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Mustard Greens Growth and Yield Caused by Liquid Organic Fertilizer in Peat Soil

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ABSTRACT

Mustard is one type of leaf vegetable favored by the community because it tastes fresh and contains lots of vitamins A, B, and a little vitamin C. The large area of peatlands in Indonesia and the lack of mineral soils that can be used as agricultural land, make peatland use necessary. Peat is used for agricultural development, with the main limiting factor for growing media conditions that are not conducive to root development, especially land conditions that are saturated with water, react with acid, and contain organic acids at levels that can poison plants, so that some reclamation measures are needed for the land condition peat becomes more suitable for plant development. This study aims to determine the response to the concentration of liquid organic fertilizer (LOF) and its interaction on the growth of mustard greens (Brassica juncea L.) in peatlands. This research was conducted from April to May 2018 using a completely randomized design (CRD). The treatment given was a dose of LOF consisting of 0; 500; 1000; 1500; 2000 and 2500 L/ha. The variables observed included soil pH, plant height, number of leaves, above-ground fresh weight, below ground fresh weight, above-ground dry weight, and below-ground dry weight. The results of this study indicate that dosing of LOF has a significant effect on plant height, above-ground fresh weight, and above-ground dry weight. However, it did not have a significant effect on soil pH, leaf number, and below ground fresh weight and ground dry weight. The application of the highest LOF at 2500 L/ha was able to increase plant height by an average of 7.75 cm.

Keywords: mustard, liquid organic fertilizer, peat soil

INTRODUCTION

Mustard is a type of leaf vegetable that is favored by people and consumers from various groups. Almost all people like mustard because it tastes fresh and contains lots of vitamins A, B, and a little vitamin C, E, and K (Sunarjono, 2004).

Mustard plants grow well on soil that contains lots of nutrients, loose structures, and good drainage (Haryanto *et al*., 2006). Therefore, to increase the yield of the mustard plant, more intensive management is needed, followed by improved soil fertility. One of the actions that can be taken to meet and improve the chemical properties and soil nutrients is the provision of organic fertilizers (Gusnidar *et al*., 2011). However, the lack of productive agricultural land makes it necessary to use peatland to become productive agricultural land. Peat is one of the ecosystems that has a large enough potential to be developed as productive agricultural land as long as it is properly managed because its area is quite large.

Badan Restorasi Gambut (2017) informs that the area of peatland in Indonesia reaches 18.9 million ha. However, in developing peatlands into productive lands, it faces various obstacles, both physical, chemical, and biological. The low productivity of peatlands is caused by several factors, including a high content of phenolic acids that can poison plants, high soil acidity (low pH), and very high cation exchange capacity with very low base saturation (Suastika, 2004).

Marginal land such as peatlands can be increased into productive land by applying appropriate technology. Peatlands are characterized by high organic matter content, high soil acidity, but very

low availability of macro and micronutrients. Also, in the rainy season, there will be stagnant water and in the dry season, there will be drought, so that water management is an absolute necessity (Yusuf, 2010).

Although peatlands are marginal lands with various constraints, seeing their area reaching 30,000 ha in Bengkulu, this land has the potential to be developed. For that, we need an approach pattern based on characteristics and characteristics by considering the irrigation system, fertilization, compatibility of commodities, and varieties. One of the approaches is the application of LOF.

The use of synthetic fertilizers is an effort to increase mustard production. This fertilizer can increase the yield of cultivated crops, however, the use of synthetic fertilizers in the long term can damage the soil and reduce crop yields so that the soil is no longer able to increase its productivity. Therefore, it is necessary to find alternative technologies that can reduce the use of synthetic fertilizers, but still produce products that are acceptable to consumers and are environmentally friendly (Ichwan, 2007). The use of organic fertilizers is one of the alternatives to provide nutrients for plants so that mustard production can increase. The addition of organic matter can improve soil properties, thereby determining the status of soil fertility (Hanafiah, 2010).

