soils and grows rapidly in sites with low levels of soil nutrients even on acidic soils and degraded sites (National Research Council, 1983) [7]. It performs well on lateritic soils i.e. soils with high amounts of iron and aluminium oxides (Ostamo, 2002) [9]. It is capable of producing mean annual volume increment of 40 m3 ha-1 yr-1 to 46 m3 ha-1 yr-1 (Khasa *et al.*, 1995) [3]. It reaches maximum MAI in volume at 6 to 9 years depending upon the site quality (Mead and Miller,1991) [6]. It is primarily used for pulpwood and commercial production of veneer.

The utility of *A. mangium* as a timber species is increasing all over the world primarily for furniture, plywood, poles, tool handles and agricultural implements. The timber properties improve gradually with maturity (14-15 years).The wood of *A.mangium* is used as fuelwood and the leaves can serve as forage for livestock. The sawdust provides good-quality substrate for edible mushrooms (Lemmens *et al.*, 1995) [4]. The trees are useful for shade, ornamental purposes, screening, boundaries and windbreaks, they are also used in agroforestry and erosion control. Many farmers choose to plant the species to improve soil fertility of fallowed field or pastures. They can also fix atmospheric nitrogen and produce a rich harvest of litter, which increases soil biological activity and rehabilitates the physical and chemical properties of the soil (Otsamo *et al.*, 1995) [8]. Therefore they can be used for reclamation of waste and degraded sites where readily available minerals are deficient (Awang and Taylor, 1993) [1]. They grow well in acidic soil (Turnbull *et al.*, 1997) [12] as well as tolerate extended drought (Midgley and Vivekanandan,1987) making it suitable for tropical areas where acidic soil is widespread and in region where long dry season prevails. This make the species ideal for adoption in plantation program in India where most of the plantation program is being established outside forest reserves mostly in wastelands.

In Odisha 70% of soil are acidic in nature and requires soil reclamation before carrying out any plantation programmes. The physiology of *Acacia mangium* indicates that it can acclimatize varied soil environment. Many industries in Odisha have planted *Acacia mangium* in mined out soil and in waste area management. Despite of its importance and demand of *Acacia mangium*, there is unavailability of quality planting materials for establishing plantations. Although many studies have been conducted by various institutes on a few growth parameters but practically, no information is available on the superiority of *A. mangium* sources in terms of various properties *viz*. growth attributes, wood quality, utility as pulp and paper wood, etc., as well as no information on variability among provenances. Hence, tree improvement initiatives are of paramount important for establishing plantation of superior quality planting materials. Therefore, to cater the need for better understanding of the variation that exists among the provenances of *A.mangium*, the present experiment had been carried out with the objective of to study about the growth performance of different provenances, to study about the pattern of variation among different provenances and to select the best provenance to obtain planting materials for future tree improvement programmes.

## Materials and Methods

The experiment was carried out in the College of Forestry, OUAT, Bhubaneswar, Odisha during 2017-2018. The experimental site was situated in the OUAT agroforestry field. The seeds of *Acacia mangium* were collected from nine different provenances, six from Odisha and one each from Karnataka, Kerala and Assam for the study. Ten representative trees in the natural stand were selected which were at least 100 meter apart from each other. Superior candidate plus trees were identified based on the superior morphological characters using Comparison Check Tree Method developed by Zobel and Talbert (1984) [13].

a) Height
b) Girth at breast height
c) Crown width

Seeds from nine different provenances were collected during March-April. Seedlings were planted in the main field using Randomized Block Design with 4 replication. The plants were planted with a spacing of 2.5m X 2.5m. The trial was planted on the month July – August, 2016. All the intercultural operations like hoeing, irrigation, weeding and inter cultural operations were done in time in order to minimise the mortality.

Observations with respect to seven characters i.e, plant height, collar diameter, no. of branches/ plant, length of leaf, width of leaf, leaf area and crown spread were recorded at 21 months after planting and were used for analysis through statistical parameters.(mean, coefficient of variation, analysis of variance).

