Vegetative propagation with branch cuttings as a solution for the mass development of giant atter species (Gigantochloa atter (Hassk) Kurz) in industrial plantations

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Abstract. Giant atter species (Gigantochloa atter (Hassk) Kurz) is one of the non-timber forest products that is currently widely used by the community in various needs, including: conservation plants, buffer zone plants, home building construction materials, and for handicraft materials. However, the large number of uses of this bamboo as raw material is not balanced with efforts to preserve and develop it through cultivation, causing the giant atter declining in nature. Therefore, the multiplication technique using branch cuttings is one of the important choices for mass development of the bamboo in the future. This study aims to determine the effect of the position of branch cuttings on bamboo stems and the concentration of hormones that can provide the best growth in the field. The treatment consists of two factors as follows: the first factor is the position of branch cuttings on the stem, namely: the base, the middle part, and the tip of the bamboo stem. The branch cuttings were lubricated with growtone hormone with a dose variation of 15 mg, 30 mg, 45 mg, and 60 mg for each branch cuttings. The results showed that the development of giant atter in a large quantities, branch cuttings can be used from all parts of the bamboo stem as plant material, and a dose of growtone hormone as much as 30 mg gives a good ability to grow in the field. The impact of this study is expected to be a guideline for policy makers in the Department of Forestry in the context of mass development of bamboo through vegetative cultivation.

1. Introduction
The Bamboo is an important non-timber forest product and is currently widely used by the community in various needs. Bamboo plants can be used as conservation plants and buffer plants, and the trunks can be used in a variety of purposes such as building houses, souvinier, handicraft materials, and other physical building construction [1,2].

In addition, the bamboo shoots are very much needed as food ingredients at very high prices both domestically and abroad. One bamboo species that is very widely used by people on various needs is Parring Bamboo (Gigantochloa atter (Hassk) Kurz) or also called giant atter or sweet bamboo [3,4].

The types of bamboo that are widely used in Indonesia are betung bamboo, bamboo atter, bamboo andong, and black bamboo [5]. Bamboo is a fiber-rooted plant that is able to hold soil grains so that it can withstand erosion both on river banks and other slope sites [6].
Bamboo plants have the ability to maintain environmental balance because the root system can regulate water circulation and can grow on marginal land [7,8].

Until now bamboo exploitation is very much done but it is not balanced with efforts to mass propagation. The use of bamboo as raw material is not balanced with its preservation efforts. The development of bamboo cultivation is rarely carried out causing bamboo stands to become increasingly reduced.

The method of propagation that is often carried out so far is through rhizomes or humps by dismantling the clumps so that they have to cut down and damage the bamboo clumps [9]. This method requires a lot of time and money when developing in large quantities. Therefore, the multiplication technique using branch cuttings is one of the important choices for the development of the mass of bamboo in the future [10].

The use of branch cuttings can produce more seeds because there are many branches in the stem sections. The growtone hormone, which is part of the Rootone-F hormone, is a synthesis hormone with the active ingredient included in the group of auxin, which is basically used to speed up the physiology process of plants for root formation [11].

In this study, propagation by branch cuttings was stimulated using Growtone growth hormone to accelerate the growth of roots and shoots in the early stages.

2. Research methods
This research was conducted at the Faculty of Forestry's nursery, Hasanuddin University, Makassar, South Sulawesi from September to December 2018. The planting media used for rooting cuttings is a mixture of top soil, sand and manure with a ratio of 1: 1: 1 in volume size (dm³). Before being inserted into a polybag, the media is sprayed with Benslate Fungicide to prevent the fungus attack.

Cuttings are obtained from branches on bamboo stems. Collecting cuttings is done by knife and sawing parts of the knot where branches appear on the stem with uniform cuttings that have 2 segments.

Growtone hormone is given by applying it to the bottom of the cuttings according to the specified concentration. Because growtone is in powder form, it is then mixed with distilled water first to form a paste and then applied to the base of the bamboo branch. Branch cuttings that have been covered with Growtone hormones are put into a polybag of 20 cm x 30 cm in sizes.

