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# Growth Increase of Gelam (*Melaleuca Leucadendron)* Burnt Peatland Through the Provision of Soil Conditioner (Study in Londerang Peat Protection Forest)

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**Abstract:** The protected forest of Londerang Jambi is an area of hydrological unity with a surface area of 12.484 ha that is located in the district of Tanjung Timur and Muaro Jambi, which is surrounded by palm plantations and forest of industrial crops and 10 villages in the Districts of Tanjung Jabung Timur and Jambi. Based on the results of the Landsat 8 OLI image analysis and the SPOT 7 image interpretation by WWF Indonesia in 2015 that the Londerang Forest Protection Area (HLG) has an area of 12.848 Ha, currently the steep vegetation cover that canopies closely on the HLG Londerang remains only less than 10% of the area of HLG londerang due to forest fires in 2015. An attempt to overcome the situation has been made, one of them in the HLG Londerang being made an of the Hydrological Union of Mendahara-Sungai Batanghari which has been intervened by the Badan Restorasi Gambut (BRG). This effort was also carried out by the KIFC (Korea Indonesia Forest Center) by revegetating the blocks of land that had been burned in HLG Londerang. The planting has been carried out from the beginning of 2022 to December 2022. The species of plants planted among them are Pulai Rawa (*Alstonia scholaris*), Balangeran (*Shorea balangeran*), Gelam (*Melaleuca leucadendron*). In order to support the success of the revegetation, intensive maintenance is required, including the provision of soil fertilizers such as dolomite and NPK fertilizer. The research was conducted for seven months from May to December 2023 at HLG Londerang. Measuring fields are made with group random designs (RAK). The clustering is based on the difference in the height of the groundwater surface.

**Keywords:** HLG Londerang; Melaleuca Leucadendron; Peat Forest; Soil Amandement

## Introduction

The type of soil on peat forest is the deposit formed from the residue of plant tissue that continues to accumulate at a depth of at least 40 cm and belongs to the type of histosol soil (Survey Staff, 1999)Peat ecosystem is divided into two ecosystems, the protective function and the cultivation function (Peraturan Pemerintah Republik Indonesia, 2016)The protective ecosystem is a characteristic of the ecological system that has a primary function in the protection and balance of water systems, storing carbon reserves, and capable of preserving biodiversity.

Forest fire, which often occurs in the peat land, has a lot of serious effects on the soil, including: (1) destroying soil structures; (2) reducing soil porosity; (3) losing material; and (4) the death of soil, flora & fauna, and microorganisms. Therefore, it is essential to restore the ecosystem of the land that has been damaged by forest fires**.**

Specific soil conditions and many limiting factors, resulting in only a few species of forest plant being

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viable and adaptive. Therefore, local crops are one of the solutions in repairing damaged soil, because the indigineous tree species are able to adapt well (Tamin & Napitupulu., 2022) Jelutung (*Dyera lowii*), Bintangur (*Callophyllum* sp), Renghas (*Gluta renghas*), and Arang-Arang (*Diospyros mangayi*) are species of trees native to the ecosystem of the peat swamp forest (Tamin et al., 2019).

According to Tri et al., (2020) Gelam (Melaleuca leucadendron) is commonly found in lowland areas, shallow peat forests, and swamp areas. In fact, according to (Wibisono et al., 2023), gelam is a potential species for rehabilitating peat land area , resistant to fire and according to (Rachmanady et al., 2003)gelam is a type of plant that is adaptive to extreme environmental conditions and low levels of acidity, waterlogged and high salinity. Gelam plants can support peatland rehabilitation activities (Kartikawati et al., 2014) and it is emphasized by (Rachmanady et al., 2003) that gelam has good prospects to be managed and developed because of the rapid growth of gelam, with 1-1.5 cm per year. However, rehabilitation and land management efforts on peat areas that have been burned are still very slow and difficult. Peatland rehabilitation often fails because plants are unable to adapt to the environment.

Peatlands also have economic and ecological value, as well as environmental functions (N.A. Ulya et al., 2015).Ecological value and environmental functions include high biodiversity, hydrological functions in water storage and release management, and carbon storage functions (Saragi-Sasmito Meli F et al., 2019), all of which are related to climate change mitigation.

The province of Jambi has the 3rd largest peat ecosystem in the island of Sumatera which has an area of about 14% of the area of the province Jambi or about 736.227,20 ha. The peat land is spread out in 6 districts namely Tanjung Jabung Timur 311.992,10 ha, Muaro Jambi 229.703,90 ha, Tanjung Jabung Barat 154.598 ha, Sarolangun 33.294,20 ha, Merangin 5.809,80 ha and Tebo 829,20 ha (Hero Saharjo & Yulia Eka Nurjanah, 2021).

