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Chlorophyll Content of Aromatic Rice *Mentik Susu* in Peat Soils Due to Ash Ameliorant and *Jakaba* LOF

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ABSTRACT

Paddy chlorophyll is one of the determinants of plant growth and development, as photosynthesis plays a role in capturing light and transforming inorganic compounds into nutrients that plants need. The problem with the cultivation of paddy in the palm soil is the high saturation of the soil. There is a need to improve the ashes, ashes of palm powder, and empty palm cane ashes to lower the saturation. In addition, applying *Jakaba* LOF (liquid organic fertilizer) is necessary to boost the growth of rice plants, especially in the formation of chlorophyll. This research aims to determine the effect of *Jakaba* on the chlorophyll content of aromatic rice *Mentik Susu* in peat soil where ash ameliorant has been applied. This study used a nested factorial completely randomized design (CRD). The *Jakaba* application factor was nested in the ash type. The ash type factor (s) were: s_0 = no ash, s_1 = rice husk ash, s_2 = sawdust ash, and s_3 = empty palm fruit bunch ash. The dose factors for *Jakaba* (j) were: j_0 = without *Jakaba*, j_1 = *Jakaba* 15 mL^{-1}. The research results showed that the application of *Jakaba* had no significant effect on the chlorophyll content. Applying ash ameliorant to peat soil increased rice's chlorophyll-b content and total chlorophyll. Treatment without ash ameliorant (s_0) increased the chlorophyll-b content and total chlorophyll content by 16.45 mg mL^{-1} and 15.27 mg mL^{-1}, respectively compared to the treatment of rice husk ash (s_1), sawdust ash (s_2), and empty palm fruit bunch ash (s_3).

Keywords: soil acidity, rice husks, sawdust, empty palm fruit bunch.

1. Introduction

Rice (*Oryza sativa* L.) is one of the most important food crops and is included as the second largest cereal crop in the world (Haryanto et al., 2008) it is also one of the staple foods consumed by around 50% of the world's population and many Indonesians (Mingyai et al., 2017). Aromatic rice has a fragrant aroma like the aroma of pandanus when cooked, a fluffier texture, and a delicious taste (Sajib et al., 2012).

Rice leaves contain chlorophyll, a pigment that gives green color and is a means of photosynthesis, which allows plants to obtain energy from light (Zakiyah et al., 2018). The chlorophyll content in plants influences the process of plant growth and development. The higher the chlorophyll content, the faster the rate of photosynthesis will increase, thereby making the absorption of nutrients from the soil more optimal and stimulating plant growth and development.

Potential land is directed for developing wetland food crops (paddy fields) through intensification of 221.281 ha and extension of 869.133 ha. Peat soil is a suboptimal wetland that has a limiting factor on the chemical properties of the soil. In addition to the low element of harvest, the soil has a high saturation (low soil pH). The decomposition process of the soil produces organic acids that can affect the level of soil acidity (Moore et al., 2011).

Adding ameliorant can be used as a physical condition of the soil. Lestari et al. (2013) stated that minerals, limestone, compost, and residues of combustion ashes can be used to improve soil fertility. Substances that are potentially improved and easily obtainable include peppermint (farm field), powder (industrial field), and empty palm coconut doughnuts (industry field). Empty copper mint, palm oil, ashes, powdered wood, and ashes were analyzed for several chemical properties in the laboratory, including pH, CaO, MgO, and SiO_2, to find out their ability to neutralize H^+ ions (increasing pH) in peat soil (Saputra et al., 2022). One of the elements that is found in ashes is Mg, which has a strong influence on the formation of chlorophyll (Andri & Wawan, 2017).

In addition to the amelioration of ash, *Jakaba* can help in the process of chlorophyll formation. *Jakaba* is a liquid organic fertilizer (LOF) made from the wastewater of rice wash. The benefits of *Jakaba* include accelerating the growth of dwarf plants, prolonging the lives of plants, and overcoming fusariums (Azisah, 2021). The research aimed to determine the effect of *Jakaba* on the chlorophyll content of aromatic rice *Mentik Susu* in peat soil applied with ash ameliorant.

2. Materials and Methods

Materials

The research was carried out in July–December 2023 in the greenhouse, the Laboratory of Production, and the Integrated Laboratory Department of Agroecotechnology, Faculty of Agriculture, Lambung Mangkurat University, Banjarbaru, South Kalimantan, Indonesia.

The materials used in this research were peat soil, rice husk ash, sawdust ash, empty palm fruit bunch ash, *Mentik Susu* aromatic rice varieties, *Jakaba*, washed rice water, rice bran, bamboo roots, sugar, sprouts, shrimp paste, duck eggs, flavor additives, white lime paste, leaves of paddy, NPK fertilizer, and acetone 80%. The tools used are a hoe, shovel, meter, buckets, blenders, string, porous fabric, bottle, wafer, sack, scales, test sieve 20 mesh, mortar, spectrophotometer, erlenmeyer, condenser, centrifuge, tube, pipette, camera, and labels.

Methods

The first factor was ash type (s), i.e., s_0 = without ash, s_1 = rice husk ash, s_2 = sawdust ash, and s_3 = empty palm fruit bunch ash. The second factor is the application of *Jakaba* LOF (j), i.e.: j_0 = without *Jakaba* LOF, j_1 = 15 mL^{-1} *Jakaba* LOF, obtaining as many as 8 combinations of treatments, each repeated 4 times, thus obtaining 32 experimental units.

The implementation of the research was divided into several stages, namely:

<u>The manufacture of *Jakaba*</u>. The first step is to put the rice wash water (ACB) in a clean container. Next, smooth the 200 g of sprouts with clay water to facilitate mixing. Insert the decoction, enough clay water, terrace, chopped limestone, sugar, and sprouts that have been smoothed into the plate and boiled until the texture turns into flour. When the ingredients are cold, continue to mix them with clay water in each container of 15 L. Insert the bamboo roots that have been hit to smooth into the container and mix until they are flat. The bamboo roots were previously soaked in water for 24 hours. Then cover the top of the container with porous cloth to close with rubber. During the fermentation process, the *Jakaba* is placed in a shaded place (not exposed to sunlight) for 35 days, after which the container is opened. There will be red spots that are the future fungi of the department. During the storage process, the container should not move so that the rice washing water sulfur does not fall. Continue the process and let the *Jakaba* grow as big as you want. If for 30 days the mushroom does not appear, then the process is deemed to have failed (Sahidj, 2021).

Preparing the ingredients and tools first, add all ingredients (eyes, flavor additives 100 g, and shrimp paste 5 g, *Jakaba* lily water into the blender until it is mixed smoothly). Then insert *Jakaba* lilies into a bottle of mineral water enough to keep a space. The ingredients that have been smoothed are inserted into the mineral water bottle with *Jakaba* water. Cover the bottle tightly and fold it until the *Jakaba* LOF is scaly. Then, exposed it to sunlight for 15 – 30 days until it turns red and keeps folding every five days (Sumartono, 2020). The process of making the ashes is based on the principle of perfect open combustion and using a 20-mesh patch to make the material uniformly sized (Nurida, 2014).

<u>Soil preparation</u>. The land was taken from the farmers' fields in Kurnia Street of Gambut District, Banjar Regency, South Kalimantan, Indonesia (-3.3985770 – 114.7278330). The soil is taken from several points with a depth of 0-30 cm as much as 272 kg.

<u>Preparation of rice seed</u>. Rice seeds aromatic *Mentik Susu* were immersed in the water last night for one night. Floating seeds and dirt are removed, while sinking seeds are taken for sowing using a 35 cm x 27 cm pan containing topsoil and cattle cage fertilizer in a ratio of 1:1. Seeding was done for 12 days.

