Study of the Use of Block Compost on the Growth of Teak (*Tectona grandis*) in Used Lands of Kapur Stone Mine

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Abstract. The limestone mining area is a karst area that has important ecological function as a water conservation area. After the mining process, the ex-mining area becomes critical land that is poor in nutrients, decreases soil microbial diversity, increases soil pH and temperature. This study aimed to examine the use of conventional and block compost based on plant height parameters and stem diameter. Block compost was made using the bokashi method with the ingredient of teak leaf litter (*Tectona grandis*). The composition of leaf litter (30%), manure (40%), and sawdust (30%). Block compost is made by adding adhesive and it is made using a pressing device. Block compost application on plants is very effective compared without block compost. The average plant height with block compost is 163.2 cm, while without block compost is 27 cm. the average of stem growth diameter of plants with block compost of 1.61 cm, while without block compost was 0.71 cm. This shows that block compost is a solution in mining land reclamation.

Keywords: mine land, block compost, conventional compost, growth of plant height and plant diameter.

1 Introduction

The limestone mining area is a karst area that has important ecological functions, including as a water conservation area. After the mining process, the ex-limestone mining area becomes critical land which is poor in nutrients. Post-mining lime is one of the critical lands with low nutrient content, decreasing soil microbial diversity, increasing soil pH and temperature, and having a compact soil structure. [1], [2]. This is one of the obstacles to the conversion of land after limestone mining to
productive land. And reclamation efforts need to be made to improve the quality of the former limestone mining area. Therefore, the government through Government Regulation of the Republic of Indonesia Number 76 of 2008 concerning Forest Rehabilitation and Reclamation requires every mining company to revegetate critical ex-mining lands [3].

One of the suitable plants for planting on ex-limestone mining areas is teak (Tectona grandis) and sonokeling (Dalbergia latifolia Roxb.). Teak (Tectona grandis Linn.f.) is a plant that is suitable for the site on the former limestone mining area. This plant is easy to grow in tropical areas and is not too attached to one particular soil type [4]. Teak trees also have a long life span [5]. To support the process of reclamation and the sustainability of the teak trees, topsoil is sprinkled on the surface of the post-mining land before planting reclamation vegetation. The thickness of the top soil varies from 30-100 cm [6]. However, the availability of top soil is quite limited, so it is necessary to think about alternative ways to replace top soil with sufficient nutrient content so that plant growth in the revegetation process can be optimal. To support nutrient availability, leaf litter can play a role in the revegetation process on the forest floor. This is because most of the return of nutrients to the forest floor comes from litter. Inorganic compounds from the decomposition of litter into mineral nutrients that can be utilized by plants [7]. Therefore, litter is said to be one of the main routes of the nutrient cycle [8]. The nutrient content in the litter used as compost will affect the nutrient content of the compost produced. Plants from the leguminosae family generally have a high content of organic matter, have greater absorption of nutrients and have root nodules that help lure nitrogen from the air, so they are good for use as compost. [9].

Block compost is an alternative to the use of direct compost which is effective and can be applied to land after lime mining. The use of compost in block compost has several advantages. Among them are fertilizers that provide nutrients to plants, facilitate absorption of rainwater, improve the ability of the soil to bind water so it does not dry out easily, reduce erosion, provide good media for plant roots, improve aeration, increase pH, increase soil fertility, and can make growth. the plants got better, seen from the parameter of the number of leaves more and a stronger root system [10]. The purpose of this study was to examine the use of block compost with embankment and conventional types in supporting the growth of teak plants in the former limestone mining area.

2 Materials And Method

2.1 Study sites
This research was conducted in the conservation area of PT. Semen Indonesia (Persero) Tbk, Kerek District, Tuban Regency, East Java Province. The research took place from August to September 2019.

2.2 Tools And Materials
The tools needed in this study are a chopping machine, trowel, ziplock plastic, pH meter, thermometer, camera, humidity measuring device, tarpaulin, paralon pipe, bucket, block compost press, and gloves. While the materials used in this study were manure, leaf litter (teak, johar, tamarind, neem, and mahogany), sawdust, tapioca flour, EM4, and water.

