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Hydroponic Innovations Through Enhancing Kangkung Growth with Liquid Fertilizers and Plant Media

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ABSTRACT

This research aims to analyze the effects of different plant media and concentrations of liquid fertilizer derived from tofu waste on the growth of Kangkung using hydroponic methods. The study employs a field experiment designed with a Randomized Complete Block Design (RCBD) featuring two primary factors. The first factor consists of three types of planting media: rice husk (M1), river sand (M2), and a combination of river sand and rice husk (M3). The second factor involves varying concentrations of tofu waste liquid fertilizer, with four levels: P0 (0%), P1 (10%), P2 (20%), P3 (30%), and P4 (40%). Key growth variables include plant height, leaf count, and fresh weight, measured weekly over four weeks. Data analysis will utilize Duncan's Multiple Range Test (DMRT) at a 5% significance level. As an results indicate that treatment M1P3, which combines rice husk with a 30% concentration of tofu waste fertilizer, yields the best growth and production of Kangkung.

INTRODUCTION

Kangkung, also known as water spinach (*Ipomoea aquatica*), is a short-lived vegetable known for its economic value and high nutritional content. It is rich in vitamins A, B, and C, as well as protein, calcium, phosphorus, sitosterol, and minerals, particularly iron, which are essential for healthy growth and overall well-being (Abdullah et al., 2024; Malalavidhane et al., 2000; Stanislaus et al., 2017).

Hydroponic cultivation presents an effective alternative for growing kangkung. In this method, plants receive nutrient elements through a specially prepared nutrient solution (Barrett & Fox, 1997; Dhanraj, 2020; Li et al., 2015). This solution can be delivered in static pools or in a flowing state, depending on the hydroponic system used. The planting medium in hydroponics can consist of natural materials such as gravel, river sand, coconut coir, husk charcoal, pumice stone, peat, and wood pieces, or artificial materials like brick shards .(Hanafiah et al., 2021)

When cultivating kangkung hydroponically, special attention must be given to the choice of planting medium, as not all substrates are suitable for its growth. The selected medium should provide adequate support for the roots and retain nutrients, which are crucial for the healthy development of the plants. Nutrients play a vital role in the success of hydroponic systems; without them, plant growth will be stunted. Both macro and micro-nutrient elements must be available for optimal growth, and each nutrient type has a distinct composition (Nurwahyudi & Hatta, 2021).

Incorporating organic materials can serve as an additional or alternative nutrient source for kangkung in hydroponics. For instance, liquid waste from the tofu production process may contain beneficial nutrients that can promote plant growth (Alkiyumi et al., 2012).

There are several advantages to hydroponic cultivation, including the ability to grow vegetables in a controlled environment, ensuring the quality and safety of the produce while minimizing reliance on chemical fertilizers. Nutrients in hydroponics dissolve in water, allowing for precise control over fertilizer concentrations as needed (Kaur et al., 2016).

Research is needed to understand the effects of different planting media and the concentration of liquid fertilizers on the growth of kangkung in hydroponic systems. The goal of such studies is to optimize the conditions for growing kangkung, thereby enhancing yields and promoting sustainable cultivation practices (Suaka et al., 2022).

METHODS

The research employed a field experiment with a factorial design, specifically a Randomized Block Design (RBD), to manage variability among experimental units. The two factors included:, Factor 1: Planting Media, M1: Rice Husk Charcoal, M2: River Sand, M3: Combination of River Sand and Rice Husk Charcoal, Factor 2: Liquid Fertilizer Concentration, P0: 0% liquid fertilizer, P1: 10% liquid fertilizer, P2: 20% liquid fertilizer, P3: 30% liquid fertilizer, P4: 40% liquid fertilizer

1. Experimental Setup

The experiment consisted of 15 treatment combinations (3 planting media × 5 fertilizer concentrations) with three replications, resulting in a total of 45 experimental units. Each treatment was randomly assigned to different blocks to reduce the effects of environmental variability.