<u>Preparation of planting media</u>. The soil is removed from the remains of plants such as branches, roots, and leaves, that are mixed in the process of harvesting and then inserted into a container of 8.5 kg. After that, each container is filled with water as high as 3 cm from the surface of the soil, then incubated for two weeks. During the incubation period, the water level is maintained at 3 cm of the ground surface in the container.

<u>Ash ameliorant application</u>. Rice husk ash, sawdust ash, and empty palm fruit bunch ash are added to each experimental bucket equivalent to an organic fertilization dose of 10 t ha^{-1} or equivalent of 113 g $bucket^{-1}$ (Saputra & Sari 2021). Application of amelioration by spreading on the clay soil and mixing it evenly.

<u>Rice planting</u>. Rice seedling aromatic *Mentik Susu* are transferred to the experimental limbs after 12 days in the seed of as many plants as one for each bucket.

<u>Basic fertilizer applications</u>. Fertilizers added to each bucket are given as basic fertilizer and are equivalent to the dosage for peanut crops in Indonesia, the administration of urea fertilizers of 100 kg ha^{-1}, SP36 of 50 kg ha^{-1} and KCl of 50 kg ha^{-1} (Idwar et al., 2014). Urea fertilizer is given gradually, i.e., 50% at planting, 25% at 3 weeks after planting (WAP), and 25% at 5 WAP, while SP36 and KCl fertilizers are given once during planting. Application of this NPK fertilizer in a way that is sprinkled on each bucket.

<u>Application *Jakaba* LOF</u>. Application of *Jakaba* as liquid organic fertilizer is by taking 40 mL of *Jakaba* water and adding 10 L of common water or wells. Applications by spraying on the leaves of a paddy plant of 15 mL *Jakaba* LOF per plant once a week from the first week to the tenth week until the final vegetative period marked by the appearance of rice panicles.

<u>Sampling</u>. Leaf sampling was taken when the paddy showed the first flower, and at least three pot plants had removed the malai. The leaves on each bucket are cut as much as one thread from the base part or book, and on the top leaves 1 to 3 with the same or uniform leaf position on every bucket. Then the sample is inserted into the plastic linen labeled and then put into a box containing an ice stone. After that, the sample was analyzed in the laboratory with observation parameters of chlorophyll a, chlorophyll-b, and total chlorophyll.

The observation in this study is that the chlorophyll content of paddy leaves was measured when it showed the first panicle, and at least there were 3 pots of plants that had extracted the flower. The leaves in each pot are cut as much as 1 thread, on the top leaves 1-3 with the same leaf position on each pot, and then 1 g leaves are extracted with 80% acetone and determined by a spectrophotometer according to the Arnon Method (Shinha et al., 2013). The leaves are chopped into fine flour with the addition of 20 mL of 80% acetone. Centrifuged (5,000 rpm) for five minutes. The supernatant was transferred to 100 mL of pumpkin roasted with 80% acetone. The absorption of the solution is measured at light wavelengths of 645 and 663 nm against the blank solvent (80% acetone) (Scwartz & Elbe, 1994).

Chlorophyll count:

1. Chlorophyll-a (mg mL^{-1}) $= 12.7\ (A663) - 2.69\ (A645) \times \frac{V}{1000xW}$
2. Chlorophyll-b (mg mL^{-1}) $= 22.9\ (A645) - 4.68\ (A663) \times \frac{V}{1000xW}$
3. Total chlorophyll (mg mL^{-1}) $= 20.2\ (A645) + 8.02\ (A663) \times \frac{V}{1000xW}$

Description:

V = Final volume of chlorophyll extract in acetone 80%

W = Fresh weight of tissue extracted

A = Light wave absorption

Data analysis. The statistical analysis of the data of the effect of treatment on the chlorophyll content was performed using the GenStat Software. Before analysis of variance (ANOVA) is carried out, a Bartlett test is first performed, if the variance is homogeneous then the variation is continued and if not, the data is transformed to be homogenous. The results of the ANOVA showed that the treatment had a real influence ($P \leq 0.05$), then a different treatment test was performed using a Honestly Significant Difference (HSD) at a level of 5%.

3. Results and Discussion

Chlorophyll-a

The results of the ANOVA showed that the application of *Jakaba* on the three different ashes (rice husk ash, sawdust ash, and empty palm fruit bunch ash) did not affect the chlorophyll content of aromatic rice *Mentik Susu* in peat soil. The highest content of chlorophyll in the applications of *Jakaba* LOF and without ameliorant ($j_1 | s_0$) was 23.44 mg mL^{-1}, while the lowest content in without *Jakaba* LOF and rice husk ash application ($j_0 | s_1$) was 11.65 mg mL^{-1} (Figure 1).

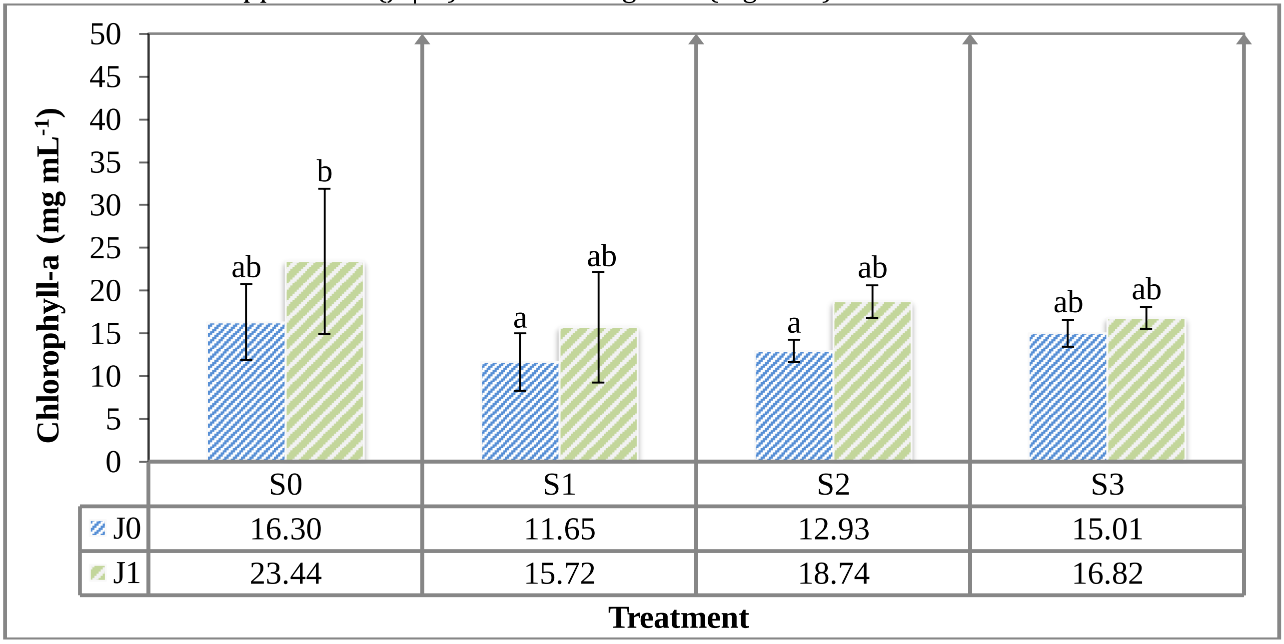


Figure 1. Chlorophyll-a content of aromatic rice *Mentik Susu* in peat soil applied with ash ameliorant and *Jakaba* LOF. Description: without *Jakaba* LOF and without ameliorant ($j_0 | s_0$); *Jakaba* LOF application without ameliorant ($j_1 | s_0$); without *Jakaba* LOF and rice husk ash application ($j_0 | s_1$); *Jakaba* LOF application and rice husk ash application ($j_1 | s_1$); without *Jakaba* LOF and sawdust ash application ($j_0 | s_2$); *Jakaba* LOF application and sawdust ash application ($j_1 | s_2$); without *Jakaba* LOF and empty palm fruit bunch ash application ($j_0 | s_3$); *Jakaba* LOF application and empty palm fruit bunch ash application ($j_1 | s_3$). The line above the bar chart is the *standard error* (n=4). Different letters above the line indicate that the treatments have different effects based on the Honestly Significant Difference (HSD) 5%.