Maintenance during the study was carried out by watering twice daily with the same amount of water. The measurement of research variables was carried out once every week for shoot height, leaf number, and number of shoots while for root volume measured at the end of the study.

The treatment variable of this study consisted of 2 factors: The first factor is the position of the branch consisting of 3 levels, namely: C1 (branch cuttings at the base of the stem); C2 (branch cuttings in the middle of the stem); C3 (branch cuttings at the end of the stem).

The second factor is the dose of growtone hormone which consists of 4 levels, namely: G1 (15 mg per cuttings); G2 (30 mg per cuttings); G3 (45 mg per cuttings); and G4 (60 mg per cuttings). Both of these factors (origin of cuttings: 3) and (dosage of hormones: 4) are combined to get 12 treatment combinations. Each treatment combination was repeated 10 times so that the total parrin bamboo cuttings were 120 cuttings.

2.1. Data analysis
Data analysis using ANOVA method with SPSS 16. The treatment that significantly affected was tested further by using the Tukey Test.

\[ W = q_{\alpha(p,fe)} SY \]

Where:
- \( W \) = Tukey test value (BNJ)
- \( q_{\alpha} \) = Tukey table value
- \( p \) = Number of treatments
fe = Degree of error  
SY = Default error mean value = \sqrt{KTG / \tau}  
r = Number of replications

3. Results and discussions
The results of the variance analysis showed that the treatment of the origin of the branch cuttings on the stem gave no significant effect on shoot height, number of shoots, and number of leaves, but significantly affected the root volume of cuttings.

3.1. Growth trend of bamboo shoots.
Branch cuttings that have been given growtone hormone increase continuously until week 10 (figure 1), while cuttings that were not given hormones die at 9th week.

![Figure 1. The growth rate of shoot length of bamboo branch cuttings](image)

Likewise, the growth response of the number of shoots for 10 weeks (figure 2) shows that the leaves begin to appear after the second week in several shoots, and overall leaf shoots appear at week 5.

During the study period there was an increase in the number of leaves from week 1 to week 10 even though in certain periods there were some leaves that fell.

![Figure 2. Trend of increasing number of leaves](image)
Shoots of bamboo branch cuttings begin to appear in the first week after planting, an increase in the number of shoots takes place over time until the 6th week of observation and then stabilizes. While the non-smeared cuttings begin to sprout in the 2nd week to the 8th week and after the 9th week no more shoots grow.

3.2. Productivity of bamboo cuttings based on the position of the branch cuttings
The productivity of bamboo cuttings was assessed by the increment of growth, both shoot length increase, number of shoots and number of leaves. There is a similar tendency to these three variables, increasing the dose of hormone to a certain dose seems to increase shoot growth, but with higher doses will tend to reduce growth, and treatments of G3 and G4 tend to give a decreased response.

The average shoot height increases in each treatment (figure 4) shows the average height of shoots of bamboo cuttings with treatment C1 (branches at the base) ranging from 17.75 cm - 27.45 cm or an average of 22.36 cm and lowest in treatment C3 (position of stem tip) which ranged from 14.33 cm - 26.95 cm or an average of 21.24 cm.

Figure 3. Increasing number of shoot trends
Figure 4. Average Height Increase in Shoots of Bamboo Atter Branches in a combination of Branch Position Treatment (C) and Hormone Dose (G).
The average number of leaf increment in (Figure 5) is the highest in treatment C1 with a range between 11.0 - 18.75 strands (or an average of 14.06 strands), and the lowest in treatment C3 (stem ends) ranging from 8-18.5 strands (or average 13.5 strands).

Figure 5. The average number of leaf increment in a combination of Branch Position Treatment (C) and Hormone Dose (G).

