Utilization of low plants peat bricks for macadamia (Macadamia integrifolia) planting

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Abstract. Currently, the use of organic materials as organic fertilizer has been widely used by farmers. The awareness of farmers to use organic fertilizers has made organic fertilizers increasingly difficult to obtain. Organic fertilizers from chicken, goat and cow farms have generally been ordered and purchased by certain farmers. Therefore, alternative uses of other organic fertilizers need attention. Lowland peat is quite widely available in Indonesia, especially in North Sumatra. Peatlands are spread from the east coast of Aceh Province to the east coast of the Riau Province border. This potential makes it possible for peat to be modified into alternative organic fertilizers. One of the disadvantages of organic fertilizers is the large volume and weight. To overcome this problem, peat is made into briquettes through a pressing process so that its volume can be reduced to 1/3 times its previous volume. In addition, the acidic nature of peat is also expected to be greatly reduced by wasting peat water content. After being made into briquettes, the briquettes are used as organic fertilizer treatment for planting macadamia plants in the field. The results showed that the provision of briquettes from peat could increase the growth of macadamia plants compared to control. However, giving briquettes at a dose of 0.5 kg was not significantly different from giving briquettes up to 1.5 kg.

1. Introduction

Indonesia has peatlands spread across Sumatra, Kalimantan and Papua. One of the provinces in Kalimantan that has a large enough peat potential, namely South Kalimantan, which is estimated at 1,484,000 Ha. The peat potential in Indonesia is quite wide, which is around 27 million Ha and is the fourth largest peat reserve in the world after Canada (170 million Ha), Russia (150 million Ha), and the United States (40 million Ha). It is appropriate that peat can be used as an alternative energy in the form of peat briquettes [1].

There are quite a lot of alternative renewable energy sources in Indonesia, including biomass or organic waste materials. Sources of raw materials for making briquettes vary, including coal, coconut shells, and others. In addition, other materials derived from biomass in Indonesia are very abundant, with low utilization [2]. One of the promising sources of biomass to be utilized is the treatment of waste from various materials, besides that peat soil is also an abundant source and has minimal utilization [3].

Briquette is a material in the form of powder or small pieces which are compacted using a press machine with mixed adhesive to produce a compact form. Briquettes that have good quality are briquettes that have a low moisture content, ash content, flour content, burning rate, but have a high
density, calorific value and temperature of fire or charcoal produced. If briquettes are used among households, the important thing to note is the low volatile matter and ash content [4]. According to The Environmental Agency of North Sumatra Province (2011) stated that there has been a decrease in forest area in the Lake Toba area. This happens due to the conversion of forest areas into fields, rice fields, reeds, shrubs, and settlements, as well as environmental pollution from agricultural activities and home industries. The hilly and mountainous topography of the Lake Toba Catchment Area (DTA) has resulted in the Lake Toba catchment area being eroded very often due to tree cutting by local communities living in the Lake Toba catchment area [5].

Currently, the condition of the Lake Toba ecosystem is very critical as a result of land use patterns that do not comply with conservation principles and due to forest area encroachment and timber theft. Land burning is also done intentionally for cattle grazing and often causes fires to get out of control so that they spread to forested areas and cause very large land and forest fires. This practice is one of the causes of excessive land use, especially in the upstream, so that it is not in accordance with the land's ability. Deforestation of the forests around Lake Toba caused by uncontrolled logging, so that the green land cover area becomes depleted, in the near future the mountains around Lake Toba will become barren. Reforestation efforts carried out by the government by planting pine have failed because they were destroyed by fire (burned) which caused increasingly severe environmental damage [6].

Communities around the Lake Toba area generally have jobs as farmers and fishermen, but as the results of fishermen decrease, some people begin to switch to farming, this causes environmental damage because people do not have special skills / abilities in farming using only traditional methods, even though they are not few people have land planted with multipurpose trees (MPTS/Multi Purpose Tree Species) in the Lake Toba catchment, because it has been planted for generations starting from their ancestors since ancient times. MPTS species in an area are usually superior in several respects to woody species with a single benefit, both endemic and exotic species. These advantages, among others, come from their natural habitat, have been tested and are able to adapt to their environment, are valuable for preserving biodiversity, and are financially of high economic value and are liked by the community. So that these tree species will be more prospective to provide opportunities for the success of critical land rehabilitation activities if they are offered as tree species used for the rehabilitation of the Lake Toba catchment area [7].

This study aimed to try the use of lowland peat as a briquette material to be used as an organic material as well as a water storage material, to increase the resistance of Macadamia plants to grow in the field with minimal maintenance. The results of the study are expected to provide information about whether or not lowland peat can be used as an alternative to organic fertilizer as well as a material for storing water reserves for plants growing in the field, especially in the catchment area of Lake Toba which does not receive maintenance action due to extreme topographic conditions.