The application of *Jakaba* LOF to various types of ash ameliorant has not been able to have a significant effect on the chlorophyll-a content of aromatic rice *Mentik Susu* in peat soil because the N and Mg content contained in *Jakaba* LOF is relatively low. This is in accordance with research by Rachmawati (2023), the results of lab analysis tests for the nitrogen content in *Jakaba*, were 0.36%, which is low, the resulting water from fermented *Jakaba* obtained a lower value, namely 0.06% and the LOF of *Jakaba* is the lowest, namely 0.04%. The N content in *Jakaba* LOF does not meet the nitrogen required by chlorophyll because it is still below the Ministry of Agriculture standard Number 261/Kpts/Sr.310/M/4/2019, namely 2-6%. According to Rachmawati (2023), the results of the analysis of magnesium (Mg) content were low, namely 0.01%. Based on the standardization of the Ministry of Agriculture's decision Number 261/Kpts/Sr.310/M/4/2019, a minimum of 2-6%, the Mg content did not meet the standard minimum requirements for quality liquid organic fertilizer. Analysis of the nitrogen content in the resulting LOF obtained lower values than in *Jakaba* and *Jakaba* water. This is because the microorganisms that can produce NO_3 in the nitrification process are still in the process of adapting to their environment (Meriatna et al., 2018).

Nitrogen (N) is one of the main constituents of chlorophyll, an indicator of green leaf color. N and Mg function in the formation of chlorophyll, and enzyme activators needed in the photosynthesis process, play a role in capturing light, the process of changing inorganic compounds (CO_2 and H_2O) into organic compounds of carbohydrates, glucose, and O_2 with the help of sunlight to produce nutrients that are distributed to all parts of the plant. as a continuation of the growth process and can influence production results (Campbell, 2010).

The highest chlorophyll-a content was in the application of *Jakaba* LOF in without ameliorant ($j_1 | s_0$) while the lowest was in the application of *Jakaba* LOF in rice husk ash ($j_0 | s_1$), of the three types of ameliorant application of ash and without ash, with the application of *Jakaba* LOF showing the content results chlorophyll-a is higher than without the application of *Jakaba* LOF (Figure 1), this is due to the influence of Al in the ash which is bound to other particles in the combustion process, then concentrates in acidic soil so that it binds nutrients that are really needed by plants, reducing plant absorption capacity, as well as the water-soluble form of Al can also be toxic to plants which interferes with the formation of chlorophyll and photosynthesis (Kusumastuty, 2018). However, the pH contained in the *Jakaba* LOF is more normal so that the application of *Jakaba* it can be higher, the pH of *Jakaba* water is 6.89 and the pH of *Jakaba* LOF is 7.65. The pH is neutral (Rachmawati, 2023). The pH reaches the minimum standard of the Ministry of Agriculture Number 261/Kpts/Sr.310/M/4/2019, namely 4-9. pH and soil structure factors influence the absorption of nutrients needed by chlorophyll, besides that chlorophyll is also sensitive to drought stress and quickly decreases before maturity or entering the generative phase (Handayani et al., 2013).

Chlorophyll-b

The results of the ANOVA showed that the application of *Jakaba* LOF (j_1) and without *Jakaba* LOF (j_0) on the three different types of ash ameliorant, rice husk ash (s_1), sawdust ash (s_2), and oil palm empty fruit bunch ash (s_3), did not affect chlorophyll-b content of aromatic rice *Mentik Susu* in peat soil. The highest chlorophyll-b content in the application of *Jakaba* LOF without ameliorant ($j_1 | s_0$) was 18.55 mg mL^{-1}, while the lowest content without *Jakaba* LOF in the application of rice husk ash ($j_0 | s_1$) was 9.95 mg mL^{-1} (Figure 2).

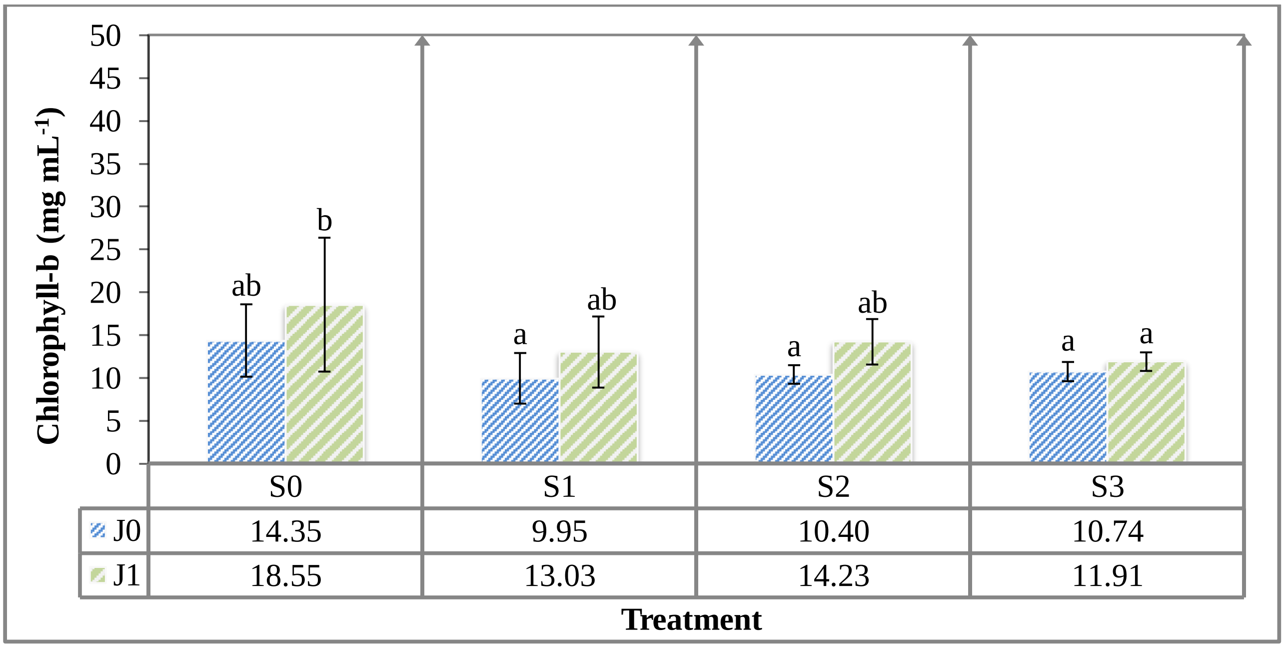


Figure 2. Chlorophyll-b content of aromatic rice *Mentik Susu* in peat soil applied with ash ameliorant and *Jakaba* LOF. Description: without *Jakaba* LOF and without ameliorant ($j_0 | s_0$); *Jakaba* LOF application without ameliorant ($j_1 | s_0$); without *Jakaba* LOF and rice husk ash application ($j_0 | s_1$); *Jakaba* LOF application and rice husk ash application ($j_1 | s_1$); without *Jakaba* LOF and sawdust ash application ($j_0 | s_2$); *Jakaba* LOF application and sawdust ash application ($j_1 | s_2$); without *Jakaba* LOF and empty palm fruit bunch ash application ($j_0 | s_3$); *Jakaba* LOF application and empty palm fruit bunch ash application ($j_1 | s_3$). The line above the bar chart is the *standard error* (n=4). Different letters above the line indicate that the treatments have different effects based on the Honestly Significant Difference (HSD) 5%.