Although the treatment factor for branch position did not significantly influence the number of leaves, there was a tendency for treatment C1 (branch cuttings from the base of the stem) to be the branch position with the best average number of leaves (14.06 strands).

Branch position treatment showed the highest number of shoots in C1 treatment ranged from 3 to 4 shoots with an average value of 3.56 shoots. While the lowest number of shoots was in treatment C3 (branch position at the end of the stem) ranging from 2.5 to 4.5 shoots with an average of 3.31 shoots (Figure 6).

Figure 6. Increment of the number of shoots during measurements

The results of the variance analysis showed that branch positions and doses had no significant effect on the number of shoots. Branch position treatments and hormone doses, although giving no significant effect on shoot growth, there was a tendency for treatment C1 (the branch in book 1) to have the highest growth value with an average of 3.56 shoots.
3.3. Effect of Growtone Hormone Treatment

The results of the variance analysis showed that the treatment of the dose of growtone hormone had a very significant effect on all variables of shoot height, leaf number, and root volume but were not significantly different for the number of shoots.

The Tukey Test Results (table 1) show that the treatment of G2 (30 mg) in the test (α = 0.05) gave the best effect and was different from the other treatments.

Table 1. The results of the Tukey Test analysis for the shoots length, number of leaf, and number of shoots in the Treatment of Hormone Doses.

| Growtone hormone dose | Shoots Length (cm) | Tukey Test α=0.05 | Number of Leaves | Tukey Test α=0.05 | Number of Shoots | Tukey Test α=0.05 |
|-----------------------|--------------------|-------------------|------------------|-------------------|-----------------|-------------------|
| G2                    | 26.79              | a                 | 17.75            | a                 | 3.50            | a                 |
| G3                    | 22.97              | ab                | 15.83            | ab                | 4.00            | a                 |
| G1                    | 20.3               | ab                | 11.67            | ab                | 2.83            | a                 |
| G4                    | 17.4               | b                 | 10.08            | b                 | 3.42            | a                 |

The longest shoot length and the highest number of leaves were obtained at the G2 dose while for the highest number of shoots in the G3 treatment.

3.4. Root Volume

Root volume was obtained at the end of the study by measuring each root volume in each treatment (see figure 7)

![Figure 7. Average Volume of Parring Bamboo Branches](image)

Figure 7 shows that the treatment of branch positions with the highest average root volume was found in treatment C2 which ranged from 1.58 ml - 3.1 ml or an average of 2.3 ml, and the lowest volume was found in the treatment of branch position C1 with a range the value is 0.98 ml - 2.6 ml or an average of 1.93 ml.

The highest average root volume found at the dose of G3 hormone (45 mg) ranged from 2.3 ml - 3.48 ml or an average of 2.73 ml, while the lowest average root volume was at the dose of the hormone G1 (15 mg ) ranges from 0.98 ml - 1.58 ml or an average of 1.37 ml.

The results of the variance analysis showed that growtone hormone doses significantly affected root volume increment while the position of branches on the stem had no significant effect, but there was a tendency for C3 treatment (branches at the end of the stem were branch
positions with the best root volume with an average value of 2.3 ml. Tukey test for hormone
dose treatment can be seen in table 2.

**Table 4. Tukey Test Results for Root Volume of parrin branch cuttings**

| Growtone Hormone Dosage | Average Increase in Root Volume (ml) | Tukey Test Results 0.05 (W = 1.31) |
|-------------------------|-------------------------------------|----------------------------------|
| G3                      | 2.73                                | a                                |
| G2                      | 2.39                                | ab                               |
| G4                      | 1.99                                | ab                               |
| G1                      | 1.37                                | b                                |

Table 2 shows that growtone hormone treatment can stimulate new root formation in
bamboo parring branch cuttings. The 45 mg hormone dose is appropriate for stimulating the
roots of bamboo branch cuttings, while higher doses have an effect that begins to decrease in
root cuttings formation.