**Table 1:** Experimental details of the trial

| Sl.no | Name of Provenance | Replication | No. of trees per Replication | Accession no. |
|---|---|---|---|---|
| 01. | Bhubaneswar, Odisha | 04 | 05 | T-1 |
| 02. | Balia, Chandikhol, Odisha | 04 | 05 | T-2 |
| 03. | Villigram, Gop, Odisha | 04 | 05 | T-3 |
| 04. | Haripur, Pipli, Odisha | 04 | 05 | T-4 |
| 05. | Bhuan, Puri, Odisha | 04 | 05 | T-5 |
| 06. | Tirthathali, Odisha | 04 | 05 | T-6 |
| 07. | Dharwad, Karnataka | 04 | 05 | T-7 |
| 08. | Thrissur, Kerala | 04 | 05 | T-8 |
| 09. | Kahikuchi, Assam | 04 | 05 | T-9 |

## Results

Observations of morphological parameters were taken at 21 months after planting of *Acacia mangium*. The details of recording were given as follows-

**Table 2:** Morphological parameters of *Acacia mangium* at 21 months after planting

| Treatment no. | Plant Height (m) | Collar diameter (cm) | Crown Spread (m) | Number of branches | Leaf Length(cm) | Leaf Width(cm) | Leaf Area ($cm^2$) |
|---|---|---|---|---|---|---|---|
| T1 | 6.008 | 7.088 | 2.930 | 8.018 | 18.993 | 6.118 | 84.958 |
| T2 | 5.328 | 5.970 | 2.280 | 6.568 | 19.000 | 4.980 | 83.430 |
| T3 | 6.600 | 8.088 | 2.735 | 5.843 | 18.820 | 6.220 | 83.653 |
| T4 | 4.563 | 4.890 | 2.093 | 8.010 | 18.823 | 4.378 | 76.020 |
| T5 | 6.128 | 7.835 | 2.540 | 8.880 | 18.970 | 5.533 | 80.390 |
| T6 | 5.263 | 4.828 | 1.770 | 7.570 | 19.100 | 5.260 | 66.580 |
| T7 | 5.220 | 5.980 | 2.523 | 7.163 | 19.385 | 3.955 | 76.358 |
| T8 | 5.195 | 5.663 | 2.330 | 7.968 | 17.423 | 5.860 | 80.115 |
| T9 | 4.090 | 3.930 | 1.788 | 6.510 | 19.570 | 5.450 | 73.120 |
| Mean | 5.377 | 6.030 | 2.332 | 7.392 | 18.898 | 5.306 | 78.291 |
| SE | 0.328 | 0.560 | 0.173 | 0.560 | 0.209 | 0.483 | 3.551 |
| CD 5% | 0.963 | 1.643 | 0.508 | 1.644 | 0.614 | 1.419 | 10.426 |

Plant height: T-3 exhibited maximum height (6.600 m) which was statistically at par with T-1 (6.008 m) and T5 (6.128 m), while T-9 (4.090 m) recorded minimum height which was statistically at par with T-4 (4.563 m).
Collar diameter: After 21 month of planting T-3 exhibited maximum collar diameter (8.008 cm) which was statistically at par with T-1 (7.088 cm) and T5 (7.835 cm), while T9 (3.930 cm) was recorded with minimum collar diameter growth which statistically at par with T-4 (4.890 cm) and T6 (4.828 cm).
Crown spread: T-1 exhibited maximum crown spread growth (2.930 m) which was statistically at par with T-3 (2.735 m), T-5 (2.540 m), while T-6 recorded with minimum (1.770 m) crown spread growth which was statistically at par with T-4 (2.093 m) and T-9 (1.788 m).
Number of branches: T-5 exhibited maximum (8.880 nos) number of primary branches which was statistically at par with T-1 (8.018 nos), T-4 (8.010 nos), while T-3 was recorded with minimum (5.843 nos) number of branches.
Leaf length: Significant difference was observed in leaf length among different provenance. The provenance T-9 was found with maximum (19.57 cm) leaf length which was statistically at par with T-1 (18.993 cm), T-6 (19.100 cm), T-7 (19.385 cm), while T-8 (17.423 cm) was found to have the minimum leaf length.
Leaf Width: There was significant difference in leaf width among the provenances. The T-3 provenance recorded the maximum (6.220 cm) leaf width which was statistically at par with T-1 (6.118 cm), T2 (4.980 cm), T5 (5.533 cm), while T7 recorded lowest size of leaf width (3.955 cm) which was statistically at par with T2 (4.980 cm) and T4 (4.378).
Leaf Area: Significant variation was observed in the leaf area among different provenances. The provenance T-1 found with maximum (84.958 $cm^2$) leaf area which was statistically at par with other treatments except T-6 and T-9. T-6 recorded with minimum leaf area of 66.580 $cm^2$ which was statistically at par with T-9 (73.120 $cm^2$).