The chlorophyll-b content applied by *Jakaba* LOF to various types of ash ameliorant has also not been able to have a real effect on Mentik Susu on peat soil because the Nitrogen (N) in *Jakaba* LOF is low and below the Ministry of Agriculture standards. Based on Rachmawati (2023), lab test results showed that the nitrogen content in *Jakaba* LOF was the lowest, namely 0.04%, the water from the fermentation of *Jakaba* produced was 0.06% and *Jakaba*, namely 0.36%, was still relatively low. The N content in *Jakaba* LOF is not sufficient required by chlorophyll because it is still below the Ministry of Agriculture standard Number 261/Kpts/Sr.310/M/4/2019, namely 2%-6%. This can be caused by microorganisms in the nitrification process are still unable to adapt to their environment as nitrate producers (Meriatna et al., 2018). The application dose level of *Jakaba* LOF also affects the nutrients absorbed by the plant. According to Rachmawati (2023), the results of the analysis of Mg content were low, namely 0.01%, based on the standardization of the Ministry of Agriculture's decision Number 261/Kpts/Sr.310/M/4/2019, a minimum of 2-6%, the Mg content is not sufficient standard minimum requirements for quality liquid organic fertilizer.

N-rich nutrients are needed in quite large quantities during the vegetative phase to regulate overall growth (Hidayah, 2016). Nitrogen is needed and absorbed by plants in the form of ions, namely nitrate (NO_3^-) and ammonium (NH_4^+), which play a role in influencing the formation of chlorophyll in rice plants (Mawardiana et al., 2013), and the presence of magnesium ions in the soil supports the formation of chlorophyll. Loss of chlorophyll in a plant will cause the leaves to turn yellow, fall, and eventually die (Suherman, 2013).

The highest chlorophyll-b content was in the application of *Jakaba* LOF in without ameliorant ($j_1 | s_0$) while the lowest was in the absence of *Jakaba* LOF in rice husk ash ($j_0 | s_1$), of the three types of ash and without ash ameliorant application, with no application of *Jakaba* LOF the content results were chlorophyll-b is lower compared to the application of *Jakaba* LOF (Figure 2), this is due to the influence of Al (aluminum) in the ash which is bound to other particles in the combustion process, then concentrates in acidic soil so that it binds nutrients needed by plants, reducing the absorbed by plants, and the water-soluble form of Al can also be toxic to plants which interferes with the formation of chlorophyll and photosynthesis (Kusumastuty, 2018).

Figure 3 shows the influence of a single factor of ash ameliorant, the results of the analysis of variance show that without ameliorant (s_0), the application of ameliorant from three different types of ash, rice husk ash (s_1), sawdust ash (s_2), and empty palm fruit bunch ash (s_3) has a real influence on the chlorophyll-b content of aromatic rice *Mentik Susu* in peat soil. Treatment without ameliorant (s_0) is the best treatment.

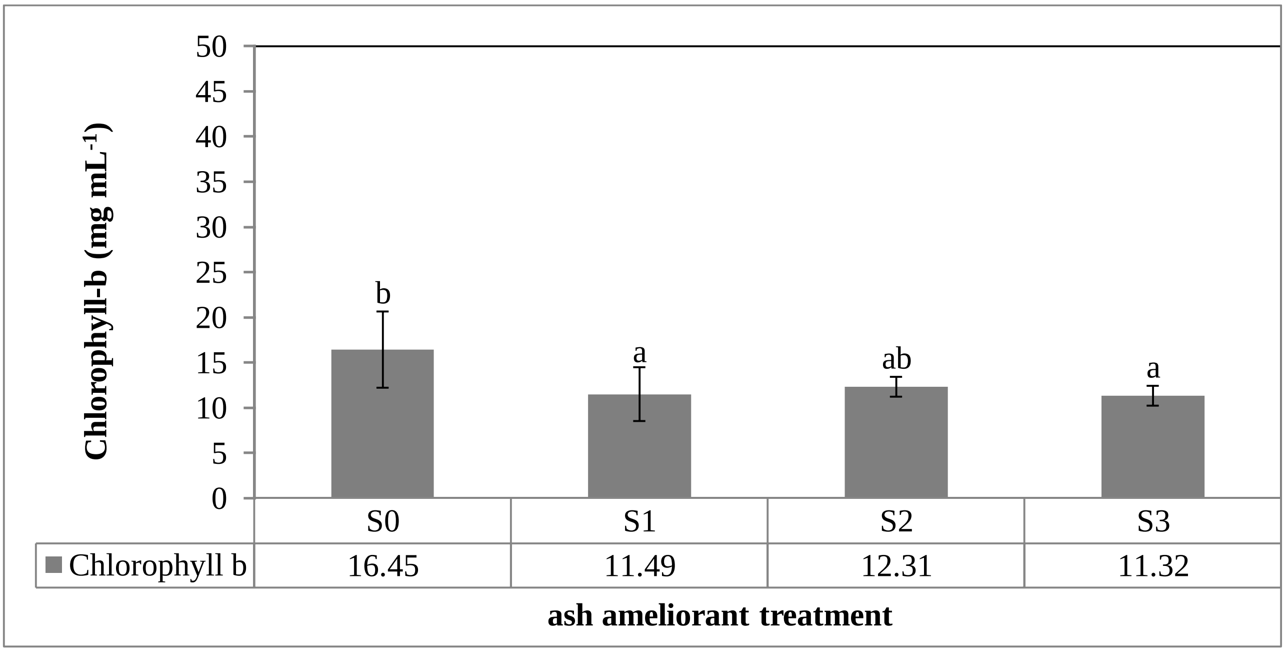


Figure 3. Chlorophyll-b content of aromatic rice *Mentik Susu* in peat soil applied with ash ameliorant. Description: without ameliorant (s_0); rice husk ash (s_1); sawdust ash (s_2); empty palm fruit bunch ash (s_3). The line above the bar chart is the standard error (n=4). Different letters above the line indicate that the treatments have different effects based on the Honestly Significant Difference (HSD) 5%.

Figure 3 shows that treatment s_0 (without ameliorant) gave the best results, namely 16.45 mg mL^{-1}, compared to treatment s_2 (sawdust ash), which was 12.31 mg mL^{-1}, treatment s_1 (rice husk ash) which was 11.49 mg mL^{-1}, and the lowest in the s_3 treatment (empty palm fruit bunch ash) was 11.32 mg mL^{-1}.

One of the reasons why treatment without ameliorant is better than the application of ash ameliorant, rice husk ash, sawdust ash and empty palm fruit bunch ash is the chlorophyll-b content of aromatic rice *Mentik Susu* in peat soil. This was like chlorophyll a, namely the effect of aluminum oxide. (Al_2O_3) contained in ameliorant ash from the combustion process assisted by oxygen can cause a decrease in the rate of photosynthesis and chlorophyll in plants (Martignago et al., 2019). An increase in Al_2O_3 in roots and leaves causes Mg and N concentrations to decrease, so that plant chlorophyll decreases and inhibits the photosynthesis process (Putri et al., 2021). According to Abdullah (2021), Al dissolves in acidic soil at the same time, so the soil tends to have more potential to cause toxicity, which inhibits the absorption of water and nutrients. Al toxicity is a potential growth-limiting factor for plants growing in acidic soils (Kisnierinene & Lepeikaite, 2015).

