Growth of *manglid* (*Manglietia glauca* Bl.) from three provenances until age 4.5 years at Candiroto Temanggung
Central Java

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**Abstract.** This study was carried to examine the best provenance of seed source of *Manglietia glauca* at 4.5 years old. The study was conducted in Candiroto, Temanggung, Central Java. A Randomized Complete Block Design with three provenances consisting of 15 parent trees from Tasikmalaya, ten parent trees from Sumedang, and 75 parent trees from Sukabumi, West Java, were divided into ten replications. Each replication has 100 plots, and each plot consists of four plants with a planting distance is 4 m x 3m. The plant characteristics, including height and stem diameter, were measured at the age of 0.5, 1.5, 2.5, 3.5 and 4.5 years. Variant analysis and Duncan Multiple Range Test in each measurement stage were performed. The significant differences of plant height among provenances were found from 0.5 to 3.5 years old and were not significantly different afterward. The stem diameter differs significantly among the provenances at 1.5 years old only; afterward, they were not significantly different. The average plant height and stem diameter at 4.5 years old were between 864-917 cm and 12.34-12.48 cm, and they were not significantly different. Therefore, it is possible to choose any seed sources of the three provenances of manglid to be used for plantation.

1. Introduction

*Manglid* (*Manglietia glauca Bl.*) is one of the indigenous species from Indonesia. The natural distribution of Manglid is in Sumatra, Java, Bali, Lombok, and Sulawesi Islands. Nowadays, Manglid is quite difficult to find in its natural habitat, which mainly exists at the altitude of 900 m to 1700 m above sea level in a humid and fertile mixed forest. The Manglid tree has a straight stem, yellow flower, and rcalcitrant seed [1]. In Situ Gunung Sukabumi, which was one of the natural habitats of Manglid, the abundance of this species was 1.2, which means it was classified as rare[2]. Therefore, this species needs to be preserved for its existence since it has an economic value. In addition, Manglid is classified as fast-growing tree species with a cycle of less than ten years [3].
Manglid wood can be used as a raw material for making bridges, household appliances, tables, chairs, cabinets, house buildings, doors, wooden boards, and plywood. Manglid wood is classified in the 3rd strength class and the 2nd durable class with the properties: glossy, smooth, lightweight, solid structure, and easy to work with [4]. The local community is interested in planting manglid because of the plant and the wood properties. In most cases, the local community plants manglid in the scheme of community forest [5].

In order to get valid information on the plant growth of manglid seed source, it is necessary to perform a planting trial of manglid which the seeds derived from some provenances. Therefore, the purpose of this study

2. Materials and Methods

2.1. Time and place of the research
Manglid seed source plantation was established at Candiroto, Temanggung, Central Java, in April 2016. The seeds are derived from several provenances, including Tasikmalaya, Sumedang, and Sukabumi, West Java Province [6]. The measurement of plant growth was done five times, namely at the age of 0.5, 1.5, 2.5, 3.5, and 4.5 years. The manglid seed source plantation site was at an altitude of 457-464 m above sea level with soil type of latosol [7].

2.2. Materials and tools
The tools consist of a pole stick, digital caliper to measure the diameter at breast height (DBH), tally sheet, design map of seedlings seed orchard, fieldnotes, and stationeries. The research materials including manglid seedling seed orchard for progeny test.

2.2.1. Research design. The research design in the field used Randomized Complete Block Design (RCBD) with 100 parent trees of manglid derived from Tasikmalaya provenances (15 parent trees), Sumedang provenances (10), and Sukabumi provenances (75). The provenances were divided into ten replications, each replication had 100 plots and each plot consisted of 4 plants; the planting distance was 4 m x 3 m. The measured plant growth characteristics were total height and stem diameter. The measurement of trees' total height was carried out from the ground level to the end of the growing point of the main axis. The stem diameter was measured at breast height which was approximately about 130 cm above the ground level.

2.2.2. Data analysis. The measurement data of plant height and stem diameter were analyzed using variance analysis to determine the effect of several provenances on the plant growth characteristics. If there is a significant difference, it will be continued to Duncan's Multiple Range Test (DMRT).

3. Results and Discussion

3.1. Result
The results of variance analysis of plant height and stem diameter can be seen in Table 1. DMRT test was performed because there is a significantly different from the results of variant analysis for plant height and stem diameter, as shown in Table 2. The graph of plant height and stem diameter can be seen in Figure 1 and Figure 2.
Table 1. Variance analysis of plant height and stem diameter of manglid trees from three provenances.

| Age            | Sources of variations | df | Height Mean Square | df | Diameter Mean Square |
|----------------|-----------------------|----|--------------------|----|----------------------|
| 0.5 years old  | Provenance            | 2  | 38887.7175**       | -  | -                    |
|                | Error                 | 1685 | 17299.67          |    |                      |
|                | Corrected total       | 2784 | 38887.7175**       | -  | -                    |
| 1.5 years old  | Provenance            | 2  | 60820.969**        | 2  | 9.8504440**          |
|                | Error                 | 2366 | 4393.81           | 2240 | 1.467457           |
|                | Corrected total       | 2465 | 38887.7175**       | 2240 | 1.467457           |
| 2.5 years old  | Provenance            | 2  | 129954.198**       | 2  | 10.784324           |
|                | Error                 | 2365 | 10604.42          | 2337 | 4.48279            |
|                | Corrected total       | 2464 | 38887.7175**       | 2337 | 4.48279            |
| 3.5 years old  | Provenance            | 2  | 133507.604**       | 2  | 19.357953           |
|                | Error                 | 1958 | 21126.19          | 1956 | 12.72046           |
|                | Corrected total       | 2057 | 38887.7175**       | 1956 | 12.72046           |
| 4.5 years old  | Provenance            | 2  | 251720.89          | 2  | 4.01844             |
|                | Error                 | 1622 | 101894.0          | 1623 | 98.6995            |
|                | Corrected total       | 1685 | 38887.7175**       | 1623 | 98.6995            |