4. Discussion

4.1. Position of Branches on Bamboo Stems

Based on the results obtained, it is known that the treatment of branch positions had no
significant effect on height increase, number of leaves, number of shoots and root volume.
These results indicate that the branch buds from the base of the stem to the end of the stem are
feasible to be made as cuttings material and provide the same potential for shoot growth ability.

However, branch cuttings have a low reserve of organic matter so they need to be assisted
through stimulating hormone growth. Nevertheless, there is a tendency that treatment C1
(branches at the base of the stem) provides the best shoot growth followed by the middle part of
the stem and the lowest originating from the end of the stem.

As stated by Saefudin and Tati [12], branch cuttings have low growth due to food reserves
which are limited in branch cuttings.

Decreased number of shoots is caused by food reserves in cuttings material began to decline,
and also because the roots are still not formed much at a certain period of time which causes the
roots to not optimally absorb nutrients.

In addition, the cause of death of some shoots is suspected to be due to competition between
shoots to get food available at the branch.

The same opinion was expressed by Soeseno [13], that branch cuttings originating from the
stem approximately half down are very well used as cuttings. He suggested that branch cuttings
taken from the bottom gave better results than higher parts.

Therefore, bamboo branches are useful to be developed into new plants before they are
wasted because these branches will become waste when bamboo culms are harvested.

The ability of cuttings to produce roots is also influenced by the presence of shoots, where
shoots act as the center of endogenous auxin production which plays a role in stimulating root
formation [14].

4.2. Hormone dose variations

The results of the variance analysis showed that the dose of growtone hormone had a very
significant effect on shoot height, leaf number and root volume but had no effect on the number
of shoots.

Accelerating root growth in cuttings is generally done by providing growth regulators, either
in solid or in liquid form [15]. Wiratri [16] states that the immersion method is an effective
method while the method with pasta is the simplest method.
Giving hormones with the right dose can stimulate the growth rate of cuttings. Low hormone concentration causes rooting time to last longer, whereas if the hormone dose is too high it can inhibit root formation [14].

The Tukey test results showed that administration of the hormone growtone 30 mg (G2) gave a significant effect on shoot height and number of leaves compared to other doses. These results indicate that 30 mg of the hormone dose is the right dose for the height increment and the number of leaves of bamboo parring branch cuttings.

Branch cuttings have a low growth ability due to limited food reserves. Giving hormones at the right concentration plays a role in cell differentiation. However, a higher hormone concentration can reduce plant growth [17].

The administration of exogenous auxin hormones can stimulate endogenous auxin activity and can increase the content of the cytokinin hormone [18]. This condition is caused by the influence of the content of auxin in growth stimulants plays a role in increasing the number of leaves. As stated by Mahfudz and Hidayat [19] that auxin besides being able to increase the length of shoots also plays a role in increasing the number of leaves and leaf area.

The 45 mg (G3) hormone dose gives the best influence on root formation, which is caused by the influence of auxin in the growth regulator which has the role of increasing the formation of roots at these dosages. According to Hartmann and Kester in Febriana [20] that growth regulators from auxin groups can increase the percentage of rooted cuttings and increase the number and quality of roots formed.

It is assumed that the hormone dose of 30 mg (G2) is the right dose and in accordance with the needs of bamboo cuttings to grow new shoots. The right dose can stimulate growth, but if it exceeds the right dose level it will suppress and can inhibit the growth of branch cuttings.

In line with [21] argues that the hormone / growth regulator at the right level will encourage the growth of new shoots, while higher levels will inhibit growth and can even kill plants. Furthermore, by Febriana [20] states that growth regulating substances (ZPT) are commonly used to spur plant growth but can also be a growth inhibitor (retardant).

5. Conclusion
For the purpose of mass development of atter bamboo in the field, branch cuttings can be used from all parts of the bamboo stems as plant material. However, the best branch cuttings are those from the base of the stem followed by the middle part. While the treatment of growtone doses of 30 mg to 45 mg provides optimal growth for branch cuttings in the field.

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