The use of natural organic fertilizers that can be used to help overcome agricultural production constraints, namely LOFs. This organic fertilizer is processed from raw materials in the form of livestock manure, compost, natural waste, plant hormones, and other natural materials. Also, LOFs can improve the physical, chemical, and biological properties of soil, help increase crop production, improve the quality of plant products, reduce the use of inorganic fertilizers, and as an alternative to manure (Indrakusuma, 2000). This study aims to obtain the best dose of LOF on the growth of mustard plants in peatlands.

MATERIAL AND METHOD

The research was conducted in a greenhouse and Soil Science Laboratory, Faculty of Agriculture, UNIB, in April 2018. This research used a completely randomized design (CRD) with 6 treatments and was repeated 4 times from each treatment, in total there were 24 experimental units. The treatments are as follows: 0, 500, 1000, 1500, 2000, and 2500 L/ha.

Initial soil analysis was carried out by taking 1 kg of composite peat soil samples from 3 points, then drying and sieving using a 0.5 mm sieve. Soil samples were then analyzed for pH (H_2O), C-organic, total N, P-available, K-dd. The final soil analysis of the experiment was carried out by taking a soil sample of 0.5 kg from each experimental unit, then drying and sieving with a 0.5 mm sieve. The soil sample is then analyzed for acidity.

Liquid organic fertilizer is made directly in the Curup area with ingredients, namely: paitan, cow urine, EM4, sugar, cow dung, and compost. The ingredients are mixed and stirred until blended, then the liquid organic fertilizer is incubated for 3 weeks or until ready to use.

The mustard seed is sown in a tray filled with a planting medium in the form of a mixture of peat and LOF with a ratio of 1: 1. The nursery is done by spreading the mustard seeds on the seedling media that has been saturated with water.

Preparation for planting begins with the preparation of the planting media. The soil used as a planting medium in this study is peat soil taken from the front of the Agricultural Industrial Technology Laboratory, Bengkulu University. Peat is taken composite from two points at a depth of 0-20 cm from the soil surface. Each experimental unit used 2 kg of absolute dry equivalent soil, then the peat was put into a 3 kg polybag.

After the seeds are two weeks old in the nursery or have 2 to 3 leaves, then transferred to polybags filled with soil weighing 2 kg (absolute dry equivalent) two weeks before planting, each polybag is planted with 1 mustard plant. Watering the mustard plant is done 2 times a day, namely in the morning and evening. The application of LOF is done when the mustard greens are 7, 15, and 21 days old. The method of applying LOF is by spraying liquid organic fertilizer around the plants according to the treatment. Manual weeds control by removing weeds that grow around the plant.

Pests and diseases in mustard plants are controlled manually because this research was conducted in a greenhouse and used polybag media so that it was easy to control the pest.

Harvesting is done when the mustard greens are 43 days old and the leaves have opened completely. Soil samples were taken at the end of the experiment. 250 g of soil samples were taken for each polybag. The soil was then dried and sieved with a 0.5 mm sieve and analyzed for several chemical properties of the soil.

The variables observed in this study were pH (Electrometric), plant height, number of leaves, above ground fresh weight, below ground fresh weight, above ground dry weight, and below ground dry weight. The research data were analyzed using analysis of variance (ANOVA). The results of the analysis showed that the real difference was carried out by Orthogonal Poliminal to obtain a model of the relationship between independent and dependent variables at the 5% level.

RESULT AND DISCUSSION

The land used in this study is peat soil located in front of the Agricultural Industrial Technology Laboratory, Faculty of Agriculture, Bengkulu Uni-

versity. The peat used is inundated and sapric maturity (± 15% fiber content) with a depth of 80 cm, and has a characteristic black color.

