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The effect of vermicompost stimulator *Trichoderma* sp. and local liquid microorganism of hyacinth on growth and production of Lettuce (*Lactuca sativa* L.)

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Key words: Vermicompost, *Trichoderma* sp., Local liquid, Microorganism, Lettuce

Abstract

The importance of this research is to increase public awareness about local resources that can be utilized for healthier and more sustainable agriculture. This research can be a recommendation to reduce soil damage due to synthetic chemical fertilizers as well as an alternative when farmers have trouble about rare fertilizers in Indonesia. This research used an experimental method with experiments in the greenhouse of the Faculty of Agriculture, University of 45 Mataram. The design used was a Completely Randomized Design (CRD) with a factorial experiment. The first factor is vermicompost with 5 levels, and second factor is Local Liquid Microorganisms (M) which consists of 5 levels. The results showed that the treatment with the addition vermicompost could significantly increase the growth and yield of lettuce. The best wet weight yield was 14.53 grams per plant, obtained with the addition 7kgs of vermicompost, while the yield of 5.67 grams per plant was obtained without the addition vermicompost so that the increase in yield was 156.26%. Liquid water hyacinth local microorganisms have not been able to give a significant effect on the growth and yield of lettuce (*Lactuca sativa* L). The yield of wet weight of 14.17 grams per plant was obtained with the addition of liquid water hyacinth local microorganisms 8 cc/liter of water while the yield of 11.50 grams per plant was obtained without the addition local liquid microorganisms of water hyacinth. The interaction between vermicompost and local liquid microorganism's water hyacinth has not had a significant effect.

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Introduction

Lettuce (*Lactuca sativa* L.) belongs to the world-famous group of leaf vegetables. This type of vegetable contains nutrients, especially vitamins and minerals that are complete to meet the nutritional needs of the community (Suryati, 2009). Therefore, the demand for this plant continues to increase in accordance with population growth, so there is a need for technological development efforts in the cultivation of lettuce that are not only effective but can also support sustainable agriculture. The technology that can be used as an alternative is local vermicompost resources with a stimulator *Trichoderma* sp. and Local Liquid microorganisms of hyacinth.

Vermicompost is an organic fertilizer that is formed through composting involving macro and microorganisms such as earthworms, bacteria and fungi. This composting can be accelerated by using the microorganism *Trichoderma* sp. which can produce cellulose enzymes (Apzani, 2015) so that the release of nutrients becomes faster and available to plants. The vermicompost has the ability to hold great water so that the vermicompost can increase water storage in the soil. Vermicompost contains 0.63% nitrogen, 0.35% phosphorus, 0.20% potassium, 0.23% calcium, 0.26% magnesium, 0.07% sodium, 17.58% copper, 0.007% zinc, 0.003 manganese.%, iron 0.790%, boron 0.2221%, molybdenum 14.48%, CEC 35.80 me/100 g, water storage capacity 41.23% and humic acid 13.88% (Mulat, 2003). In addition to vermicompost, a source of nutrition for plants can come from local liquid microorganisms (LLM) made from water hyacinth. In addition to containing beneficial microorganisms for plants, LLM also contains various nutrients that are available to plants. The results of the analysis of the nutritional content of water hyacinth LLM are as follows. pH = 4.77 (acidic), C-organic = 0.32%, N-Total = 0.15% C/N Ratio = 2.13 P-Available = 0.10%, K = 0.41%, Ca 2540,32 ppm, Mg = 3256,23 ppm, Na 863,55 ppm.

In a previous research by Apzani and Wardhana (2018a), it was shown that local liquid microorganisms of hyacinth were able to increase the growth of shallot plants. Later in the same year, a subsequent research by Apzani and Wardhana (2018b) showed that the local liquid water hyacinth microorganism combined with coffee leaf bioactivator could increase the production of shallots. This is the motivation for the authors to investigate further about the effectiveness of Local Liquid microorganisms from water hyacinth when combined with vermicompost stimulator *Trichoderma* sp. and used on lettuce so this research needs to be done. This study aims to determine the effectiveness of local resources of water hyacinth, vermicompost and *Trichoderma* sp. which can be developed as a technology in lettuce cultivation so that it can increase public awareness to prioritize healthy and sustainable organic agriculture. This research also aims to increase public knowledge about the many local resources that can be used as an alternative to synthetic chemical fertilizers in lettuce cultivation in Indonesia..