Total Chlorophyll

The results of the ANOVA showed that the application of *Jakaba* LOF (j_1) with a dose of 15 ml L^{-1} and without *Jakaba* (j_0) on the three types of ash ameliorant was different from rice husk ash (s_1), sawdust ash (s_2), and empty palm fruit bunch ash (s_3) does not affect the total chlorophyll content of aromatic rice *Mentik Susu* on peat soil. The highest total chlorophyll content in the application of *Jakaba* LOF without ameliorant ($j_1|s_0$) was 17.26 mg mL^{-1}, while the lowest was without *Jakaba* LOF in the application of rice husk ash ($j_0|s_1$), namely 9.22 mg mL^{-1} (Figure 4).

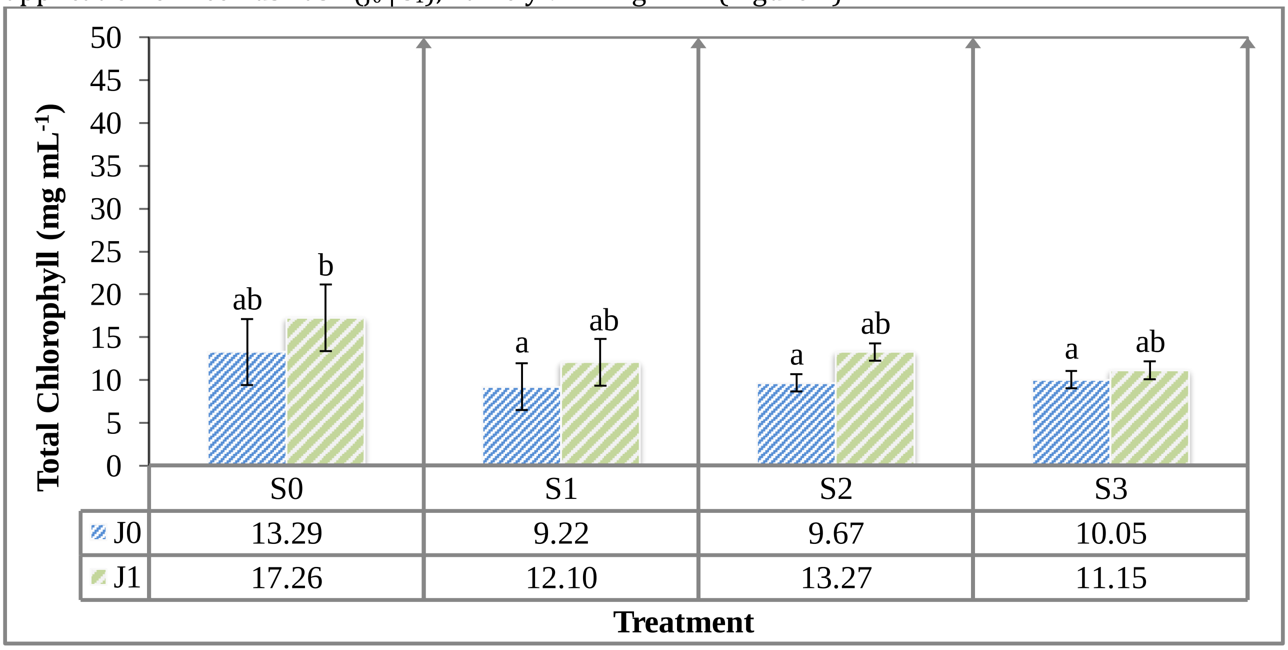


Figure 4. Total chlorophyll of aromatic rice *Mentik Susu* in peat soil applied with ash ameliorant and *Jakaba* LOF. Description: without *Jakaba* LOF and without ameliorant ($j_0|s_0$); *Jakaba* LOF application without ameliorant ($j_1|s_0$); without *Jakaba* LOF and rice husk ash application ($j_0|s_1$); *Jakaba* LOF application and rice husk ash application ($j_1|s_1$); without *Jakaba* LOF and sawdust ash application ($j_0|s_2$); *Jakaba* LOF application and sawdust ash application ($j_1|s_2$); without *Jakaba* LOF and empty palm fruit bunch ash application ($j_0|s_3$); *Jakaba* LOF application and empty palm fruit bunch ash application ($j_1|s_3$). The line above the bar chart is the *standard error* (n=4). Different letters above the line indicate that the treatments have different effects based on the Honestly Significant Difference (HSD) 5%.

Total chlorophyll refers to the total amount of chlorophyll. There are several types of chlorophyll such as chlorophyll-a and chlorophyll-b, which have slightly different light absorption spectra. The total amount of chlorophyll is often measured as an indicator of the health and photosynthetic productivity of a plant. The determination of total chlorophyll can be done with a spectrophotometer. The lowest total chlorophyll average is found at the tips of the leaves, namely 5.4 mg mL^{-1}, while the highest amount is found at the base leaves, namely 22.4 mg mL^{-1} (Hendriyani, 2018). Correlation between chlorophyll a, b, and total chlorophyll, chlorophyll-a makes up 75% of the total chlorophyll 25% chlorophyll-b makes up. Chlorophyll in plants amounts to around one percent of the dry weight of plants (Pratama & Andi, 2015). The chlorophyll content of rice as a SPAD (soil-plant analyzes development) value ranges from 18.4 mg mL^{-1} to 34.3 mg mL^{-1} at the tillering stage, 19.5 mg mL^{-1} to 36.8 mg mL^{-1} at initiation panicles, and 14.3 mg mL^{-1} to 26.5 mg mL^{-1} at the harvest stage (Sivaranjani et al., 2020).

The application of *Jakaba* LOF to various types of ash ameliorant has not been able to provide a real influence on the total chlorophyll of aromatic rice *Mentik Susu* in peat soil because the N content contained in *Jakaba* LOF does not meet the N required for chlorophyll and is still below the standard of the Ministry of Agriculture Number 261/Kpts/Sr,310/M/4/2019, namely 2%-6%. In accordance with research by Rachmawati (2023), the results of laboratory analysis tests for the nitrogen content in *Jakaba*, namely 0.36%, were classified as low, the water from the fermentation of *Jakaba* obtained a lower value, namely 0.06% and the LOF of *Jakaba* was the lowest, namely 0.04%. Analysis of the nitrogen content in the resulting LOF obtained lower values than in *Jakaba* and *Jakaba* water, this is because the microorganisms that are capable of producing nitrate in the nitrification process are still in the process of adapting to their environment (Meriatna et al., 2018). Application of LOF doses of *Jakaba* can also affect the total chlorophyll content. the results of the analysis of magnesium (Mg) content are low, namely 0.01%, based on the standardization of the Ministry of Agriculture's decision Number 261/Kpts/Sr.310/M/4/2019, a minimum of 2-6%. The Mg content does not meet the minimum standard requirements for liquid organic fertilizer quality.

High-nitrogen nutrients can help in the process of forming vegetative organs such as leaves. The wider the leaf, the greater the amount of chlorophyll, and the rate of photosynthesis increases. This is following the statement of Sutrisno (2015), explaining that the nutrient N can trigger the growth of organs related to photosynthesis and can increase the yield of plants producing leaves and wide plant leaves with a greener color, and the presence of magnesium in the soil supports the formation of chlorophyll.