2. Materials and Equipment

The following materials and equipment were utilized in this research:, Equipment, 1-liter manual sprayers, Poly bags (20 x 25 cm), Labels for treatment identification, Buckets and dipper for water management, Ruler for measuring plant height, pH meter for soil pH measurement, Digital scales for weighing fresh plants, Brown envelopes for sample collection, Stationery for recording observations, Digital camera for photographic documentation, Materials, River sand, Rice husk charcoal, Seeds of land cress, Groundwater from wells, Liquid tofu waste, Coconut water, Effective Microorganism 4 (EM4).

3. Data Collection.

Observations were made on several growth parameters at specific intervals:, Plant Height: Measured weekly from the first to the fourth week after planting (1-4 MST). Number of Leaves: Recorded weekly for the same duration (1-4 MST). Weight of Fresh Plants: Measured at the end of the fourth week (4 MST).

4. Data Analysis

Data obtained from the experiments were analyzed using Analysis of Variance (ANOVA) to determine the significant effects of the treatments on plant growth. The following steps were following the Calculation of means for each treatment combination, Application of ANOVA to assess the significance of the main effects and interactions, If significant differences were found, Duncan's Multiple Range Test (DMRT) was employed for post-hoc analysis to identify which specific treatment means were significantly different at a 5% significance level.

RESULTS AND DISCUSSION

Result

Liquid fertilizer from waste is fermented tofu liquid waste tofu, coconut water, and EM4 for 10 days starting from 27 April to 7 May 2018. Liquid fertilizer from waste knows who has been through the process of fermentation for 10 days and then taken to a lab to do the analysis of content of nutrient elements Nitrogen (N), Phospor (P), and potassium (K). Based on the results of a laboratory analysis showed that liquid fertilizer from waste know contains nutrient N-total: 1.165%, P: 0.052%, and K: 1.144 percent.

1. Parameters the number of strands of Cress Leaves the ground.

The results of the analysis of fingerprints against a variety of a number of strands of Cress plant leaves showed that the army on Sunday I don't there is a noticeable influence on the interaction between the media and the growing use of liquid manure waste know against the number of strands of Cress leaves land. However, on the media, there is a noticeable influence of planting, so on waste liquid fertilizer factor know there is also a real influence so that on each of these factors is continued with real honest difference test at 5% significance level.

Tabel 1. The Influence Of Planting Media to the Number Of Strands Of Cress Leaves Land On First Week

Treatment	Total	Avarage	Notation
Rice husk charcoal Pasir	65	4,33	b
Sand River	60	4	a
Combination with A+P	62	4,13	ab
$HSD_{0,05}$	= 0,27		

Remark: The figures followed by the same letter in a column notation means not significant tests through LSD test in level 5 %.

The results of the analysis of the prints range in week-to-week II, III and IV show the presence of the influence of the interaction between the media and the growing use of liquid manure waste know against the number of strands of Cress leaves the ground. Analysis of the results of observations of the II, III, and IV advanced test done using MST Duncan Multiple Range Test (DMRT) at the 5% level that aims to find out the degree of difference between the treatments.

Tabel 2. Pengaruh Pupuk Cair Limbah Tahu Terhadap Jumlah Helai Daun Kangkung Darat Pada Pengamatan Minggu I

Treatment	Total	Avarage	Notation
Consentration 0 %	35	3,88	A
Consentration 10 %	36	4	ab
Consentration 20 %	36	4	abc
Consentration 30 %	42	4,66	ab
Consentration 40 %	38	4,22	
$HSD_{0,05}$	= 0,35		

Remark: The figures followed by the same letter in a column notation means not significant tests through LSD test in level 5 %.

Advanced trials with real honest difference test (BNJ) on levels 5% showed that planting rice husk charcoal media has the most high production potential in comparison with the two other planting media. While the concentration of liquid manure waste know that have high production potential, namely the concentration of 30%.

Tabel 3. The average of leaf growth in 2-4 week past cultivation.