Materials and methods

Location and Execution Time

This research was carried out at the Green House, Faculty of Agriculture, University of 45 Mataram (West Nusa Tenggara, Indonesia), from August 2021 to February 2022.

Equipments and Materials

The tools used in this research were hoe, shovel, measuring cup, ruler, handsprayer, analytical scale, stationery, small sieve, watering can, and hand counter. While the materials used in this research were vermicompost, *Trichoderma* sp., soil, Local Liquid Microorganisms of Water Hyacinth, polybags, and botanical pesticides.

Fig. 1. Vermicompost.

Fig. 2. Local Liquid Microorganism of Hyacinth.

Fig. 3. The biological agent of *Trichoderma* sp.

Research Stages

The soil sample used was topsoil soil at the University of 45 Mataram. The top soil is taken about 10 cm deep, after that it is sifted so that it is smooth. Then the soil was weighed each with a weight of 10kgs/polybag as much as 75 polybags and given vermicompost treatment according to the treatment dose. Meanwhile the lettuce seeds are soaked for one night with lukewarm water which aims to break the dormancy of the seeds. Then the seeds are drained with a cloth and then sown in the nursery, after 7-8 days after planting the seeds are transferred to polybags. Furthermore, the vermicompost was given before planting according to the treatment. Meanwhile, Water Hyacinth Liquid Local Microorganisms were given at the age of 14 DAP (Days After Planting). The application of local microorganisms was carried out by spraying onto plant leaves at a dose of 0 cc, 1 cc, 2 cc, 4 cc, 8 cc per liter of water according to the treatment. Meanwhile, to control pests and diseases, botanical pesticides are used from neem leaves. After the plant is 35 days after planting, harvesting is carried out to measure yield parameters.

Observation Variables

The variables observed included growth parameters namely plant height, number of leaves, and dry weight of plant roots. While the yield parameters include wet weight and dry weight of lettuce.

Experimental design

The research used a factorial experiment designed with CRD (Completely Randomized Design). Factor 1: vermicompost stimulator *Trichoderma* sp. (P) which consists of 5 levels, namely P0 = Soil without vermicompost, P1 = Soil + 1kg vermicompost, P2 = Soil + 3kgs vermicompost, P3 = Soil + 5kgs vermicompost, P4 = Soil + 7kgs vermicompost. Factor 2: Local Liquid Microorganisms of Hyacinth (M) which consists of 5 levels, namely M0 = 0 cc/liter of water, M1 = 1 cc/liter of water, M2 = 2 cc/liter of water, M3 = 4 cc/liter of water, and M4 = 8 cc/liter of water. There were 25 treatment combinations and repeated three times so that 75 experimental units were obtained.

Data analysis

The observational data are made in tables and then analyzed by Analysis of Variance (ANOVA). Treatments that showed significant differences result were further tested with the Honestly Significant Difference (HSD) at a significance level of 5%.

Results and discussion

In this research, it was found that giving vermicompost can increase growth and production on all parameters. Vermicompost is very effective to use as a source of nutrients to support the growth and yield of lettuce. While the provision of Local Liquid Microorganisms (LLM), did not give significant results on all parameters. For more details, the following will discuss the effect of the two treatment factors on all observed parameters.

The result of application vermicompost had an effect on plant height, number of leaves, wet weight, root dry weight, and plant dry weight. However, the treatment with the addition of Local Liquid Microorganism (LLM) of hyacinth and the interaction between the two factors did not affect all the observed parameters.

Table 1. Summary of ANOVA Observed Parameters.

Parameters	Source of Diversity		
	Vermicompost	LLM of hyacinth	Interaction
Plant height	S	NS	NS
Number of Leaves	S	NS	NS
Wet Weight of Plants at Harvest	S	NS	NS
Dry Weight of Plants at Harvest	S	NS	NS
Root Dry Weight at Harvest	S	NS	NS

Note: S = Significant, NS = Non Significant

Plant Height

The vermicompost treatments gave better growth than without vermicompost on plant height but the LLM of hyacinth treatment gave insignificant growth. The following is a table of the average plant height for the two treatment factors.