The highest total chlorophyll was in the application of *Jakaba* LOF without ameliorant ($j_1 | s_0$) while the lowest was in the treatment without *Jakaba* LOF in rice husk ash ($j_0 | s_1$), of the three types of application of ash and without ash ameliorant, with the application of *Jakaba* LOF showing the total content results chlorophyll is higher than without the application of *Jakaba* LOF (Figure 4), this is due to the influence of Al on ash ameliorant which is concentrated in peat soil so that it binds nutrients that plants need, reduces plant absorption and can also be toxic to plants. which interferes with the formation of chlorophyll and photosynthesis (Kusumastuty, 2018), however the pH contained in the *Jakaba* LOF is optimal so that with the application of *Jakaba* the total chlorophyll is higher, the pH of the *Jakaba* water is 6.89 and the pH of the *Jakaba* LOF is 7.65. The pH is neutral (Rachmawati, 2023). The pH reaches the minimum standard of the Ministry of Agriculture Number 261/Kpts/Sr.310/M/4/2019, namely 4-9. Apart from the low pH factor, chlorophyll is also because the plant has entered the generative phase, so it quickly declines towards maturity and is sensitive to drought stress (Handayani et al., 2013).

Figure 5 shows the effect of a single factor of ash ameliorant, the results of the analysis of variance show that without ameliorant (s_0), the application of ameliorant from three different types of ash, rice husk ash (s_1), sawdust ash (s_2), and empty palm fruit bunch ash (s_3) has a real influence on the total chlorophyll of aromatic rice *Mentik Susu* in peat soil. The best treatment without ameliorant (s_0) was 15.27 mg mL^{-1}.

The results showed that the S_0 treatment (without ameliorant) gave the best results, namely 15.27 mg mL^{-1}, compared to the S_2 treatment (sawdust ash) which was 11.47 mg mL^{-1}, the S_1 treatment (rice husk ash) which was 10.66 mg mL^{-1}, and the lowest in the s_3 treatment (empty palm fruit bunch ash) was 10.60 mg mL^{-1} (Figure 5).

The application of ameliorant types of ash, rice husk ash, sawdust ash, and empty palm fruit bunch ash did not give good results compared to without ameliorant on the total chlorophyll of aromatic rice *Mentik Susu* in peat soil. Total chlorophyll is greatly influenced by the application of soil amendment, this is related to chlorophyll-a and b. However, the effect of Al_2O_3 in ash ameliorants can cause a decrease in the rate of photosynthesis and chlorophyll formation in plants (Martignago et al., 2019). Al content in the ameliorant ash resulting from burning organic materials such as wood or litter is usually in the low range, <1% in the total weight of the ash, rice plants can survive at aluminum concentrations reaching

20-30 ppm equivalent to 0.2-0.3% or higher. Increasing Al in the roots and leaves causes the Mg concentration in these two organs to decrease, so that the total chlorophyll content and photosynthesis process also decrease (Putri et al., 2021). According to Abdullah (2021), Al dissolves in acidic soil at the same time, so the soil tends to have more potential to cause toxicity, which inhibits the absorption of water and nutrients, reducing the rate of photosynthesis. Altoxicity is a potential growth limiting factor for plants growing in acidic soils (Kisnierinene & Lepeikaite, 2015).

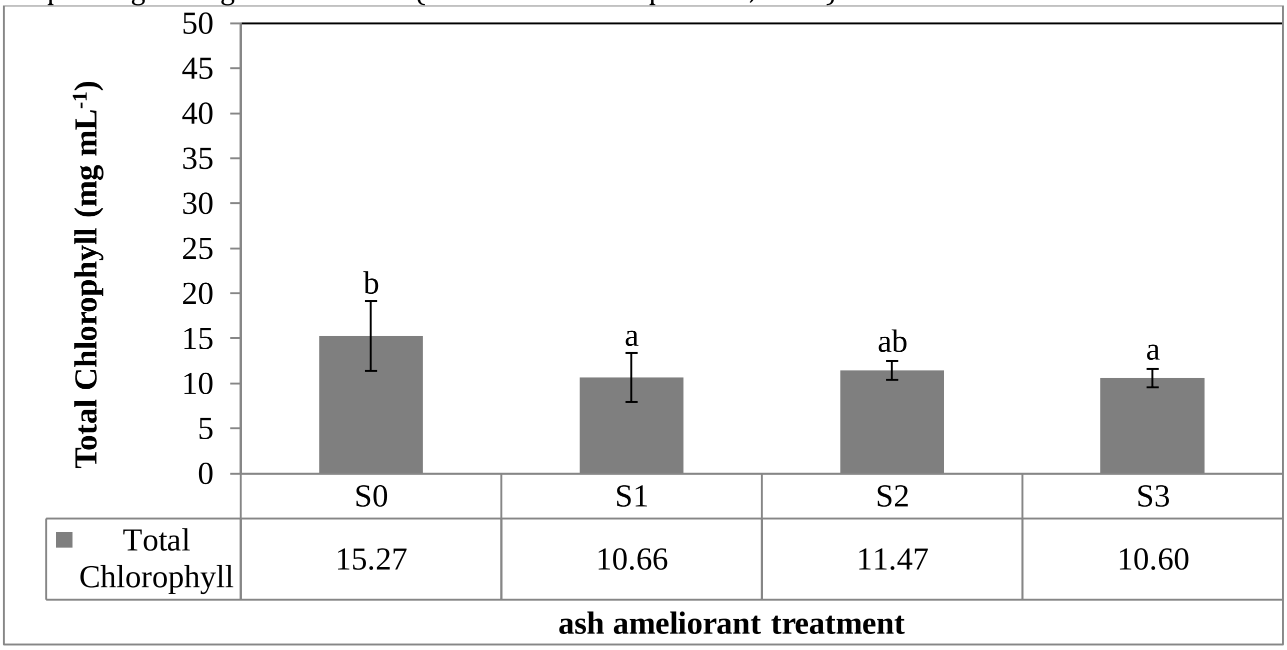
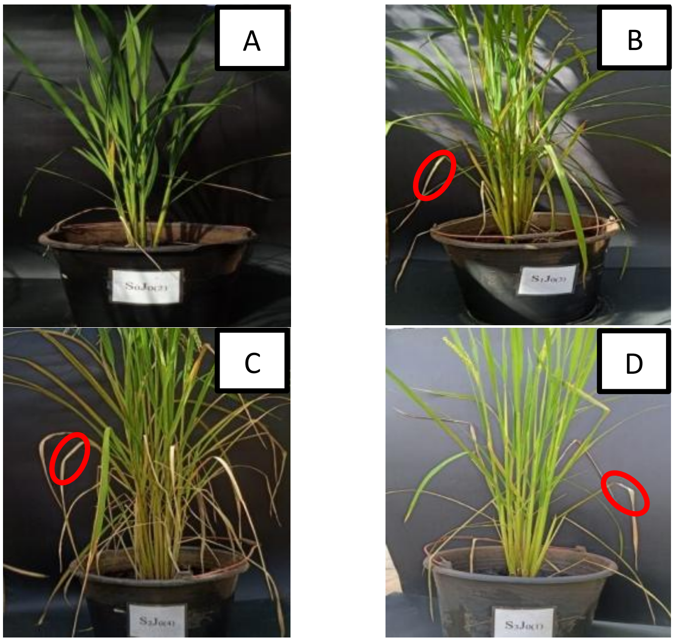


Figure 5. Total chlorophyll of aromatic rice *Mentik Susu* in peat soil applied with ash ameliorant. Description: without ameliorant (s_0); rice husk ash (s_1); sawdust ash (s_2); empty palm fruit bunch ash (s_3). The line above the bar chart is the *standard error* (n=4). Different letters above the line indicate that the treatments have different effects based on the Honestly Significant Difference (HSD) 5%.

