



Effectiveness of liquid organic fertilizer of hyacinth (*Eichhornia crassipes*) Fermented by *Trichoderma* spp. for Growth of Lettuce (*Lactuca sativa* L.)

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Article published on December 21, 2017

Key words: Water hyacinth, *Trichoderma* spp., Growth, Lettuce

Abstract

This research is important to be done with the aim to increase domestic lettuce production, development of area potency through the discovery of natural resources, and utilization of organic water hyacinth in Lombok island. This research was conducted at Green House Faculty of Agriculture University 45 Mataram. This study aims to determine the effectiveness of liquid organic fertilizer water hyacinth fermentation results *Trichoderma* spp. on the growth of lettuce. The research method used is experimental method with experiment in Green House. This research was designed using Randomized Complete Randomized Design (RAL) experiment with single factor experiment that is liquid organic fertilizer water hyacinth fermentation *Trichoderma* spp. which consists of 5 levels and 5 repetitions. The initial phase of the research was to arrange the experimental layout according to the treatment code of 25 experimental units, the planting of lettuce seeds, the provision of liquid organic fertilizer, irrigation, pest and weed management, and data collection. The next stage of data was analyzed by regression analysis to determine the effectiveness of fertilizer and the best dosage of fertilizer from the acquisition of regression coefficient value (b). Analisis results show that liquid organic fertilizer water hyacinth is effective in improving the growth of lettuce plants. Research shows that water hyacinth can be used as an alternative base liquid organic fertilizer that is cheap and easily available on the island of Lombok and has enough mineral content for the growth of lettuce plants.

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Introduction

Lettuce (*Lactuca sativa* L.) is one of the horticultural crops cultivated in Indonesia. The nutrients contained in 100 grams of lettuce are 95 grams of water, 1.2 grams of protein, 0.2 grams of fat, 1.2 grams of carbohydrates, 5800 mg of vitamin C, 102 mg of calcium, 2.0 mg of iron, 27 mg of magnesium, 37 mg of phosphorus, 180 mg of potassium and 100 mg of sodium (Sagala, 2010). The complete nutritional content provides a high enough economic value for lettuce so that the demand for the availability of this plant is increasing (Yuliarta, 2014). Meanwhile, lettuce production in Indonesia is below 1000 tons/year while the value of lettuce consumption is 300 thousand tons/year (FAO, 2007). This resulted in an unbalanced supply of production with demand for lettuce in the country. Therefore, it is necessary to develop techniques in the cultivation of lettuce cultivation.

In the cultivation of lettuce can not be separated from fertilization activities (Aminah, 2016). Usually farmers tend to use chemical fertilizers to support their farming activities. However, the use of chemical fertilizers if not offset by the addition of organic matter so the ground will experience degradation (damage). Therefore, to support the continuity of farming, it is necessary to apply organic materials technology to improve yield and maintain the quality of the soil.

Soil organic matter has an effect on the physical, chemical and biological properties of the soil (Stevenson, 1984). If the level of organic matter in the soil decreases then the plant growth will not be optimal. This results in a decline in crop yields that will affect the availability of agricultural commodities. One way that can be used to increase soil organic matter content is by using organic fertilizer. According Hadisuwito (2012) organic fertilizer is a fertilizer made from organic materials such as plants, livestock manure or living things that have died. Furthermore, Yuniwati (2012) stated that without organic fertilizer, efficiency and effectiveness of nutrient absorption will not run smoothly because of the effectiveness of nutrient absorption is strongly

influenced by organic fertilizer that play a role in maintaining soil function so that nutrient in soil provided by chemical fertilizer is easy absorbed by plants. One of the plants that can be utilized as organic fertilizer is water hyacinth. Hyacinth is a plant whose existence is considered weed in the waters (Sittadewi, 2007). This is because water hyacinth can grow quickly and disrupt the life in it (Ratnani, 2011). Therefore, alternative ways are needed to help reduce this population of weeds. One alternative way that can be used is to use water hyacinth as organic fertilizer.