Londerang Protection Forest located in East Tanjung and Muaro Jambi Districts with an area of 12,484 ha is a Peat Protection Forest (HLG) area surrounded by oil palm plantations, industrial timber plantations and ten villages. Based on historical records in Londerang HLG, there was a forest fire in March 2014 with an area of 125 ha in the company's concession area, both oil palm plantations and industrial timber plantations. Currently, the standing vegetation cover in Londerang HLG remains 10% of its area due to forest fires in 2015 (Zainuddin et al., 2019).

In the peat ecosystem protection and management plan, there needs to be an effort to provide soil conditioners and fertilizers, which are needed to support the success of peat ecosystem rehabilitation with planting and maintenance activities in burned peat ecosystems.

Peat soil has relatively low productivity, so it is necessary to pay attention to the plant's nutrient needs. Tropical peatlands are important carbon store so restauration as a key nature for climate change mitigation (Brown et al., 2023).According to (Pulunggono Heru Bagus et al., 2019), fertilization is carried out when there is a deficiency of nutrients, and (Christopheros et al., 2018)states that the addition of nutrients causes the seedlings to grow normally. Fertilization is the activity of adding nutrients needed by plants in their growth with the aim of improving growth that affects the production yield of those plants (Wasis & Noviani, 2010).

The availability of nutrients in the soil greatly affects plant growth; if there is a deficiency of nutrients, it can cause stunted plant growth. It is necessary to fertilize young trees planted on cut-over peatlands. Fertilizer had a negative impact on vegetation growth in the research area due to soil deficiencies in phosphorus, potassium, and other minerals. The effect of fertilization may range by geography and based on the original nutrient state of the soil. NPK fertilizer will be more efficiently absorbed by plant roots so that the available nutrients can increase plant growth (Lautt et al., 2020).

Plant require three basic nutrients for proper growth and development: nitrogen (N), phosphorus (P) and potassium (K). A lack of any of these nutrients during the life cycle has a negative impact on plant growth. Nitrogen is essensial for chlorophyll synthesis , by extension, and photosynthesis (Duarah et al., n.d.).P promotes cell division, root expansion, and blooming(Khan et al., n.d.). Interestingky, N uptake was higher in fire damage soil than intact soil. Nitrogen is regarded as the most limiting nutrient for plant growth and it was the most deficient in fire-damaged soil (Khalofah et al., 2023).

On fire damage soils, increasing NPK levels dramatically increased tree growth, indicating that adding NPK could accelerate the growth of plant. Tree high is another essential feature, as taller trees may generate more offspring than trees with shorter height (Gioria et al., 2014), and higher growth and biomass accumulation are considered key for plant establishing success (Van Kleunen et al., 2011), forest fire alters soil organics matter, macro and micronutrients, soil texture, colour, pH, and soil biota (Y. Zhan et al., 2020).

Wildfires have both positive and negative effects for forest ecosystems, help to preserve forest ecosystmes diversity and stability while also affecting a variety of soil properties (Verma & Jayakumar, 2012).

## Method

*Study Area*

This research was conducted from Mei to December 2024 at Block KIFC (Korea Indonesia Forest Center) Revegetation in HLG Londerang on an area of 200 Ha (Figure 1).