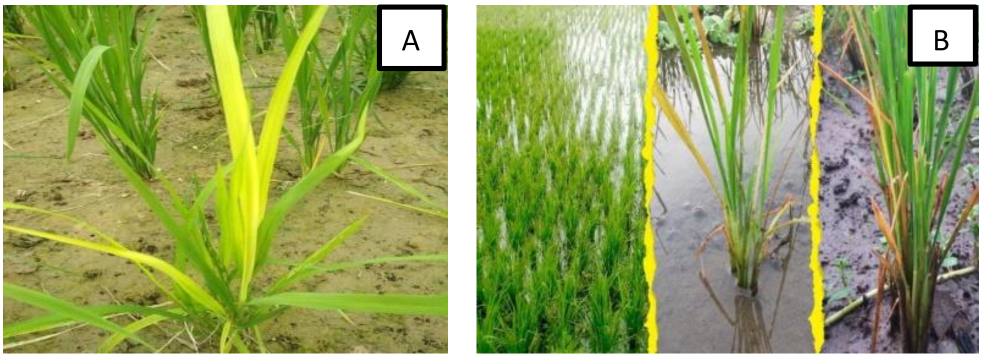
According to Susandi et al. (2015), the pH in the rice husk ash treatment (4.39) was still low, and the empty palm fruit bunch ash (7.23) was too high. The increase in pH due to the application of ash is caused by an increase in Ca in the soil, which can shift the position of absorbed H^+ ions so that the soil pH increases, as well as a high concentration of Al dissolved in peat soil, which also causes poor plant growth. The cause of the increase in pH when giving rice husk ash and empty palm fruit bunch ash after incubation is probably due to decomposition or decomposers that release alkaline cations such as K, Ca, and Mg, which can increase the pH considering the physical properties of rice husk ash and empty palm fruit bunch ash. used in the ashing process to bind Al particles with oxygen, this is shown by the remains of organic material that are still found in empty bunch ash and rice husk ash (Himawati et al., 2017).

External and internal factors influence the amount of chlorophyll a, b, and total chlorophyll content of plants. External factors are mainly soil, air, soil humidity, light, nutrients, soil pH, and water supply. The internal factors in question are genes, hormones, anatomical structure, and plant morphology (Mawardi & Mustafa, 2021).



Notes: A = s_0 (without ameliorant); B = s_1 (rice husk ash); C = s_2 (sawdust ash); D = s_3 (empty palm fruit bunch ash).
Figure 6. Symptoms due to toxic Al on aromatic rice *Mentik Susu* on peat soil (Personal documentation, 2023).

Since the beginning of growth, rice plants have always been faced with various obstacles in peat soil, such as high levels of organic acids, low soil pH, and low nutrient content, which hinder the growth process. In suboptimal peat soils, plants can experience Al poisoning, which is the main factor limiting agricultural crop production (Samac & Tesfaye, 2003). Aluminium (Al) in peat soil can come from wood residues and litter that accumulate in the soil body, it has not been decomposed optimally, it will produce organic acids which that increase the acidity of the peat. Al is also found in peat colloids which can also be caused by organic amino acids (Ratmini, 2012). Symptoms of Al poisoning can be seen from the presence of some leaf damage starting from the yellowing of the leaf tips when they are 6-8 weeks old (Figure 6 (A) s_0 (without ameliorant), (B) s_1 (rice husk ash), (C) s_2 (sawdust ash), and (D) s_3 (empty palm fruit bunch ash). This is in line with the statement of Roslim et al. (2010), the length of the leaves turns yellow at a position of 1-4 cm from the tip of the leaf, and then the yellowing of the leaves changes until the leaves begin to wilt, break, dry, and even collapse.



Notes: A = nitrogen deficiency; B = Al toxicity.
Figure 7. Differences in the impact of nitrogen deficiency and Al (aluminum) poisoning on rice plants (Bumi Kita, 2019).

This is different from the symptoms of N deficiency (Figure 7), namely leaf chlorosis and necrosis, and yellow leaves spreading to the base of the leaf through the leaf veins (V-shaped). If the deficiency becomes more severe, the second and third oldest leaves experience a similar deficiency pattern, and the leaves the oldest at that time will become perfect chocolate (Sugito, 2012).

4. Conclusions

The application of *Jakaba* LOF did not have a significant effect on the chlorophyll content of aromatic rice *Mentik Susu* in peat soil based on the type of ash ameliorant. Application of ash ameliorant to peat soil planted with aromatic rice *Mentik Susu* can increase the chlorophyll-b content and total chlorophyll of rice. Treatment without ash ameliorant (s_0) can increase the chlorophyll-b content and total chlorophyll content of rice by 16.45 mg mL^{-1} and 15.27 mg mL^{-1} respectively compared to the treatment of rice husk ash (s_1), sawdust ash (s_2), and empty palm fruit bunch ash (s_3).

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References

Abdullah, S. S., Djide, N., & Natsir, S. (2021). KLT bioautografi hasil partisi ekstrak etanol herba bandotan (*Ageratum conyzoides* L.) terhadap *Shigella dysentriae*. *Chem Prog*., 14(1): 14-21. DOI: https://doi.org/10.35799/cp.14.1.2021.34076.

Andri, R. K., & Wawan, W. (2017). Pengaruh pemberian beberapa dosis pupuk kompos (*greenbotane*) terhadap pertumbuhan bibit kelapa sawit (*Elaeis quieneensis Jacq*) di pembibitan utama. *J-online Mahasiswa Fakultas Pertanian Universitas Riau*, 4(2): 1–14. DOI: https://doi.org/10.20961/agrotechresj.v4i1.41121.

Azisah. (2021). JamurJakabaPPLKec.Palakk.http://cybex.pertanian.go.id/artikel/98027/jamurjakaba/. http://cybex.pertanian.go.id/mobile/artikel/98027/JAMUR-JAKABA.

Bumi Kita. (2019). Mengatasi Gejala Asam Tanaman Padi. https://bumikita.id/artikel/detail/Mengatasi-Gejala-Asam-Asaman-pada-Tanaman-Padi

Campbell, N. A., Reece, J. B., & Mitchell, L. G. (2010). *Biologi*. Jakarta: Penerbit Erlangga.

Handayani, T., Basunanda, P., Murti, H. R., & Sofiari, E. (2013). Pengujian stabilitas membran sel dan kandungan klorofil untuk evaluasi toleransi suhu tinggi pada tanaman kentang. *Jurnal Hortikultura*, 23(1): 28-35.

Haryanto, Dwi, T. A., Suwarto, S., & Yoshida, T. (2008). Yield stability of aromatic upland rice with high yielding ability in Indonesia. *Plant Prod. Sci*., 11(2): 96-103. DOI: https://doi.org/10.1626/pps.11.96.

Hidayah. (2016). Pengaruh pemberian pupuk urea dan pupuk kandang ayam terhadap pertumbuhan dan hasil tanaman jagung manis (*Zea mays Saccharata Sturt* L.) varietas gendis. *Jurnal Viabel Pertanian*, 10(1): 1–19.

Himawati, S., Purwanto, B. H., & Utami, S. N. H. (2017). Kinetika dan serapan kalium padi sawah yang diperlakukan dengan pupuk organik di inceptisol Kalitirto, Sleman. Tesis, Universitas Gadjah Mada, Yogyakarta.

Idwar, Syofjan, J., & Ardiansyah, R. F. (2014). Rekomendasi pemupukan N, P dan K pada tanaman padi sawah (*Oryza sativa* L.) dalam program operasi pangan Riau Makmur (OPRM) di Kabupaten Kampar. *J. Agrotek*, 3(1): 32- 38.

Kusumastuty, D. A. (2018). Analisis perubahan morfologi dan kadar korofil pada tanaman kersen (*Muntigia caabura* L.) di area pertambangan Wonocolo kelembagaan Universitas Malang. http://eprints.umm.ac.id/38097/3/B AB II. pdf Minyak Kabupaten Bojonegoro. Gudang, UMM. Muhammadiyah.