Based on the results of previous research, it is known that water hyacinth has nutrient content that can be utilized by plants. The result of chemical analysis of water hyacinth in fresh state comprised of organic matter equal to 36.59%, organic C 21.23%, total N 0.28%, P total 0.0011%, K total 0.016%, C/N ratio 75.8% and 20.6% crude fiber (Ratri *et al.*, 2007). It was also reported that dried hyacinths contained 75.8% of organic matter; 1.5% nitrogen, 24.2% ash, 7.0% phosphorus, 28.7% potassium, 1.8% sodium, 12.8% calcium, and 21.0% chloride (Kusrinah *et al.*, 2016). Complete nutrient content in water hyacinth enables water hyacinth to be used as an alternative to liquid organic fertilizer.

Although water hyacinth contains nutrients needed by plants, high fiber content and C / N ratios result in composting process of water hyacinth takes longer time compared to other organic materials.

Therefore, to accelerate the decomposition process used microorganisms that serve as decomposers but does not cause a negative impact for cultivated plants (Sudantha, 2008). One of the *Trichoderma* spp (Apzani, 2015). *Trichoderma* spp. is able to remodel cellulose, hemicellulose and lignin from plant litter into simple compounds that can be utilized by plants (Sudantha, 2008). Aside from being a decomposer, *Trichoderma* spp. also has the ability to protect plants from the onslaught of soil pathogens and increase plant growth (Setyowati *et al.*, 2003). Based on the above description, the authors need to conduct research entitled the effectiveness of liquid organic

fertilizer (LOF) water hyacinth (*Eichhornia crassipes*) fermentation *Trichoderma* spp. on the growth of lettuce (*Lactuca sativa* L.).

Materials and methods

Location and time of study

This research was conducted at the Laboratory of Green House, Faculty of Agriculture University 45 Mataram (Nusa Tenggara Barat, Indonesia), from March to September 2017.

Equipments and materials

Laminar Air Flow Cabinet, petri dish, hotplate, beaker, measuring cup, knife, ent needle, bunsen lights, autoclave, oven, Erlenmeyer and analytical scales. Tools used for fermentation specifically aquarium hose, jars, polybags and soil cultivators.

Utilized materials namely PDA, *Trichoderma* spp. fungi, water, rich water, coconut water, palm sugar, alcohol, streptomycin, hyacinth, lettuce seeds, urea and phonska fertilizer.

Research stages

Experiment preparation and implementation

Trichoderma spp. was used as the breeding species in which is isolated from the rhizosphere of bamboo plants followed by purification and propagation processing with Potato Dextrose Agar (PDA) as the medium (Fig. 1). Liquid organic manure is composed from a mix of solid hyacinth (5 kg), coconut water (5 liters), rice water (5 liters), palm sugar (0.25 kg) and *Trichoderma* spp (1 petri). All the ingredients are then placed into the fermentator for a period of 7 days.

Sifted soil with a bulk density of 1.2gr/cm³ was used as the growing medium and is inserted into a 10 kg polybag. Lettuce seeds are sowed into the seedling medium until it grows with four leaves and subsequently moved for cultivation in the prepared medium. Hyacinth manure is then given to the crops according to dosage. Weeding is performed during grounding and pest control.

Observation variables

The variables include plant growth parameters specifically by height, and leaves count.

Experimental design

This research was designed using Randomized Complete Randomized Design (RCD) with single factor LOF hyacinth fermentation fungus *Trichoderma* spp. which consists of 5 levels ie P₀ = without treatment (0 ml/liter), P₁ = 2 ml/liter, P₂ = 4 ml/liter, P₃ = 8 ml/liter, and P₄ = 16 ml/liter. Each level uses 5 replications to obtain 25 experimental units.

Data Analysis With SPSS Statistics Varsion 17.0

Data of observation of variables were analyzed by regression analysis to obtain regression coefficient value (b) as a benchmark in knowing the effectiveness of liquid water organic fertilizer water hyacinth into the product in this research.