Treatment	Total Leaf		
	2 week	3 week	4 week
M1P0	4,5 abc	4,5 abc	4,83 c
M1P1	6 de	6,16 def	6,83 ef
M1P2	6,16 ef	7,16 hi	8,16 gh
M1P3	8,83 i	9,83 lm	10,83 lm
M1P4	7,83 h	9,16 l	10,16 l
M2P0	4 a	4 a	4 a
M2P1	5,5 d	5,83 de	6 d
M2P2	6 de	6,33 efg	6,83 ef
M2P3	6,33 efg	7,5 ij	8,33 ghi
M2P4	6,16 ef	7,16 hi	8 g
M3P0	4,16 ab	4,16 ab	4,16 ab
M3P1	5,5 d	5,5 d	6 d
M3P2	6 de	6,5 efgh	6,83 ef
M3P3	6,33 efg	7,83 ijk	8,83 hijk
M3P4	6,16 ef	7,5 ij	8,5 ghij

Remark: The figures followed by the same letter in a column notation means not significant tests through DMRT in level 5 %.

Further trials using Duncan Multiple Range Test (DMRT) on levels 5% shows that began on the mean values showed the MST II number of strands of different land Cress leaves are real Interstate treatment. The value of the average number of strands of Cress leaves land at the treatment medium for planting rice husk charcoal and concentration of liquid fertilizer is 30% (M1P3), namely the number of average values is 8.83 strands of leaves on the highest observation II MST and different real with other treatment. III observations on MST shows the value of the average amount of land Cress leaves real different between treatments. The value of the average number of strands the highest land Cress leaves are shown on the media treatment of planting rice husk charcoal and concentration of liquid fertilizer is 30% (M1P3) namely 9.83 and no different with the media treatment of planting rice husk charcoal and concentration of 40% (liquid fertilizers M1P4).

On the observation to the MST-IV also shows the value of the average amount of land Cress leaves real different between treatments. The value of the average number of strands the highest land Cress leaves are shown on the media treatment of planting rice husk charcoal and concentration of liquid fertilizer is 30% (M1P3) namely 10.83 and no different with real media treatment of planting rice husk charcoal and concentration of 40% (liquid fertilizers M1P4). Therefore at the age of I-IV shows a pattern of high value added MST plant kangkung land are positive kuadratik. On to-I there MST noticeable difference on the growth of higher plants particularly ground water spinach Ipomoea aquatica. At the age II MST visually has shown the difference a real plant height at different treatment. Land Cress plant height increase over the increase of the concentration of fertilizer used and shown in all media of cropping (rice husk charcoal, sand River, rice husk charcoal and sand River).

The use of media of different cropping (rice husk charcoal, sand and mix the rice husk charcoal and sand River) and the giving of liquid waste fertilizer out by varying the concentrations of 0%, 10%, 20%, 30% and 40% showed differences in plant height land Cress. On each week's observations showed the value of average height growth of the plant was increased along with the increased use of liquid manure waste out.

Media treatment of planting rice husk rang and liquid fertilizer concentration 30% (M1P3) showed the highest chart at all age observations i.e. begin observations to-I to observations to-IV. While the lowest graph for high land Cress plants shown on the media treatment of planting the sand River and liquid fertilizer concentration 0% (M2P0) for all age observations (observation to I – IV MST).

2. Parameters of Heavy Wet Plant Sprouts the ground.

Observation of wet weight water spinach crop parameter is only done at the time of harvesting or age of the 4th observation MST. The results of the analysis of fingerprints against the weight of the wet variety plant sprouts the ground shows there is a real influence on the interaction between media and liquid fertilizer waste know so to do follow-up testing using Duncan Multiple Range Test (DMRT) levels 5% to find out the level of differences between the treatments. Advanced test results using Duncan Multiple Range Test (DMRT) levels 5% showed the value of average weight of wet land Cress plants that differ markedly between different Treatment. The value of the average weight of wet land Cress lowest shown in Treatment medium for planting the sand River and liquid fertilizer concentration 0% (M2P0) namely 6.80 grams that does not differ markedly by Treatment media for planting rice husk charcoal mixed with sand and river liquid fertilizer concentration 0% (M3P0) i.e. 7.1 grams as well as different real with other Treatment. The highest average value indicated on the Treatment medium for planting rice husk charcoal and concentration of liquid fertilizer is 30% (M1P3) namely 14.33 grams and a real different with other Treatment.