2.3 Design and cultural practice
a. Fertilizer Making
Making compost in this study using the bokashi method. The basic material used in making compost is leaf litter. The leaf litter used were teak (Tectona grandis), johar (Senna siamea), trembesi (Samanea saman), neem (Azadirachta indica), and mahogany (Swietenia mahagoni). The composition of the materials used in the manufacture of compost is leaf litter (30%), manure (40%), and sawdust (30%). The leaf litter used is chopped first and then mixed with other ingredients. Furthermore, the material is added with bioactivator EM4 and water. The mixture is fermented until the compost is ripe (about 4 weeks). During the composting process the temperature and humidity are controlled by turning the compost material upside down.
b. Planting Plants with the Embankment System

The embankment system was planted on teak (Tectona grandis). Planting with this system is done by making embankments in the former limestone mine from the soil layer. In that layer, a 50 x 50 cm² hole is made. In these holes, compost blocks are placed. Furthermore, teak and sonokeling plants were planted in the hole that had been made in the middle of the compost block. After the plants are planted, landfilling is carried out and covered with morning straw to reduce evaporation.

c. Planting Plants With Conventional Systems

The conventional system was planted on teak (Tectona grandis). Planting with this system is done by planting crops in general. It begins with filling the former limestone mine with soil, then a 50 x 50 cm hole is made. Then the plant seeds are inserted and filled using the soil again. Beds are also made around the plants by making circular depressions in the soil surface and giving straw to the outermost pile of plants.

2.4 Data Analysis

The variables observed were plant height and stem diameter parameters. Data were analyzed using descriptive statistics with the help of SPSS Relase 23 software.

3 Result And Discussion

Analysis of Nutrient Content of Block Compost Macro

Based on laboratory testing the macro nutrient content of block compost is described in Table 1:

| Chemical properties (%) | Permentan No. 70 Th 2011 | Amount according to SNI 19-7030-2004 | Block Compost | Category  |
|-------------------------|--------------------------|--------------------------------------|----------------|-----------|
| C – organic             | Min 15                   | 9.8 - 32                             | 13.57          | Good      |
| N Total                 | Min 4                    | 0.40                                 | 2.97           | Good      |
| Phosfor (P)             | Min 4                    | 0.10                                 | 0.89           | Good      |
| Calium (K)              | Min 4                    | 0.20                                 | 0.48           | Good      |
| C/N rasio               | 15-25                    | 10-20                                | 4.57           | Low       |
| Ph                      | 4-9                      | 6.8 – 7.49                           | 6.9            | Good      |
| Water content           | 10-25                    | Max. 50                              | 6.62           | Dry       |

Nitrogen is absolutely necessary for plants which can be obtained from the addition of organic and inorganic fertilizers. Based on the test results, the nitrogen content of the organic fertilizer in the form of block compost is 2.97%, it has met the nitrogen content according to SNI 19-7030-2004, which is > 0.40%. This Indonesian National Standard is used by many groups for products sold in the market. The availability of nitrogen in high amounts due to a more complete decomposition process. Meanwhile, low nitrogen is caused by compost raw material which contains low nitrogen and possibly evaporates a lot due to poor packaging.

The P2O5 quality value of the block compost produced is 0.89% and has met the P2O5 content according to SNI 19-7030-2004, namely > 0.10%. P elements are needed by microorganisms to build cells such as protoplasm and cell nucleus. The overhaul of organic matter and the process of phosphorus assimilation occurs because of the phosphatase enzyme produced by some microorganisms [11]. If the number of microorganisms in the compost is insufficient, the process of reforming organic matter and the process of acidification of phosphorus by microorganisms is also
lacking so that phosphorus is not utilized, and vice versa, if the number of microorganisms in the composting is sufficient, the process of reforming the organic material is perfect.

The value of potassium in the analysis of the quality of the block compost is 0.48%, the block compost has met the K2O content according to SNI 19-7030-2004, namely > 0.20%. Potassium is used by microorganisms in composting materials as a catalyst, with the presence of bacteria and their activity, which greatly affects the increase in potassium content. Potassium is bound and stored in cells by bacteria and fungi, if it is decomposed again, the potassium will become available again [12].

The test results for the total organic carbon content (C-Organic) in the compost block were 13.57% and had met the nitrogen content according to SNI 19-7030-2004, namely 9.8 - 32%. Total C-organic in block compost is influenced by the quality of organic matter and the activity of microorganisms involved in the breakdown of organic matter.

The C / N value of block compost ratio, according to SNI 19-7030-2004 is 10-20. The average block compost sample under the SNI 19-7030-2004 standard is 4.57. The C / N ratio contained in the block compost illustrates the level of maturity of the block compost, the higher the C / N ratio means the compost has not broken down completely or in other words, it is not yet ripe and not ready to be sold or used as fertilizer.