Table 1. Results of analysis of several chemical properties of peat soil

Atributes	Value	Class
pH H_20	4.3	Acid
N-total	5.2	Low
P-available	1.65	Very low
K-exchange	0.92	Low
C-organic	30.24	Very high

Soil analysis conducted in Soil Science Lab., Agriculture Faculty, University of Bengkulu

Based on Table 1, it can be explained that the H_2O pH of the peat soil used in this study is in the acid category, namely 4.3. This acidic peat soil condition is caused by the accumulation of organic matter and soil in an anaerobic environment, so that many organic acids (phenolic and carboxylic compounds) are formed. The pH reaction is a parameter that is controlled by the properties of the soil colloidal electrolyte. The level of acidity can affect the availability of nutrients in the soil (Riswandi, 2001). Meanwhile, the pH of the soil that is most suitable for mustard growth ranges from 6.0 to 7.0 (Haryanto *et al*., 2006).

The P_2O_5 content in this peat soil is classified as very low (1.65 ppm). The low P in peat soil is thought to be the result of the accumulation of organic matter that has not been completely decomposed and causes the peat to be poor in P nutrients, therefore the P nutrient in peat soil is needed to change soil fertility (Agus & Subiksa, 2008). Whereas P_2O_5 plays a role in plant root growth so that it affects the fresh weight of mustard plants, the function, and benefits of phosphorus nutrients, including the function of transporting energy from metabolism in plants, stimulating flowering and fertilization, stimulating root growth, stimulating seed formation, stimulating plant cell division. and enlarge cell tissue (Yusuf, 2010). According to Purwati (2013), elements of P plays a role in stimulating root growth, especially the growth of roots of seeds and young plants.

The N-total content of peat (0.5%) is classified as low. Nitrogen in peat soil is difficult to provide for plants on peat soil because it is used by microorganisms in the decomposition of organic matter contained in the peat. Radjagukguk (2001) states that total N content in peat soils is generally high but N will only be available after drainage and mineralization, in contrast to peat soils that are inundated, N will be used for the decomposition of peat material by microorganisms so that it is not available to plants. This is very influential on the growth of mustard plants because the nutrient N plays a role in stimulating overall plant growth. According to Lingga & Marsono's (2007) statement that the main role of N for plants is to stimulate overall growth, especially stems, branches, and leaves. Also, N plays an important role in the formation of leaf forage which is very useful in the process of photosynthesis. The N element functions to increase the vegetative growth of plants, namely roots, stems, and leaves, so that plant leaves become wider and greener (Wahyudi, 2010). So it is necessary to fertilize organically, namely by using LOF.

K-dd on peat 0.92 me/100 g is in a low category. Elemental K is the third nutrient element after N and P which is absorbed by plants in the form of K + ions. The positive charge from K will help neutralize the electric charge caused by the negative charge of nitrates, phosphates, or other elements. Element K makes up an average of 1.0% of the plant. This element plays a different role compared to N, S, and P because it functions a little as a constituent of plant components, such as protoplasm, fat, cellulose, but mainly functions in regulating mechanisms (catalytic and catalytic) such as photosynthesis, translocation of carbohydrates, protein synthesis and others. (Hanafiah, 2010). Elemental K acts as an enzyme cofactor for plants.

The C-organic content of peat used in this study is in the high category (30.24%). Peat contains a lot of organic matter, this is indicated by a high C-organic value, but this soil is acidic. The acidity of the peat is very high as indicated by a pH value of 4.3. At high concentrations, organic acids are toxic to plants. Peat also has a deficiency in both macronutrients and micro (Noor, 2001). In the implementation of this research, the number of grasshopper and caterpillar pests that eat plant leaves is faced, how to control them by mechanical means, without using chemicals.

Table 2. Results of analysis of LOF

Atributes	Value	Class
pH H_20	8.1	Base
N-total	1.11	Very low
K-exchange	1.7	Low
C-organic	5.8	Low

Soil analysis conducted in Soil Science Lab., Agriculture Faculty, University of Bengkulu

The dosage of LOF did not give a significant difference to soil pH, number of leaves, and also lower wet weight (Table 3). This is because the dosage of liquid organic fertilizer is still insufficient. There is a difference due to the lack of nutrient availability, especially the element N which plays a big role in the

vegetative phase of the plant. Buckman & Brady (2015) added that the element N is beneficial for plant vegetative growth, namely the formation of new cells such as leaves, branches, and replacing damaged cells.