Tabel 4. The weight of the Wet Land Cress Plants On Age observations 4 MST

Treatment	Land Cress Plants Wet weight (grams) at the age of 4 week past cultivation
M1P0	7,60 d
M1P1	10,02 g
M1P2	12,04 l
M1P3	14,33 o
M1P4	13,76 n
M2P0	6,80 a
M2P1	7,55 c
M2P2	9,91 ef
M2P3	11,31 jk
M2P4	10,71 hi
M3P0	7,1 ab
M3P1	8,45 e
M3P2	10,43 h
M3P3	12,24 lm
M3P4	11,13 j

Remark: The figures followed by the same letter in a column notation means not significant tests through DMRT in level 5 %.

Further analysis of the results based on the weight of the wet land Cress on observation to IV shows the result of MST significant growth, where the weight of the plant sprouts the ground rises over an unavoidable increase of waste liquid fertilizer concentration knew used and occurs in all planting media even though the value of the highest reratanya on Treatment with rice husk charcoal media concentration liquid manure waste know 30% (M1P3), followed by the Treatment she mixed rice husk charcoal and concentration of river sand liquid fertilizer waste know 30% (M3P3) and next/third on media Treatment of planting the sand River and concentration of liquid manure waste know 30% (M2P3).

Discussion

Liquid waste is converted to fertilizer through knows the process of fermentation with the aid of bioaktivator EM4. Fermentation occurs in the anaerobic environment conditions. During the fermentation process, microorganisms in the substrate into a compound breaks up the EM4. The fermentation process is carried out for 10 days. Waste liquid tofu and coconut milk contain carbohydrates. The carbohydrates will be elaborated into glucose which is the source of energy for the microorganisms so as to speed up the fermentation process. Liquid waste know have a protein derived from soybeans that is making out. Protein is also found in coconut milk. Protein on tofu and coconut water waste is converted into amino acids. Amino acids consist of amino group and a carboxylic acid. The amino group has elements of nitrogen in molecular formulas, namely NH2 (Wilbraham and Matta, 1992). The addition of coconut milk in the manufacture of liquid fertilizer from waste know served as a source of glucose to be used by the microorganisms on energy as a source of EM4. Microorganisms in EM4 need glucose to be active and break down existing substrate in the liquid waste out. The result of the activity of microorganisms in the EM4 is nutrient elements that can be absorbed by plants. Fermented liquid fertilizer the colour changes from dark brown to become brownish yellow and turbid. Liquid fertilizer from waste know who have so have the scent somewhat tart like the scent of EM4 but no less intense. Liquid fertilizer waste knew before is used to fertilize the plant sprouts the ground done dilution in accordance with each Treatment. Dilution of liquid fertilizer is done by the percentage of 0%, 10%, 20%, 30%, and 40%. The use of media for planting and fertilizer concentration liquid waste know different effect on plant growth & land. The influence of planting medium and liquid fertilizer waste know can be seen from the results of observation of the three growth parameters are: the amount of strands of leaves, plant height and weight of wet land Cress. On the results of analysis, nutrient N obtained value of 1.165 percent, those values are good enough. Item N is the element that plays a role in constituent of chlorophyll, protein, and nucleic acids (Foth, 1984).

Plant growth was greatly influenced by the amount of the nutrient elements available to plants such as nutrient content of nitrogen, phosphorus and potassium. Nitrogen in adequate amounts of instrumental in accelerating the growth of plants as a whole especially the stems and leaves. Nitrogen also serves as material for the synthesis of chlorophyll, protein, and amino acids, as well as along the nitrogen phosphorus is used to set the overall plant growth (Lingga, 2006).

K (Pohtasyum) research on nutrient elements recorded 1.144 percent. That value is already good and included in the category. According to Ethics (2007), it is generally a critical point of the element K under 0.1%. Nutrient K function in setting mechanisms of photosynthesis, translocation of carbohydrates and protein synthesis (Foth, 1984).

Analysis of content of nutrient elements of P recorded 0.052%, the figure has a low value. According to Ethics (2007), it is generally a critical point P nutrient levels below the levels of nutrient N, at least 0.1%. The P element is an element that is not easy to move because it has a dynamic nature. P deficiency resulted in the transfer of energy, growth and cell metabolism and plant roots become distracted (Delvian, 2006).