**Table 3:** Phenotypic correlation among morphological characters at 21 months of planting

| Sl no. | 1. | 2. | 3. | 4. | 5. | 6. | 7. |
|---|---|---|---|---|---|---|---|
| 1. | 1 | | | | | | |
| 2. | 0.608* | 1 | | | | | |
| 3. | 0.487** | 0.510** | 1 | | | | |
| 4. | 0.018** | 0.045* | 0.047** | 1 | | | |
| 5. | 0.318 | 0.369** | 0.414 | -0.021* | 1 | | |
| 6. | -0.109* | -0.090 | -0.104* | -0.157** | 0.154* | 1 | |
| 7. | 0.274** | 0.220 | 0.162** | -0.027* | 0.168* | -0.184** | 1 |

*indicates significant correlation at 5% level of significance and ** indicates significant correlation at 1% level of significance
1-Plant height, 2-collar diameter, 3-crown spread, 4-No. of primary branches, 5-Leaf area, 6- Leaf length, 7-Leaf width

The plant height showed significant and positive correlation with collar diameter (0.608*), crown spread (0.487**), no. of branches (0.018**), and leaf width (0.274**). Height was significant and negatively correlated with leaf length (-0.109*). Collar diameter had shown significant and positive correlation with crown spread (0.510**), no. of branches (0.045*) and leaf area (0.369**). Crown spread showed significant and positive correlation with no. of primary branches (0.047**) and leaf width (0.0.162**). No. of branches had shown significant and negative correlation with leaf area (-0.021*), leaf length (-0.157**) and leaf width (-0.027*). Leaf area showed significant and positive correlation with leaf length (0.154*) and leaf width (0.168*). Leaf length showed significant and negative correlation with leaf width (-0.184**).

## Discussion

*Acacia mangium* being a fast growing multipurpose tree can meet the various needs of the people and due to its physiological and morphological characteristics. This demanded holistic and systematic tree improvement programme through selection and evaluation. Significant differences were observed for various traits such as plant height, collar diameter, number of primary branches, crown spread, leaf length, leaf width and leaf area. Among the provenances examined T-3 and T-1 found superior in most of the traits *viz*., plant height, collar diameter, number of primary branches, crown spread, leaf length, leaf width and leaf area. This superiority might have arisen due to the variation in genetic makeup of the candidate plus trees and difference in climatic and edaphic conditions. Many researcher and workers have reported the existence of significant differences and superiority of few candidate plus trees and provenances in tree species like *Albizia lebbek* (Thakur and Dhupe, 2015) [11].
Among the parameters the plant height was found to be significantly and positively correlated with collar diameter, no. of branches, crown spread and leaf area. Height and diameter were found to be positively correlated with crown spread and no. of branches which might be due to more photosynthetic surface due to more number of leaves. Buba (2012) [2] revealed significant positive correlations between stem diameter, tree height, crown height and crown diameter in *Parkia biglobosa*.. Crown spread depends upon no. of branches, the more the number of branches the more the crown spread. Leaf area was positively correlated with leaf length and leaf width. The strong phenotypic correlation coefficients between various characters revealed that there might be strong magnitude of correlation coefficient at genotypic level. The phenotypic correlation indicates there was a strong inherent association among these characters. This corroborates the results of Lokmal (1994) [5] in teak.
The performance of different treatments with respect to different morphometric traits was observed to be consistent with respect to time. Significant differences were marked at different timings among the treatments. The order of performance of treatments with respect to time pool analysis was as follows:

T-3 > T-5 > T-1 > T-2 > T-4 > T-6 > T-7 > T-8 > T-9

## Conclusion

*Acacia mangium* is of great demand and has great potential in tree improvement programs because of its fast growing nature, multipurpose use, wide adaptability in different environmental conditions. Different morphometric traits such as plant height, collar diameter, crown spread, no. of branches, leaf area, leaf length and leaf width were recorded. The collected data were subjected to Analysis of Variance (ANOVA). Based on the present investigation it was found that the provenance T-3 performed better phenotypically in height, collar diameter, crown spread and no. of branches. The genetic potential of this provenance needs to be assessed for production of quality planting material.

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