Table 3. F value calculation observation variable

Variable observed	F calculation	F table 5%
soil pH	1.36	2.77
Plant height	2.83*	2.77
Leaf number	1.82	2.77
Above-ground fresh weight	3.32*	2.77
Below-ground fresh weight	1.78	2.77
Above-ground dry weight	4.81*	2.77
Below-ground dry weight	1.39	2.77

* significant (P≤ 0.05)

Liquid organic fertilizers can improve the physical, biological, and chemical properties of the soil because in the liquid organic fertilizer there are macro and microelements that plants need. According to Prihmantoro (1996), macronutrients found in liquid organic fertilizers are N, P, K, Ca, Mg, and S. Macronutrients are nutrients that are needed in large quantities.

The acidity of peat soil cannot be neutralized only by using organic fertilizers, peat soil itself has an acidity of pH of 5.05, so it is necessary to do the basic treatment, namely liming, but in this research, calcification was not carried out. This is by Soepardi's (1983) statement that the main objective of liming is to raise soil pH to the desired level and reduce or eliminate Al poisoning.

The addition of organic matter can increase or decrease soil pH depending on the level of maturity of the added organic matter and the type of soil (Suntoro, 2003). This is by the statement of Soepardi (1983) which states that some of the benefits of organic fertilizers are that they can provide macro and micronutrients, contain humic acid (humus) which can increase the pH of acidic soils.

The dosage of LOF and plant height forms a quadratic relationship with the equation $Y = 0.000001x^2$-0.0013x+26.263 and the coefficient of determination (R^2) = 0.2853. The coefficient of determination (R^2) = 0.2853 illustrates that the regression equation formed can describe the relationship between LOF dosage and plant height of 28.53%.

Increasing the dose of liquid organic fertilizer to 2500 mL/ha can increase plant height. The increase in plant height from the dose treatment of liquid organic fertilizer had a significant effect on the height of the mustard plant. The increase in plant height is due to the nutrient content contained in organic fertilizers. Liquid organic fertilizers given at various concentrations resulted in higher plant growth compared to controls. This condition indicates that the application of LOFs can increase the availability and uptake of nutrients by plants so that they can improve plant growth and yield. These results are similar to those of Waruwu *et al*. (2018) who showed that providing LOF can increase the height of oil palm seeds.

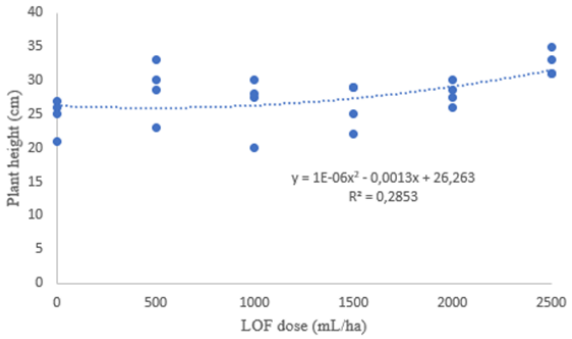

Figure 1. Relationship between LOF dose and plant height

Nutrients contained in LOF, namely N, P, K, and C-organic can increase the growth yield of mustard plants. Because the role of organic fertilizers is not only to improve the physical and biological properties of the soil but also the chemical properties of the soil. The nutrients available from liquid organic fertilizers will be used by plants to spur the photosynthesis process, the results of photosynthesis will be translocated to all parts of the plant to spur vegetative and generative plant development.

Increasing the dose of LOF to a dose of 2500 mL/ha resulted in the heaviest mean wet weight (Figure 2). The dosage of LOF and above-ground fresh weight forms a quadratic relationship with the equation $Y = 0.000001x^2 + 0.0088x + 28.38$ and the coefficient of determination (R^2) = 0.4151. The coefficient of determination (R^2) = 0.4151 illustrates that the regression equation formed can describe the relationship between LOF dosage and above-ground fresh weight of 41.51%.