Organic material with a good composting process and becomes mature compost blocks if it has a C / N ratio between 10-20. According to Permentan and SNI, compost is said to be ripe if the C / N ratio is below 20. Good compost is compost that has a C / N ratio of 10-12, good compost is one that contains a C / N ratio of 12-15. [13]. The C / N ratio will affect nutrient availability, if the C / N ratio is high, the nutrient content is little available for plants, on the other hand, if the C / N ratio is low, the nutrient availability is high and available for plants.

The pH value obtained from the compost block is 6.9. If according to SNI 19-7030-2004 the value is normal from 6.8 to 7.49. When compared with the standard value issued by MOA No. 70 of 2011 is 4-9, so the pH value in block compost is still categorized as normal. According to Utomo (2010) under normal conditions there will be no problems, as long as the composting process is carried out can maintain the pH in a neutral range. Because the pH is neutral, the activity of microorganisms in organic fertilizers runs perfectly, so that the nutrients released from the compost block are also getting better.

The test results on the compost block show that the sample has less moisture content so it is dry. This figure is under SNI 19-7030-2004 and MOA No. 70 Th 2011. Too much water content will result in the material getting denser, because it can melt the food sources needed by microbes and block oxygen from entering [14].

Performance Of Plant Height And Stem Diameter

Plant Height

Plant height is a plant size that is often observed both as an indicator of growth and as a parameter used to measure environmental influences or the treatment applied [15],[16]. Plant height growth is related to shoot and shoot development. Shoot growth that causes plants to increase in height is influenced by spacing, nutrient supply and water. After measuring plant height, it was found that the average height of teak plants in the conventional system without block compost application was 27.3 cm. The average Teak height parameters on the 163.2 cm dike system are presented in Figure 1.

Figure 1. Stem diagram of average height of teak plants in conventional systems, and dike systems in the conservation area of ex-mining lime reclamation
Teak plant height in conventional systems has the lowest average compared to planting systems using block compost. The minimum height value for teak in conventional systems is 11 cm and the maximum height value is 52 cm. The minimum plant height in the embankment system is 73 cm while the minimum plant height in the embankment system is 235 cm. The minimum and maximum height of teak growth is shown in Figure 2.

![Figure 2. Bar chart minimum and maximum height values of teak plants](image)

**Diameter in Plant Growth**

The next plant growth parameter measured was the plant growth diameter. The mean diameter of teak in conventional systems and embankments is 1.7 cm and 2.5 cm, respectively. Figure 3.

![Figure 3. Stem chart of average teak plant diameter](image)

The minimum diameter values for the conventional system and the embankment are 0.71 cm and 1.61 cm, respectively. The maximum diameter values in conventional systems and embankments are 3.43 cm and 3.61 cm, respectively. In general, the growth in diameter and height of teak stands up to the age of 12 years in several studies that have been conducted, states that the highest growth in diameter and height of teak stands occurs in the initial phase of growth, namely in the age range of 1-5 years, then there is a gradual decline in growth and seems to have decreased after the 12 year old stands. A good teak tree is a tree that has a large diameter line, has a straight trunk, and has a few branches.

### 4 Conclusion

Based on the research that has been done on the quality of compost blocks made from leaf litter from the former limestone mining conservation area of PT. Semen Indonesia (Persero) Tbk. The composition of the compost ratio for compost blocks that has been made consists of leaf litter: manure: sawdust of 2: 3: 2. Macro nutrient content in compost blocks that have been made (N = 2.97%; P = 0.89%; K = 0.48%; C = 13.57%; C / N ratio = 4.57; pH = 6.9; Water content = 6.62%) can
said to be good and fit for use because it is included in the criteria of MOA No. 70 Year 2011 and SNI 19-7030-2004 for tradable fertilizer / compost.

Based on the research that has been done, it can also be concluded that the use of block compost applications on plants is very effective compared to planting plants without block compost (conventional). The embankment planting system is more effective. The effectiveness of the application of block compost made from leaf litter can increase the growth of teak plants. Block compost application in plants is very effective compared to without block compost. The average plant height with block compost was 163.2 cm, while without block compost was 27 cm. The average diameter of plant stem growth with block compost was 1.61 cm, while without block compost was 0.71 cm. This shows that block compost is one of the solutions in mining land reclamation.

The suggestion in this research is that, first, further studies can be carried out on the macro nutrient content of each conservation plant, not only teak (Tectona grandis), it aims to make a more detailed composition recommendation and recommendations for using block compost size. The kinds of plants that will be planted for the reclamation process. And secondly, the growth of teak plants in each planting system is thought to be influenced by several factors, namely the conditions of the growing place or soil conditions and maintenance activities. Therefore, the suggestion for this research is that it is necessary to monitor the growth of teak plants.

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