Results

Based on Table 1 it can be seen that in the first week, P₄ treatment was more effective than other treatments. The P₄ treatment yielded the highest regression coefficient (b) value of 1.164 while the other treatments resulted in lower b values of -0.006 P₀, -0.205 P₁, 0.007 P₂, and 0.574 P₃.

Table 1. Results of data analysis with regression test.

Plant Age	Regression coefficient value (b)				
	P ₀	P ₁	P ₂	P ₃	P ₄
Week 1	-0,00672	-0,20596	0,007614	0,574219	1,164841
Week 2	-0,03374	-0,06951	0,037259	0,687299	0,182247
Week 3	-0,24911	0,906062	0,563169	0,606341	-0,64472
Week 4	-0,14146	0,25721	0,250091	-0,52526	0,051099

Then in the second week P₃ treatment gave the highest b value of 0.687 while the other treatments gave lower b values of -0.033 P₀, -0.069 P₁, 0.037 P₂, and 0.182 P₄. Furthermore, at the third week the highest value of b was obtained at the P₁ treatment of 0.906 while the other treatment resulted in lower b

values of -0.249 P₀, 0.563 P₂, 0.606 P₃ and -0.644 P₄. Last at the fourth week the highest b value remained at the P₁ treatment of 0.257 while the other treatment yielded the lowest b-values of P₀ = -0.141, P₂ = 0.250, P₃ = -0.525, and P₄ = 0.051.

Table 2. Standard error and regression model..

Plant Age	Treatment	Regression model	Standard error
Week 4	P ₀	$Y = 1,39 - 0,14X$	0,01
Week 4	P ₁	$Y = 1,02 + 0,26X$	0,02
Week 4	P ₂	$Y = 1,05 + 0,25X$	0,04
Week 4	P ₃	$Y = 1,88 - 0,53X$	0,02
Week 4	P ₄	$Y = 1,32 + 0,05X$	0,03

The result of the analysis showed that the treatment with the giving of LOF water hyacinth gave better result than without the application of organic fertilizer liquid water hyacinth marked by the

acquisition of b value at treatment P₁ until P₄ tended to give positive value whereas P₀ always give negative value from the first week until the fourth week.

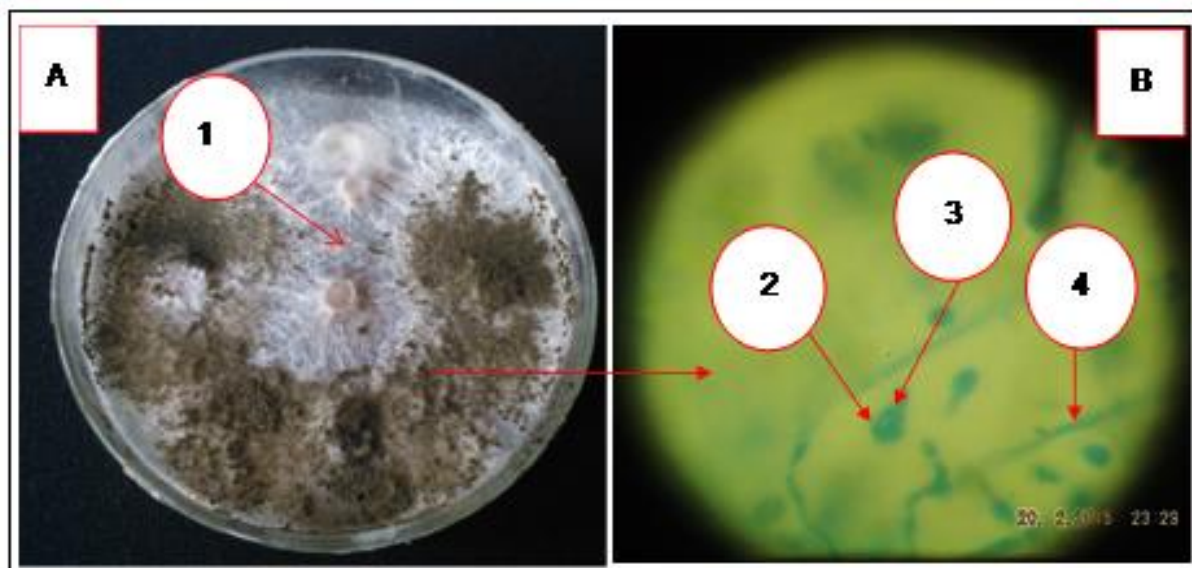


Fig. 1. Colonies (A) and morphology (B) *Trichoderma* sp. isolated from the rhizosphere of bamboo plants on Lombok island (1 = hyfa *Trichoderma* sp., 2 = phialide, 3 = phialospora, 4 = conidiofor).