Table 2. Average Lettuce Plant Height Due to Vermicompost Treatments.

Treatments	Plant Height (cm)			
	14 DAP	21 DAP	28 DAP	35 DAP
0kg	5,23 a	6,33 a	13,53 a	13,83 a
1kg	5,87 b	8,70 b	15,00 ab	15,97 ab
3kgs	5,98 bc	8,98 b	15,32 ab	19,99 c
5kgs	6,52 d	9,53 b	16,25 b	20,12 c
7kgs	6,87 d	9,78 b	17,34 b	21,50 c
HSD 5%	0,50	1,18 b	2,61	3,09

Note: Numbers in the same rows followed by different symbols are significant in the 5% HSD test.

Table 3. Average Lettuce Plant Height Due to LLM of Hyacinth Treatments.

Treatments	Plant Height (cm)			
	14 DAP	14 DAP	14 DAP	14 DAP
0 cc/ liter of water	5,50 a	7,33 a	11,50 a	16,67 a
1 cc/ liter of water	5,83 a	6,67 a	10,83 a	14,00 a
2 cc/ liter of water	5,50 a	8,42 a	13,50 a	18,92 a
4 cc/ liter of water	5,83 a	7,17 a	12,33 a	16,67 a
8 cc/liter of water	5,33 a	8,00 a	13,17 a	18,25 a

Note : Numbers in the same rows followed by the same symbol are not significant in the 5% HSD test.

The treatment with the addition 2 cc/liter LLM of hyacinth gave an increase in plant height up to 18.92 cm while the control treatment was 16.67 cm on day 35. However, statistically, the treatment was not significant. This means that the treatment with the addition of water hyacinth LLM has not been able to give a significant effect on plant height. This is presumably because the LLM of water hyacinth given is still relatively small, so the dose needs to be increased again. Lettuce treated with vermicompost showed significant results (Table 2.) vermicompost at a dose of 7kgs gave the best results on day 35. This was due to the availability of nutrients by vermicompost. Vermicompost contains a variety of essential nutrients including N nutrients (Aritonang and Sidauruk, 2020) that plants need to grow and develop. One of the benefits of nutrient N is to increase plant height (Fahmi *et al.*, 2010).

In addition, vermicompost contains growth regulators that can increase plant height. Growth regulators play a role in increasing plant height (Salisbury and Ross, 1995) because they can stimulate cell division and elongation so that the number of cells becomes more (Apzani, 2015), then the cells will enlarge and then undergo differentiation which in turn increases plant height and stimulates elongation. shoots. The following shows the plant height curve in the treatment of vermicompost stimulator *Trichoderma* sp.

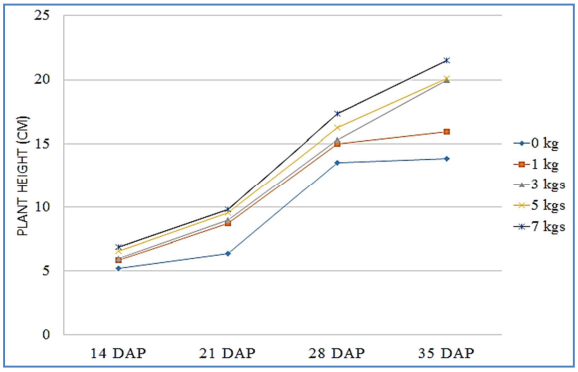

Fig. 4. Differences in the sigmoid curve of lettuce plant height in the treatment of vermicompost stimulator *Trichoderma* sp.

Based on fig. 4, it can be concluded that the significant increase in plant height with vermicompost treatment was thought to be caused by the content of vermicompost such as growth regulators, namely gibberellins, cytokinins, and auxins, and also nutrients that is N, P, K, Mg, Ca, Fe, Mn, Cu, Zn, Bo, Mo, and microorganisms *Azotobacter* sp. which is an N-fixing bacteria so that the N content of the soil is increasing which in the end all the content possessed by this vermicompost form an

integrated system that is beneficial for plants so that lettuce plants can grow optimally.