2. Methods

2.1. Time and Location
This research was conducted in the catchment area of Lake Toba, precisely at PT Inhutani IV, Sipintuangin Village, Dolok Pardamean, Simalungun Regency, North Sumatera. This research was conducted in March 2021 - June 2021. The tools used in this study were tag labels, tally sheets, manual hydraulic presses, stationery, hoes, SPSS software, rulers, and cameras. The material used in this study was peat soil originating from the lowlands, precisely in Sijawi-jawi Village, Panai Hilir District, Labuhan Batu Regency, Macadamia seeds (Macadamia integrifolia) aged 6-8 months, planting media, and water.

2.2. Procedure
The research was conducted with the following stages:
2.2.1. Adhesive Making. The manufacture of adhesive in the manufacture of peat soil briquettes uses sago flour. The ratio used between sago flour and water is 1:8. First, 1 kg of sago flour is weighed. Then, 500 mL of water at room temperature was poured. After that heated as much as 7.5 L of water until it boils, then put the flour that has been mixed with the water into the boiling water. Then stir until thickened and changes color to clear white.

2.2.2. Briquette Making. Peat soil briquettes made by reducing the water content using a manual press, then mixing the peat soil and stirring with adhesive (sago flour) with a ratio of peat soil: adhesive (10 kg: 1 kg) in a container until homogeneous. Then the briquettes were printed using a circular mold, then the briquettes were dried with the help of sunlight for 2 x 24 hours.

2.2.3. Packaging of Briquette. Peat soil briquettes packed using sacks/burlap. The peat soil briquettes were put into prepared sacks/burlap.

2.2.4. Origin of Peat Soil. The peat soil used in this study was lowland saprik peat taken at a depth of 0-30 cm. The peat soil was taken from Sijawi-jawi Village, Panai Hulu District, Labuhanbatu Regency, which was 150 km from the planting site.

2.2.5. Preparation of Macadamia (Macadamia integrifolia) Seeds. The Macadamia (Macadamia integrifolia) seeds used in this study are seeds from the Simalungun Regency area, precisely in the PT Inhutani IV Nursery. Macadamia seeds used were the result of generative propagation through seeds. The seeds used were seeds that have an age ranging from 6-8 months and have good health and physical condition as indicated by seeds that were not attacked by pests and diseases.

2.3. Field Research Implementation
The planting location was carried out on local community land located in the catchment area of the Lake Toba area, precisely in Si Pintuangin Village, Dolok Pardamean, Simalungun Regency. Before carrying out the research, the land was cleaned first of weeds, then planting holes were made. The size of the planting hole used in this study was 60 cm x 60 cm x 60 cm.

Because the research was carried out directly in the field, the plants planted directly will be used as the main crops for land rehabilitation activities so that the spacing used was adjusted to the needs of the field. The spacing used is 4 m x 5 m. After the research was completed, the plants were allowed to continue to grow until they are productive.

The treatment of peat soil briquettes was carried out together with the implementation of planting Macadamia (Macadamia integrifolia) seedlings in the field. Briquettes were buried in the soil in the planting holes around the root area. Then it was covered with excavated soil and compacted again.

2.4. Parameter
2.4.1. Seedling Height Gain (cm). Seedling height parameter data was collected every 2 weeks. Measurements were made after 14 days of planting the seeds.

2.4.2. Seedling diameter (cm). Data collection on plant diameter was carried out every 2 weeks. Measurements were made after 14 days of planting the seeds.

2.4.3. Number of leaves (strands). The number of leaves was calculated at the end of the study. Leaves that are counted are leaves that are fully open.

2.4.4. Leaf Area. Leaf area was calculated at the end of the study by taking photos of the entire leaf and measured using AutoCAD software.

2.5. Statistics Design
The study was conducted using a non-factorial Randomized Block Design method with 7 treatments and 6 replications. The treatment levels were as follows:

- $B_0 =$ control
- $B_1 =$ 0.25 kg dose of peat soil briquettes
- $B_2 =$ 0.50 kg dose of peat soil briquettes
- $B_3 =$ 0.75 kg dose of peat soil briquettes
- $B_4 =$ 1.0 kg dose of peat soil briquettes
- $B_5 =$ Dose 1.25 kg of peat soil briquettes
- $B_6 =$ Dose 1.50 kg of peat soil briquettes

Each treatment was repeated 6 times, so that the number of Macadamia (Macadamia integrifolia) seedlings was 42 seeds. Furthermore, the data analysis used in this study was one-way Analysis of Variance (Anova) to determine the effect of peat soil briquettes on the growth of Macadamia (Macadamia integrifolia) seedlings.

3. Results and Discussion

3.1. Peat Volume Decrease

From the results of research in the laboratory, it was found that sapric peat material can be reduced in weight and volume by pressing to make briquettes. The results of the calculation of peat weight and volume reduction are presented in the following figure (Figure 1).

![Figure 1](https://example.com/figure1.png)

**Figure 1.** Reduction of weight and volume of peat in the production of briquettes

Peat is rich in water content. To reduce the volume and weight to make it easier during transportation, this material needs to be pressed and transformed into briquettes. Pressing is able to reduce the volume as well as the water content of the peat. When watering is carried out in the field or when it rains, the peat will absorb and retain the water in the peat so that it can maintain soil moisture longer.