Based on the result of data analysis (Table 1), it can be seen that P₁ treatment is better than other treatment which is characterized by regression coefficient gain (b) at week 4 higher than other treatment. In addition, it can be seen also that the standard error value of P₁ treatment at week four is 0.02 (Table 2). This value is smaller than 0.25 which means that the resulting regression model is appropriate in predicting plant growth.

The regression model of P₁ treatment at week 4 was $Y = 1.02 + 0.26 X$ which means that if the number of leaves increased 1 piece then the height of the plant will increase by 0.26 cm.

Discussion

The results of regression analysis (Table 1) showed that the treatment with the application of LOF water

hyacinth was better than that without the treatment characterized by the regression coefficient gain (b) in the treatment (P1 to P4) tended to be higher than without treatment (P0). This happens because the LOF water hyacinth can improve soil fertility.



Fig. 2. Conditions acid (pH 3.3) of LOF water hyacinth fermentation *Trichoderma* spp.

The good response shown by the lettuce plant depends on the condition of the soil as a plant growing environment (Poerwowidodo, 1992). This means, soil fertility affects plant growth (Santi *et al.*, 2007). Plant growth will be optimal if the growing environment provides enough nutrients in the soil (Wiryono, 2012). The availability of nutrients in the soil is influenced by the availability of organic matter in the soil (Buckman and Brady, 1982). Organic hyacinth material has sufficient nutrient content for plants (Kusrinahet *al.*, 2016). Nutrient elements contained in water hyacinth in the form of macro nutrients (Wahyuni, 2011) and micro nutrients (Renilaili, 2015). Macro nutrients such as nitrogen phosphorus and potassium generally have an important role for the growth of plants that is to improve the process of photosynthesis, conserve water use, maintain turgor, form strong rods, as activators of various enzyme systems, and strengthen rooting (Dobermann and Fairhust 2000).



Fig. 3. Product of LOF water hyacinth fermentation *Trichoderma* spp.

One of the essential macro nutrients for plant growth is phosphorus. Phosphorus is very important for plants because the element has a charge that plays an important role in assimilate translocation, storing and transferring energy from photosynthates used in metabolic processes (Liferdi, 2010). Besides posfor very play a role in the growth of lettuce root roots (Kusrinahet *al.*, 2016). Phosphorus functions to help the formation of proteins to stimulate root growth and development (Mahbubet *al.*, 2009). If the root fibers are more then the ability of plants to absorb water and nutrients will also increase, which will eventually increase the growth of plants.

The nutrients are transported from root to leaf through the xylem vessels then assembled together organic compounds into various forms of assimilates such as functional proteins and structural proteins which are then translocated throughout the plant body to form biomass for plant growth (Gardner, 2008). It was also reported that the assimilation of nutrients would be translocated to the more dominant part of apical and if the assimilate was sufficient in the apical part, the assimilate would be translocated to another part to increase the plant growth (Simanjuntak *et al.*, 2000).

The result of regression analysis showed that treatment of P1 (2 ml/liter) was better than other treatment which was marked by regression coefficient gain (b) P1 at week 4 higher than regression coefficient value (b) in other treatments. This shows that LOF water hyacinth dosage 2 ml/liter contains enough nutrients to improve plant growth. As the research result of Yadi (2016), that dose 2 ml/liter of LOF can increase the growth of mustard plant. According to Kristanto *et al.*(2003) water hyacinth contains high enough nitrogen nutrient to support

plant growth. Nitrogen is a very important macro nutrient for plant growth (Nurdinet *al.*, 2008), since this nutrient is instrumental in the formation of proteins as components of plant biomass (Buckman and Brady, 1982). If this nutrient deficiency, then the growth of the plant becomes slow (Moeskops, 2007). It is also reported that nitrogen is needed by plants to stimulate the formation of leaves because nitrogen serves to stimulate the enzymes that play a role in the process of leaf formation (Yanuarismah, 2012).