In the fig. above (Fig. 4), it can be seen that all the vermicompost factor levels show sigmoid growth. The growth shown by all levels on this factor looks normal but what distinguishes it is, each level shows different sigmoid growth. The best sigmoid growth was found at the 7kgs level with a plant height of 21.50 cm. While the other levels show a lower plant height. This happens because the vermicompost with a tier of 7kgs contains more complete nutrients, so the plants get sufficient nutrients for growth. Vermicompost contains various nutrients that can be utilized by plants optimally (Simanjuntak, 2004), this of course can have a positive impact on plants. Nutrients are utilized by plants as materials for protein synthesis. Nutrients absorbed by plants will combine with glucose derived from photosynthesis and form amino acids, each amino acid combines to form structural proteins to synthesize biomass such as roots, stems and leaves.

Number of Leaves

The result of observation on number of leaves parameter shows that the treatment with addition vermicompost can produced more leaves than the treatment without vermicompost. While table 5 shows that the treatment with the addition of LLM water hyacinth did not show a significant increase in the number of leaves. The following is a table of the average number of leaves on the two treatment factors.

Table 4. Average Lettuce Number of Leaves Due to Vermicompost Treatments.

Treatments	Number of Leaves (strands)			
	14 DAP	21 DAP	28 DAP	35 DAP
0kg	3,13 a	4,13 a	4,93 a	5,40 a
1kg	3,15 ab	4,15 ab	4,99 ab	5,55 ab
3kgs	3,73 c	4,73 c	6,00 c	6,73 c
5kgs	4,12 d	4,89 cd	6,76 d	7,54 d
7kgs	4,15 d	5,21 d	6,98 d	7,88 d
HSD 5%	0,37	0,42	0,50	0,55

Note: Numbers in the same rows followed by different symbols are significant in the 5% HSD test.

The treatment with the addition 8 cc/liter LLM of hyacinth gave an average number of leaves are 6.67 leaves while the control treatment averaged 6 leaves at the age of 35 days after planting (DAP). However, when viewed statistically the treatment was not significant. This means that the treatment with the addition LLM of hyacinth has not been able to give a significant effect on plant height. This is because the LLM of hyacinth given is relatively small, so the dose needs to be increased again. This indicates that lettuce plants require a dose of LLM of hyacinth more than 8 cc/liter of water in order to support optimal number leaf.

Table 5. Average Lettuce Number of Leaves Due to LLM of Hyacinth Treatments.

Treatments	Number of Leaves (strands)			
	14 DAP	21 DAP	28 DAP	35 DAP
0 cc/ liter of water	3,00 a	4,17 a	5,33 a	6,00 a
1 cc/ liter of water	3,17 a	4,17 a	5,17 a	5,67 a
2 cc/ liter of water	3,67 a	4,67 a	5,67 a	6,00 a
4 cc/ liter of water	3,67 a	4,50 a	5,50 a	6,00 a
8 cc/liter of water	3,67 a	4,67 a	5,67 a	6,67 a

Note : Numbers in the same rows followed by the same symbol are not significant in the 5% HSD test.

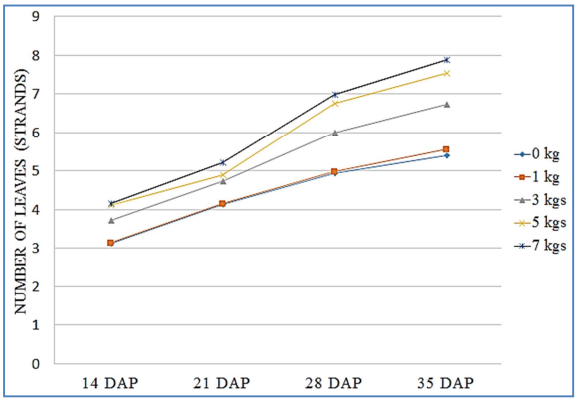

Fig. 5. Differences in the sigmoid curve on the number of lettuce leaves in the treatment of vermicompost stimulator *Trichoderma* sp.