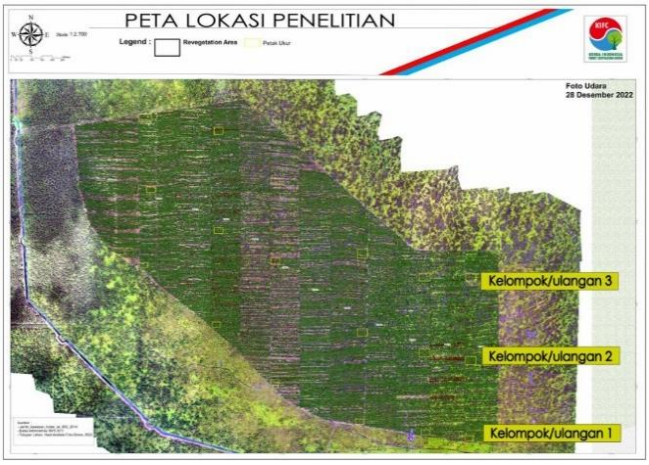


**Figure 1.** Study Area

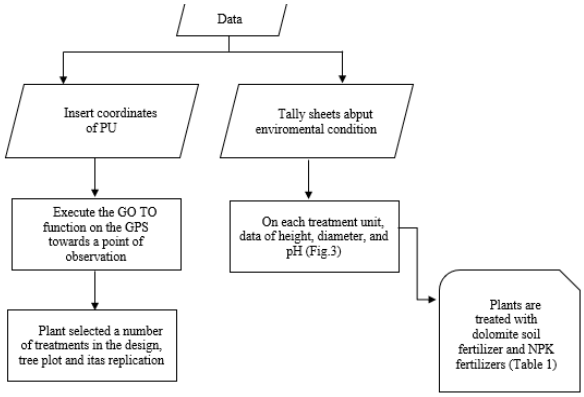


**Figure 2.** Study flowchart

*Materials*

The materials used in the study are *Melaleuca cajuputi*, which have been planted in the field as research objects, as well as some soil fertilizers such as dolomite and synthetic/artificial fertilizer. (NPK). Implementation and collection of data in the field, the following equipment is required: Working maps, flaging tapes (as plant markers), soil drilling, plant diameter measurements (digital caliber or meter tape), tree height measurement instruments (meters), GPS, Compass, Cangkul, Hoe, Tally sheet

*Data collection*

Data collected include tree DBH, height tree, and tree coordinates. All raw data from the field as research objects were entered and complied in Microsoft Excel, then the data will analyzes with randomized block design based on height of groundwater by IBM SPS Statistic versi software 20.

**Table 1.** The treatment of dolomite and NPK Fertilizer

| Dolomite | NPK Fertilizer |
|---|---|
| Control (D0) | Control (P0) |
| Dolomite 40 g (D1) | NPK Fertilizer40 gr (P1) |
| Dolomite 80 (D2) | NPK Fertilizer 60 gr (P2) |
| olomite 120 g (D3) | NPK Fertilize 80 gr (P3) |
| 60 g (D4) | NPK Fertilizer 100 gr (P4) |

## Result and Discussion

*Gelam (Melaleuca cajuputi) High Addition*

Observations of Gelam (*Melaleuca cajuputi*) high rates are done every two weeks. Based on figure 3, the best high yield is on the treatment of P2D4 (NPK fertilizer 60 gr and a dose of 160 g dolomite), while at the P3D3 (NPK fertilizer 80 gr and a dose of 120 g dolomite) treatment, yielding the lowest high growth trend result. Based on the data in Figure 4, the high growth trend occurred in the second week, but in the seventh week the high increase trend appeared to rise. Based on the results of the scale analysis, that treatment given has no real influence on the increase in height and diameter. The depth of the HLG Londerang falls into the category of deep - very deep, with the depths of 279 cm and the deepest 610 cm. Depths increase to the east and decrease to the southwest. The difference in the depth of this shell is caused by the microscopic relief of the mineral layer underneath the shell. On the research block, it belongs in the depth category between 551-625 cm.

Based on its profile, it is suspected that there has been a ground fire, which is characterized by a large number of found fine coal materials and a large amount of found pinewood. According to the results of (Dhandapani & Evers, 2020)research, after a fire in the soil, there was a decrease in the elements N, P and other basic cations, in addition to the organic elements C and N.

According to (L. Syaufina, 2008), fires can affect clay minerals and soil organic material components. Organic materials are an important role in the formation of soil structures that also depend on clay mineral and cation composition in soil. Soil with less organic material will have a lower bulk density. Low bulking density causes a very low resistance or load-bearing capacity. It is therefore consistent with (Hero Saharjo & Yulia Eka Nurjanah, 2021) statement that the decrease in water levels is due to the loss of soil-covering vegetation, thereby resulting in a decreased rainwater inhibitory function by vegetation.

In Figure 4, all of the treatments give a high growth trend, but on P2D4 treatments. Based on a survey

conducted by KIFC, the soil pH value of the HLG Londerang is 3.6 – 4.1 (very acid) and the pH of the peat water ranges between 4.99 – 5.14 (acid). P- available ranges between 6.02 – 141.19 (very low-very high), whereas the basics K, Ca, Mg can be measured very low and moderate. Giving NPK fertilizer treatment helps in filling the P element in the soil. Giving dolomites to the dried soil can raise the pH of soil that can support the life of microorganisms in the ground. The provision of inorganic fertilizers such as NPK is one of the efforts in improving the needs of plants through the improvement of the chemical properties of the soil. Giving the element P in the soil can enhance the fur of the root which serves to increase the range of the roots in the absorption of water and nutrient.