Fig. 4. Potential resource of water hyacinth (*Eichhornia crassipes*) inLombok Tengah Regency, Nusa Tenggara Barat Province, Indonesia.

In addition to high nitrogen nutrient content, organic fertilizer liquid water hyacinth supports plant growth with its content in the form of organic acid compounds namely humic acid and fulvic acid (Mulyadi, 2008) characterized by acidic conditions in the solution of fertilizer (Suntoro, 2003) with pH 3.3 after fermentation (Fig. 2). Humic acid fermented organic matter stimulates root growth, stimulates plant growth by accelerating cell division and improves plant biomass, while fulvic acid has a relatively small molecular size, so it is very easily absorbed or penetrated into the roots, stems, leaves and can act as a carrier of micro elements from the surface of plant roots into the tissues (Suwahyono, 2011).

Furthermore, Suntoro (2003) states that low molecular weight fulvic acid can have properties such as growth stimulants, so it positively affects the growth of plants which in turn can increase plant growth.

Also reported to bring humic acid and fulvic acid helps provide nutrients by forming chelates with metal compounds so that nutrients are available for plants (Suwahyono, 2011). Humic acid and fulvic acid can form a stable organometal complex with metal Cu^{2+} , Mn^{2+} , Zn^{2+} then the result of this bond will release nutrients in the form NH_4^+ , PO_4^{3-} , and SO_4^{2-} are easily absorbed by the plant (Mahbub *et al.*, 2009).

The ability of humic acid and fulvic acid to form organometal bonds is due to the carboxyl (-COOH) and phenolic (-OH) groups it possesses (Kononova, 1966 in Mulyadi, 2008). Further Kuntastyuti and Sunaryo (2000) stated that the presence of humic acid and fulvic acid in the soil accelerates the release of potassium (K⁺) ions which are bonded between the mineral grille. Potassium plays an important role in enhancing plant photosynthesis through enhancement of photophosphorylation resulting in ATP and NADPH that play a role in plant metabolism (Novizan, 2002). Potassium also makes plants resistant to drought (Rismunandar, 1990 in Sittadewi, 2007). Potassium works by maintaining the cellular turgor pressure that is essential in the availability of cell water so that cell metabolism runs optimally, potassium accumulates in the young organs of plants and forms the cortex and supports the prolongation of young cells, helping to secrete ions into root cells so that osmotic to vascular plants keeps running smoothly and eventually can support plant growth (Poerwowidodo, 1992).

Based on the above discussion it can be concluded that the LOF water hyacinth fermentation *Trichoderma* spp. (Fig.3) effectively increases the growth of lettuce plants.

Conclusion

Based on the results and discussions that have been presented in this study, it can be concluded that water hyacinth can be used as an alternative basic liquid organic fertilizer is cheap and easily available on the island of Lombok, and organic fertilizer liquid water hyacinth fermentation *Trichoderma* spp. contains minerals and organic acids that can support the growth of lettuce plants. So it is advisable to use this liquid fertilizer on the cultivation of lettuce.

Recommendation

Based on the results and discussion on this research it can be submitted some suggestions as follows: (a) determine the dose of fertilizer based on the weight of the lettuce plant, and (b) test the mineral content of LOF water hyacinth fermentation *Trichoderma* spp.

Acknowledgment

Successful completion of this research get much guidance from various parties with hope hopefully the hard work that has been given get better reward from Allah SWT, for that sincere gratitude. Authors convey to the Rector of University 45 Mataram which has provided research funding, and the Head of Institute of Research and Community Service (IRCS) of University 45 Mataram which has helped a lot in coordinating this research. The authors also conveyed gratitude to Dr. EvronAsrial who has provided much guidance and support during the research.

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