Kisnieriene, V., & Lapeikaite, I. (2015). When chemistry meets biology: the case of aluminium- a review. *Chemija*. 26(9): 148–158.

Lestari, Y., Raihana, Y., & Saragih, S. (2013). Teknologi budi daya tanaman hortikultura di lahan gambut, Dalam Noor, M, Muhammad, A, Mukhlis, Dedy, N & Muhammad, T (Eds), *Lahan gambut: Pemanfaatan dan pengembangannya untuk pertanian*, Yogyakarta: Kanisius.

Martignago, D., Bernardini, B., Polticelli, F., Salvi, D., Cona, A., Angelini, R., & Tavladoraki, P. (2019). The four FAD-dependent Histone demethylases of arabidopsis are differently involved in the control of flowering time. *Front. Plant Sci*., 10(2): 669-671. https://doi.org/10.3389/fpls.2019.00669.

Mawardiana, Sufardi, & Edi, H. (2013). Pengaruh residu biochar dan pemupukan NPK terhadap sifat kimia tanah dan pertumbuhan serta hasil tanaman padi musim tanam ketiga. *Konservasi Sumber Daya Lahan Pascasarjana Universitas Syiah Kuala*, 1(1): 16-23.

Mawardi & Mustafa, M. (2021). Analisis kandungan klorofil pada tingkat perkembangan daun kopi robusta (*Coffea canephora*). *Jurnal Agroplant*, 4(2): 1–10. DOI: https://doi.org/10.56013/agr.v4i2.1165.

Meriatna, Suryati, & Aulia, F. (2018). Pengaruh waktu fermentasi dan volume bio activator EM4 (*Effective Mikroorganisme*) pada pembuatan pupuk organik cair (POC) dari limbah buah-buahan. *Jurnal Teknologi Kimia Unima,* 7(1): 13-29.

Mingyai, Sukanya, Kettawan, A., Srikaeo, K., & Singanusong, R. (2017). Physicochemical and antioxidant properties of rice bran oils produced from colored rice using different extraction methods. *Journal of Oleo Science,* 66(6): 565– 72.

Moore, S., Gauci, V., Evans, C. D., & Page, S. E. (2011). Fluvial organic carbon losses from aa bornean blackwater river. *Journal Biogeosciences,* (8): 901- 909. DOI: http://dx.doi.org/10.5194/bg-8-901-2011.

Nurida. (2014). Potensi pemanfaatan biochar untuk rehabilitasi lahan kering di Indonesia. *Jurnal Sumberdaya Lahan Edisi Khusus*, 57-68.

Pratama, & Andi, J. (2015). Analisis kandungan klorofil gandasuli (*Hedychium gardnerianum shephard Ex Ker-Gawl*) pada tiga daerah perkembangan daun yang berbeda. *Seminar Nasional Konservasi dan Pemanfaatan Sumber Daya Alam*: Universitas Sebelas Maret, Surakarta, Indonesia.

Putri, R.S., Surianti, Hasrianti, Bibin, M., Damis, & Muhammad, F. (2021). Distribution of small pelagics in the Makassar strait in relation to oceanographic parameters. *Jurnal IPTEKS PSP*, 8(2): 48–57.

Rachmawati, L. (2023). Pembuatan dan karakterisasi fisik dan kimia POC jakaba dari air cucian beras. Skripsi, Universitas Lambung Mangkurat, Banjarbaru.

Ratmini, S. (2012). Karakteristik dan pengelolaan lahan gambut untuk pengembangan pertanian. *Jurnal lahan suboptimal*, 1(2): 197-206.

Roslim, D. I., Miftahudin, Suharsono, U., Aswidinnoor, H., & Hartana, A. (2010). Karakter *Root re-growth* sebagai parameter toleransi aluminium pada tanaman padi. *Jurnal Natur Indonesia*, 13(1): 82-88.

Sahidj, A. J. (2021). *Bagaimana Cara Menghidupkan JAKABA Mati, yang Digunakan Cairannya atau Jamurnya*? URL: https://youtu.be/hRv78C8Dy4. Diakses pada tanggal 15 Maret 2023.

Sajib, A. M., Musharaf, M. H., Mosnaz, A. T. M. J., Hossain, H., Islam, M. M., Ali, M. S., & Prodhan, S. H. (2012). SSR marker-based molecular characterization and genetic diversity analysis of aromatic landreces of rice (*Oryza sativa* L.). *J. BioSci. Biotech,* 1(2): 107–16.

Samac, D. A., & Tesfaye, M. (2003). Plant improvement for tolerance to aluminum in acid soils – a review. *Plant Cell, Tissue and Organ Culture*, 75(88): 189-207.

Saputra, R. A., Marsuni, Y., & Ilahi, N. N. N. (2022). Teknologi ameliorasi dalam meningkatkan pH tanah, pertumbuhan, dan hasil cabai rawit di lahan gambut. *J. Hort.,* 32(1): 29-40.

Saputra, R. A., & Sari, N. N. (2021). Ameliorant engineering to elevate soil pH, growth, and productivity of paddy on peat and tidal land. *IOP Conf. Ser. Earth Environ.Sci*., 648(1): 1-8. https://doi.org/10.1088/1755-1315/648/1/012183.

Scwartz, S. J., & Elbe, V. (1994). *Kinetics of chrolophyll degradation to pyropheophytin in vegetables*. *J Food Sci*., 48(4): 1303-1306. https://doi.org/10.1111/j.1365-2621.1983.tb09216.x.

Shinha, D. S., Sharman, & Dwivedi, M. K. (2013). The impact of fly ash on photosynthetic activity and medicinal property of plants. *Internasional Journal of Current Microbiology and Applied Sciences*, 2(8): 382-388. DOI: https://doi.org/10.20527/twj.v6i1.84.

Sivaranjani, C., Chithra, L., Baskar, M., Thamizh, V. R., & Subrahmaniyan, K. (2020). Pengaruh silikon dan nitrogen pada klorofil isi nasi var. TKM-13 di Entisol. *Jurnal Farmakognosi dan Fitokimia*, 9(1): 2245-2249.

Sugito, Y. (2012). *Ekologi tanaman; pengaruh faktor lingkungan terhadap pertumbuhan tanaman dan beberapa aspeknya*. Malang: Universitas Brawijaya Press (UB Press).

Suherman, F. (2013). Pertumbuhan dan kandungan klorofil pada *Capsicum annum* L. dan *Licopersicon esculentum* yang terpapar pestisida. Skripsi, Universitas Pendidikan Indonesia, Bandung.

Sumartono, E. (2020). *Kitab TOA (Tani Organik Alami).* URL: https://zenodo.org/record/4200080. Diakses pada tanggal 07 Juli 2023.

Susandi, Oksana, & Arminuddin, A. T. (2015). Analisis Sifat fisika tanah gambut pada hutan gambut di Kecamatan Tambang Kabupaten Kampar Provinsi Riau. *Jurnal Agroekoteknologi*, 5(2): 23-28.

Sutrisno, A. (2015). Fermentasi limbah cair tahu menggunakan EM4 sebagai alternatif nutrisi hidroponik dan aplikasinya pada sawi hijau (*Brassica juncea* L.). Skripsi, Fakultas Matematika dan Ilmu Pengetahuan Alam, Universitas Negeri Surabaya, Surabaya.

Zakiyah, M., Manurung, F., & Wulandari, R. S. (2018). Kandungan klorofil daun pada empat jenis pohon di Arboretum Sylva Indonesia Pc. Universitas Tanjungpura. *Jurnal Hutan Lestari*, 6(1): 48–55.