**Significantly different at 0.01

Table 2. Effect of the provenances on the average height and stem diameter growth of Manglietia glauca at the age of 0.5 to 4.5 years.

| Variable | Provenance | 0.5 | 1.5 | 2.5 | 3.5 | 4.5 |
|----------|------------|-----|-----|-----|-----|-----|
| Height (cm) | Tasikmalaya  | 85.10\textsuperscript{b} | 254.36\textsuperscript{a} | 401.19\textsuperscript{b} | 578.74\textsuperscript{b} | 888.8\textsuperscript{a} |
|           | Sumedang    | 90.51\textsuperscript{a} | 259.28\textsuperscript{a} | 418.39\textsuperscript{a} | 609.98\textsuperscript{a} | 916.8\textsuperscript{a} |
|           | Sukabumi    | 76.03\textsuperscript{c} | 241.15\textsuperscript{b} | 389.94\textsuperscript{b} | 571.84\textsuperscript{b} | 864.3\textsuperscript{a} |
|           | Average     | 79.12 | 245.43 | 395.0 | 576.72 | 873.3 |
| Diameter (cm) | Tasikmalaya | 2.78\textsuperscript{b} | 5.91\textsuperscript{a} | 9.10\textsuperscript{a} | 12.34\textsuperscript{a} | 12.34\textsuperscript{a} |
|            | Sumedang    | 3.01\textsuperscript{a} | 6.15\textsuperscript{a} | 9.66\textsuperscript{a} | 12.39\textsuperscript{a} | 12.39\textsuperscript{a} |
|            | Sukabumi    | 2.72\textsuperscript{b} | 5.95\textsuperscript{a} | 9.37\textsuperscript{a} | 12.48\textsuperscript{a} | 12.48\textsuperscript{a} |
|            | Average     | 2.76 | 5.96 | 9.36 | 12.44 | 12.44 |

Remark: Numbers followed by the same letters in the same column are not significantly different at 0.01 according to Duncan's Multiple Range Test.
The results of variant analysis of plant height from the age of 0.5 years to the age of 3.5 years showed a significant difference. However, at the age of 4.5 years, there was no significant difference at 0.01. Therefore, according to the data, the best provenance for plant height characteristics is Sumedang, followed by Tasikmalaya, then Sukabumi provenance.

The result of variant analysis of stem diameter characteristics is significantly different at the age of 1.5 years, with a value ranging from 2.72 to 3.01 cm and an average of 2.76 cm. After that, the results showed that there is no significant difference.

3.2. Discussion

3.2.1. Height of plants. The height of plants at the age of 0.5 years to 3.5 years from different provenances showed significant differences, where Sumedang's provenance revealed the highest
height growth. At the age of 4.5 years, there is no significant difference in the height of the plants. However, the Sumedang provenance was the best provenance for height growth until 4.5 years old. The plant provenances affect height growth from the beginning of its augmentation. The tropical plant species generally have a widespread with different genetic characteristics among the provenances where each individual tends to do the differentiation [8]. The research on Merbau plants showed the same thing: the differentiation of provenance causes differences in plant height growth [9]. The diversity among provenances is caused by the geographical conditions in the site characteristics such as soil type, rainfall, altitude, and the association with other plants in the different populations [10, 6]. Figure 1 shows that the highest increase in height growth occurred from year 3.5 to year 4.5 where it is shown by the rather more vertical graph line. The growth of the height is affected by various aspects such as altitude. In Vietnam, the most suitable site altitude for manglid is 550 m above sea level. Then, nitrogen and phosphorus nutrient content affects the height growth of the plants [11]. In addition, the height growth of manglid was influenced by the planting distance [12].

3.2.2. Stem diameter. The variant analysis of stem diameter of the manglid stand showed a significant difference at the age of 1.5 years only, where the diameter growth of Sumedang provenance was significantly larger than the other provenances. This means that the Sumedang seed source is more suitable for the experimental site. The large diameter indicates the big root system and stem volume [13]. The larger the stem diameter, the more nutrients and water are transported by the xylem [14]. Research by [15] on the growth of manglid at four months old in Trenggalek, East Java, indicated that the Sumedang provenance has the biggest stem diameter growth, which affects height growth. After that, at the age of 2.5 years up to 4.5 years, stem diameter growth did not show a significant difference among provenances. According to [10], a similar condition happened on the growth of Merbau plants because the genetic distance among provenances is relatively small since they came from the same population in West Java. It means that there is a close kinship among provenances so that the growth of the manglid stem diameter was not significantly different in one population or among the provenances.

4. Conclusion
There was no significant difference in plant height among provenances of Manglietia glauca at the end of the study, i.e., at 4.5 years old. The significant difference occurred from the beginning of the plant growth until the plants were 3.5 years old, where the Sumedang provenance has the highest height growth. Similar to the stem diameter growth, there was no gap among the provenances at the end of the study. While at the beginning growth of the plant, namely at 1.5 years old, a significant difference of stem diameter occurred, where Sumedang provenance also has the largest stem diameter. Although there was no significant difference among the provenances on the growth of height and stem diameter at the end of the study, in general, the Sumedang provenance performed better since it showed the best growth from the beginning. It happened because the seed that came from West Java provenances has a high kinship. Therefore, it is possible to choose any seed sources of three provenances of manglid to be used for plantation.

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Author’s contribution
All authors contributed equally to this work as the main contributor.