Fig. 5 showed that the vermicompost with 7kgs doses can increase the number of leaves significantly because the vermicompost contains the nutrients that plants need. One of the nutrients that can help increase the number of leaves is nitrogen. Nitrogen is an essential element that is needed by plants, especially for leaf development and increasing green color. As the opinion of Nurdin *et al.* (2009), which stated that nitrogen is an essential nutrient in the vegetative phase of plants, because this nutrient plays a very important role in the formation of biomass for plant growth

(Buckman and Brady, 1982). This results in the process of plant photosynthesis not hindered and the spread of assimilate throughout the plant body can be faster and more optimally which ultimately increases the number of leaves (Apzani, 2015).

Wet Weight and Dry Weight of Plants at Harvest

The result of observation shows that the wet and dry weights of lettuce were higher in the treatment with vermicompost at a dose of 7kgs, the results reached 14.53 grams per wet plant and 7.50 grams per dry plant. While the treatment with LLM water hyacinth has not shown significant results. The treatment with 8 cc/liter of water gave higher wet and dry weight results compared to other treatments. However, statistically the treatment did not provide a significant difference. The following shows the average yield of wet and dry weight of lettuce on the vermicompost and LLM of hyacinth treatment factors.

Table 6. Average Wet and Dry Weight of Lettuce Plants Due to Vermicompost Treatments.

Treatments	Wet Weight (grams per plant)	Dry Weight (grams per plant)
0kg	5,67 a	2,80 a
1kg	8,76 ab	4,20 ab
3kgs	13,73 c	6,87 c
5kgs	13,98 c	6,98 c
7kgs	14,53 c	7,50 c
HSD 5%	3,73	1,78

Note: Numbers in the same rows followed by different symbols are significant in the 5% HSD test.

Table 7. Average Wet and Dry Weight of Lettuce Plants Due to LLM of Hyacinth Treatments.

Treatments	Wet Weight (grams per plant)	Dry Weight (grams per plant)
0 cc/ liter of water	11,50 a	5,67 a
1 cc/ liter of water	12,17 a	3,67 a
2 cc/ liter of water	12,67 a	4,50 a
4 cc/ liter of water	13,00 a	3,17 a
8 cc/liter of water	14,17 a	7,17 a

Note: Numbers in the same rows followed by the same symbol are not significant in the 5% HSD test.

The significant increase in the wet weight of the plant with the addition vermicompost is due to the potassium content of the vermicompost (Simanjuntak, 2004). Potassium element plays a role in increasing the absorption of water and nutrients from within the plant so that the transportation process in the plant body is not hindered which in the end results in more assimilate. In addition, the increase in plant wet weight was also caused by the cooperation between hormones and plants. One of these hormones is auxin. Auxin can increase the content of organic and inorganic substances in the cell so that the wet weight increases (Latifah *et al*., 2011).

Giving vermicompost can increase the absorption of nutrients by plants which of course can have an impact on the formation of plant dry weight (Gardner *et al*., 1991). This is supported by the presence of Trichoderma sp. contained in vermicompost which can assist plants in increasing root growth thereby optimizing nutrient absorption (Apzani *et al*., 2017).

As stated by Lestari *et al*. (2007), that the development of plant roots is not only initiated by photosynthesis, but also stimulated by the presence of the fungus Trichoderma spp. In addition, Suntoro (2003) stated that the application of organic matter can improve the physical, chemical, and biological properties of the soil so that the soil has good quality in terms of aeration, moisture, CEC, and beneficial microorganisms for plants which in turn has a positive influence on nutrient absorption. by plant roots to increase plant dry weight.

The increase in the wet and dry weight of plants was also caused by the ability of organic vermicompost in providing nutrients to plants through the process of chelation formation, namely the complex bond between organic acids and metallic elements Al and Fe so that the essential nutrients bound by metal elements Al and Fe can be used. released and available to plants (Stevenson, 1982).