The application of inorganicand organic fertilizers to the soil to change nutrient environmental for plants (Nursyamsi et al., 2016)One of the fertilizers inorganic fertilizer used is NPK fertilizer which aims to increase the availability of nutrients N, P, and K so that their availability is more guaranteed and expected to increase seedling growth.

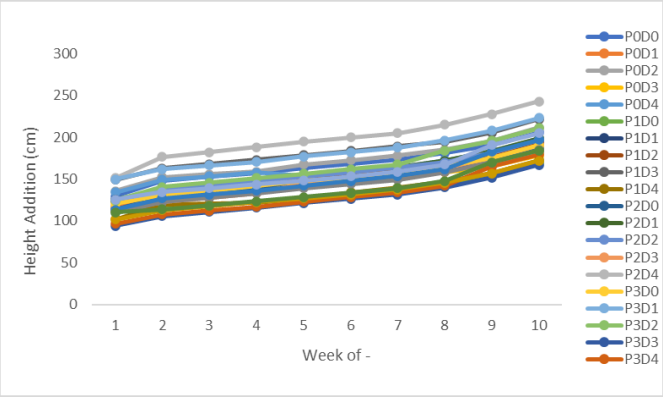


**Figure 3.** Gelam (*Melalueca cajuputi*) High Addition

*Gelam (Melaleuca cajuputi) Diameter Addition*

Based on figure 5, the best diameter yield is on the treatment of P3D1 (NPK fertilizer 80 gr and a dose of 40 g dolomite), while at the P1D4 (NPK fertilizer 40 gr and a dose of 120 g dolomite) treatment, yielding the lowest high growth trend result. The increase in height and diameter is influenced by the availability of the N element that will be used to stimulate cell division and enlargement (F Ikayanti et al., 2021).The improvement of the pH with dolomite and NPK fertilization can stimulate the growth and development of plant tissue that can support the photosynthesis activity to be optimal. Fertilization and pH increases have a relationship in increasing the availability of fertilizer elements for plants, it's same with statement from (Chotimah et al., 2022) that application inorganic fertilizer increased the chemical properties. If the pH is low, the absorption of NPK will not affect by plants. Therefore, the improvement of the pH with dolomite is very helpful in the repair of the nutrient element in the soil. Based on the results of the scale analysis, that treatment given has no real influence on the increase in height and diameter. This is supposed to be due to the influence of NPK fertilizer and dolomite still takes a lot of time in giving a real influence based on statistics. The condition of the burnt land also requires a lot of time in the recovery of the elements of the land as well as the physical, chemical and biological properties of the soil. Gelam is also adaptive at soil pH 3.46 – 3.86, and is known as the pioneer type after a forest fire.

Gelam (*Melaleuca cajuputi*) is a potential species for rehabilitating peat land area and can be grown on land has nutrient from fertile land and rich (Widiana Ana et al., 2014). Naturally distributed in Sumatera Selatan, it could be found in any swamp ecosystem, from intertidal to full submerged peat swamp forest. Gelam is reckoned to perform very well in peat swamp restoration area.

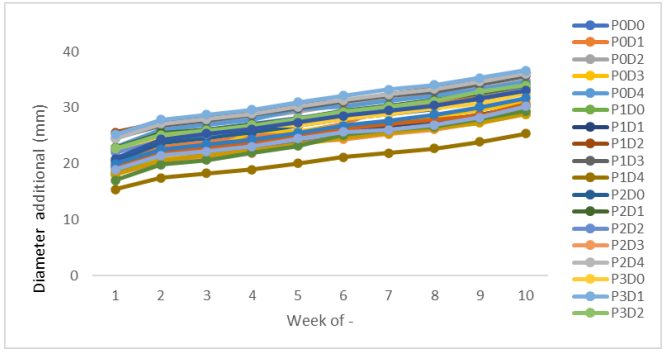


**Figure 4.** Gelam (*Melalueca cajuputi*) Diameter Addition

## Conclusion

Gelam (*Melaleuca cajuputi*) is a potential species for rehabilitating peat land area. Naturally distributed in Sumatera Selatan, it could be found in any swamp ecosystem, from intertidal to full submerged peat swamp forest. The best high yield is on the treatment NPK fertilizer 60 gr and a dose of 160 g dolomite and NPK fertilizer 80 gr and a dose of 40 g dolomite

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**Author Contributions**

Each autor contributed in some way to the project's completion. All author decided on the study materials, fundamental ideas, and research methods. Subsequently,

all autors share responsibility for data collection, data analysis, the review process and paper writing.

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**Conflicts of Interest**
No conflict of interest

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