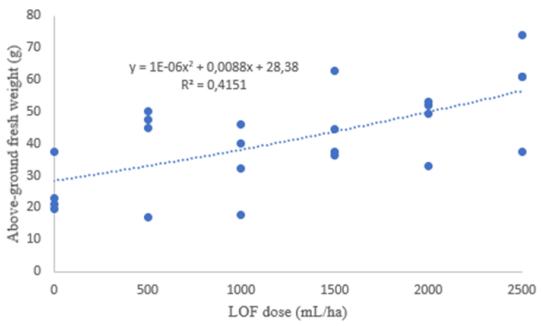

Figure 2. Relationship between LOF dose and above-ground fresh weight

Liquid organic fertilizer has the element P which causes the plant to grow older, the heavier the plant will be. P elements can increase plant height and crop weight (Fahmi *et al*., 2009).

The element P has a role in plant growth and yield, including accelerating root growth and accelerating the photosynthesis process. P elements that are available in sufficient quantities can spur the growth and development of a better root system. If the plant is deficient in P, it will cause the rate of growth and development of the plant to decrease due to the inhibition of the rate of photosynthesis. The results of the research by Ngantung *et al*. (2018) showed that the heaviest green mustard plant fresh weight was produced by plants fertilized with P besides N and compost. Organic fertilizer is able to produce fresh weight of mustard plants that are statistically the same as inorganic fertilizers (Istiqomah & Serdani, 2018).

The dose of LOF and above-ground dry weight forms a linear relationship with the equation Y = 0.0011x + 2.0798 and the coefficient of determination (R^2) = 0.5016 (Figure 3). The coefficient of determination (R^2) = 0.5016 illustrates that the regression equation formed can describe the relationship between LOF dosage and above-ground dry weight by 50.16%.

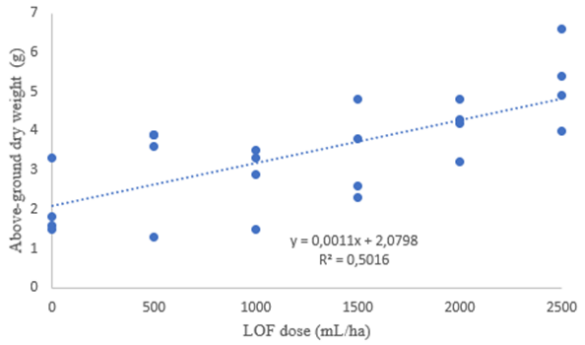

Figure 3. Relationship between LOF dose and above-ground dry weight

The results of Andri's research (2014) showed that the application of LOF for vegetable waste at a dose of 500 mL/plant produced the highest dry weight of mustard plants. The increase in plant dry weight is strongly influenced by the overall plant growth. This is closely related to the photosynthate produced from the photosynthesis process which is used to build tissues and organ systems in plants. The increasing number of leaves, leaf area, and plant fresh weight, of course, will also have a positive correlation with the dry weight of the mustard plant. However, Sudiarto & Gusmaini (2004) stated that the use of organic materials in farming generally must be followed by balanced fertilization. If the plant is deficient in N, the photosynthesis process will be disturbed, the leaves will turn yellowish-green and turn completely yellow. The nutrient N is needed for the formation of chlorophyll which is needed in the photosynthesis process and stimulates plant vegetative growth (Marsono & Sigit, 2001). The P element also plays a role in the formation of energy in the form of ATP which will then be used for photosynthate translocation to the parts of plant organs that need it. The P element contained in the liquid organic fertilizer of vegetable waste plays an important role in the formation and growth of mustard plant roots so that the roots can absorb more water and nutrients and in the end, the overall plant will grow and develop better. However, the P element in the liquid organic fertilizer is not sufficient for the lower wet weight of the plant.

CONCLUSION

The application of LOF affects plant height, above-ground fresh weight, and above-ground dry weight. The best dose of liquid organic fertilizer is 2500 mL/ha which results in an average plant height the highest (29.26 cm), above-ground fresh weight (56.63 g), and above-ground dry weight (4.83 g).

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