Root Dry Weight at Harvest

The best result in the parameter root dry weight is the treatment with the addition vermicompost as much as 7kgs. And then, the addition of Liquid Water Hyacinth Local Microorganisms can increase the dry weight of lettuce roots although statistically there is no significant difference, treatment with the addition of 8 cc/liter of water Water hyacinth local

microorganisms give better results when compared to other treatments. The following shows the average root growth in the two treatment factors.

Table 8. Average Dry Weight of Roots Due to Vermicompost Treatments.

Treatments	Root Dry Weight at Harvest (grams per plant)
0kg	0,24 a
1kg	0,33 ab
3kgs	0,43 bc
5kgs	0,58 d
7kgs	1,00 e
HSD 5%	0,11

Note: Numbers in the same rows followed by different symbols are significant in the 5% HSD test.

Table 9. Average Dry Weight of Roots Due to LLM of Hyacinth Treatments.

Treatments	Root Dry Weight at Harvest (grams per plant)
0 cc/ liter of water	0,31 a
1 cc/ liter of water	0,21 a
2 cc/ liter of water	0,34 a
4 cc/ liter of water	0,31 a
8 cc/liter of water	0,50 a

Note: Numbers in the same rows followed by the same symbol are not significant in the 5% HSD test.

In table 8. treatment with 7kgs of vermicompost gave the best results, namely 1 gram per plant when compared by no treatment with vermicompost only 0.24 gram/plant. This is because vermicompost can help in increasing the availability of phosphorus in the soil. The element of phosphorus is useful for increasing root growth and forming a good root system so as to maximize nutrient absorption resulting in more root growth (Department of Agriculture, Food Crops and Horticulture, 2016). In addition, organic vermicompost can increase soil porosity, especially medium-sized pores which contribute to the ability to hold water and soil aeration (Stevenson, 1982). Soil aeration is often associated with the respiration of microorganisms and plant roots in the soil, because aeration is related to oxygen (O_2) in the soil. Thus, soil aeration has a positive effect on root respiration and its symbiosis with soil microbial populations such as Trichoderma sp. which in turn can increase the growth of plant roots (Suntoro, 2003). The difference in plant root growth can be seen in the image below.

Fig. 6. Visualization of differences in plant root growth in the treatment of vermicompost stimulator *Trichoderma* sp.

The fig. shows that vermicompost can increase root growth, the best root growth is found in P4 (7kgs) vermicompost treatment. This occurs allegedly as a result of organic compounds humic acid and fulvic acid (Suwahyono, 2011) contained in vermicompost. These organic compounds can stimulate the growth of plant roots by activating enzymes to break the hydrogen bonds of the cellulose molecular chains on the root cell walls, so that the root cells will be more elastic to absorb water, then enlarge and grow thick. As stated by Salisbury and Ross (1995), that organic compounds can increase the growth of plant cells.

In addition, *Trichoderma* sp. contained in vermicompost can increase root growth. As quoted by Suwahyono (2003) that the plants that received the treatment of *Trichoderma* sp. must have roots that are denser and fibrous. This happens because *Trichoderma* sp. has the ability to produce the hormone auxin (Subowo, 2015). The auxin hormone produced by *Trichoderma* sp. of 9,656 (Ramadhani, 2007). which is able to stimulate the development of lateral roots and root hairs in the plant root system (Casimiro *et al*., 2001). Of course this can optimize nutrient absorption so that it will increase the dry weight of lettuce plants.

Conclusion

Based on the results of data analysis and discussion above, it can be concluded that vermicompost and water hyacinth can be used as alternative fertilizers in the cultivation of lettuce. has not been able to give a significant effect on the growth and yield of lettuce. From this research, it can be seen that the best treatment for vermicompost is 7kgs while the local microorganism liquid water hyacinth is 8 cc/liter of water. The interaction between the vermicompost

factor and local micro-organisms of water hyacinth has not had a significant effect. Based on the results of this research, the authors suggest to the next researchers to be more thorough in terms of taking parameter data in order to obtain more accurate data, and further research is needed on a more effective dose of water hyacinth liquid local microorganisms to increase the growth and yield of lettuce. Meanwhile, farmers in Indonesia are advised to apply vermicompost in lettuce cultivation.

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