3.2. Ground Water Content

Based on the results of observations made at the end of the study (4 months of observation) on the soil water content around the plant roots, the results of the soil water content were as follows.
Based on observations in the field, the climatic conditions in the last month of observation fell in the dry season. Rain did not fall at the study site for 9 days before the observation of soil water content. This means that the soil does not receive water for a sufficiently long period of 9 days. After measuring the soil water content, it turned out that the soil taken from the root part of the plant that was given briquettes was able to retain water in the soil longer. This caused the plants treated with briquettes to grow better and fresher than the control.

### 3.3. Plant Height and Stem Diameter

The results of the research conducted for 4 months in the field showed significant results among all treatments, especially between those who were treated with briquettes and those without briquettes (control). Field conditions that have extreme slope topography cause groundwater to be easily lost by the earth's gravity so that the soil dries quickly. As a result, if the plant is not given any treatment, it becomes water stress and inhibits plant growth. Meanwhile, the plants treated with briquettes looked more jagur and green (Table 1).

| Treatment (kg) | Plant Height (cm) | Stem Diameter (cm) |
|----------------|-------------------|--------------------|
| Control        | 10,51 a           | 0,73               |
| 0,25           | 18,23 ab          | 0,91               |
| 0,50           | 23,61 bc          | 0,96               |
| 0,75           | 23,87 bc          | 1,02               |
| 1,00           | 26,26 cd          | 1,19               |
| 1,25           | 27,32 d           | 1,09               |
| 1,50           | 26,25 cd          | 1,06               |

Note: The numbers followed by the same letter in the same column are not significantly different according to the DMRT test at the level of 5%.

Looking at Table 1 above, it can be seen that in the control treatment plant growth was quite inhibited. This is because the planting time falls in the dry season with minimal rainfall. As a result, due to the absence of water-retaining material in the soil, the soil immediately loses water either by gravity or evaporates into the atmosphere. Without the help of watering, the plant roots immediately
dehydrated and showed symptoms of stunted plant growth such as plant height (20.51 cm). While in the treatment of giving organic material briquettes.

Although briquettes are made from lowland peat, which is poor in nutrients, physically peat soil is an organic material that has the ability to absorb and retain water longer in the soil. This condition helps to retain groundwater longer in the soil and can provide longer water for plant roots. In the end, the performance of plant height and stem diameter was higher than in the control treatment. Giving briquettes to the 0.5 kg treatment did not give a significant effect compared to the 1.5 kg briquette treatment. This means that the organic matter given in the form of briquettes is sufficient if given to the soil in a dose of 0.5 kg only.

Peat has good permeability and hydrophilicity. Thus, peat can be used as a soil amendment and has a high prospect of being modified as fertilizer in agriculture [8].

3.4. Leaf Area and Crown Area

Table 2. Effect of treatment of various doses of peat soil briquettes on leaf area and canopy area of macadamia seedlings (*Macadamia integrifolia*)

| Treatment (kg) | Leaf Area (cm) | Canopy Area (cm) |
|---------------|----------------|------------------|
| Control       | 12.05 a        | 107.02 a         |
| 0.25          | 23.41 bc       | 188.34 b         |
| 0.50          | 25.88 bc       | 196.32 bc        |
| 0.75          | 28.27 bcd      | 195.18 bc        |
| 1.00          | 28.30 bcd      | 206.46 bc        |
| 1.25          | 30.05 cd       | 209.01 c         |
| 1.50          | 32.21 d        | 206.34 bc        |

Note: The numbers followed by the same letter in the same column are not significantly different according to the DMRT test at the level of 5%.

During 4 months of observation after the plants were planted in the field, different plant performances were obtained between control and plants given briquettes. Control plants showed symptoms of stunted plant growth so that the plants did not develop within 4 months and even tended to be stunted. Meanwhile, plants treated with briquettes were able to show better and normal growth. Leaf color is green and leaf area and crown area are wider (Table 2). However, the growth of plants given briquettes at a dose of 0.5 kg to 1.5 kg did not show significant differences in leaf area and canopy area. Of course, this is caused by the role of improving the physical properties of the soil which is able to maintain and provide soil water for longer for plant roots. However, plant growth could not be boosted again in more briquette treatments because the nutrient content (chemical properties) of peat soil was low.

However, not all peat has a low nutrient content. In Khulna, Bangladesh who conducted a study on the effect of coconut peat on the growth of Ipomoea aquatica, it turned out that coconut peat at a dose of 2.5 tons ha-1 was able to increase the growth of this plant. This is thought to be due to the high nutritional content of coconut peat [9]. That full substitution of peat with compost combined with PGP-based fertilization (a type of growth-promoting microorganism) showed the best growth of Chestnut (*Castanea Sativa*) plants and was more drought tolerant [10].

4. Conclusion

The provision of briquettes was able to increase the growth of macadamia plants planted in the field without any maintenance action. This is related to the improvement of the physical properties of the soil which is better able to retain groundwater longer in the soil and provide water for plant roots due to the addition of briquettes into the soil. However, to be able to boost plant growth better, the use of peat should be combined with fertilization.
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