The growing number of leaves of plants fertilizer fed on army & liquid waste know caused by the availability of nutrient elements nitrogen and phosphorus increased planting media. The planting medium that is able to withstand the nutrient solution is better then the plant would have had enough time to take advantage of the available nutrient elements for growth especially the number of sprouts leaves the ground.

The process of formation of the leaves is inseparable from the role of nutrient elements such as nitrogen and phosphorus in growing media and is available to the plant. Both of these elements play a role in the formation of a new and major components selsel penyususn organic compounds in plants such as amino acids, nucleic acids, chlorophyll, ADP and ATP. In plant deficiency for both the nutrient elements of plant metabolism will be interrupted so that the process of the formation of the leaves become too late (Lakitan, 1996).

The number of strands of leaves on the Treatment medium for planting rice husk charcoal and concentration of liquid manure waste know 30% (M1P3) gives the best results compared to the Treatment Plant media and n concentration liquid manure waste knows the other. The growth of the leaves is where vegetative growth nutrient elements nitrogen is involved. According to Wijaya (2008), the element nitrogen spurred the growth of the organs associated with photosynthesis. Further, broader leaves signified the availability of nitrogen element in growing media.

Land Cress plant cultivation in hydroponic cultivation with different substrates especially stir-fried ground conventionally. Cultivation in hydroponics relies on the intake of nutrient elements from outside that was given to the plant because of the planting medium used is a poor nutrient media, so that the growth of the plant (plant height and number of leaves) depends the adequacy of nutrient elements provided (Alviani, 2015).

It is in line with the results of the analysis on this research for parameter number of strands of leaf and plant height at planting all the media Treatment (rice husk charcoal, sand Creek, and a mixture of both) with a concentration of liquid manure waste know 0% indicates the mean value is the lowest compared to the use of liquid manure waste know 10%, 20%, 30%, 40% on all media.

The addition of higher plants occurring in the meristem interkalar on sections of the stem. The apical meristem activity also leads to duplication of new cells at the tip of the plant so that plant be high (Gardner et al., 1991).

The elements nitrogen, phosphorus and potassium in the activity of the meristem. Nitrogen function in the acceleration of growth. Nitrogen is protein-forming. Phosphorus is a core part of the cell that controls all activity in the cell including cell division. Potassium in the fertilizer serves as a shaper of the protein. Nitrogen is a part of the enzyme that is biokatalisator on each of the reactions of metabolism. The supply of nitrogen element in the form of ions of NO_3-and NH_4 + will affect plant growth. A lack of nitrogen led to stunted growth. Together in plant nutrient deficiency of N and K then it will lower crop production and make the plants become stunted (Lakitan, 2011).

Terhambatnya growth and plants become stunted or high plants less normal as seen on the Treatment of waste liquid fertilizer unannounced know (0%) or the giving of the fertilizer with a low concentration of, for example, at concentrations of 10% as well as with use of the media to plant less able to retain water or a solution of nutrient elements. This is demonstrated in the Treatment M2P0, M2P1, M3P0, M1P0, and M3P1.

Each plant has a maximum ability in absorbing nutrient elements in order to support its growth. The concentration of fertilizer given to plants has a point of saturation if the maximum capabilities exceed the plant in absorbing such nutrient elements so that when the granting of pupuknya excessive then it will not be absorbed and can also are poisoned for the plant. Therefore the concentration of the nutrient that is too high will cause a decrease in the absorption of the nutrient by plants (Sutedjo, 2002).

Decrease the absorption of nutrient elements can be seen in the Treatment medium for planting rice husk charcoal and concentration of liquid manure waste know 40% (M1P4) the reratanya value lower than the Treatment medium for planting rice husk charcoal and concentration of liquid manure waste know 30% (M1P3). That is, the giving of liquid manure waste know best is the concentration of 30% for plant growth & land as well as the medium is the medium rice husk charcoal. Visually it is clearly visible on the graph with age observations to II-IV up to the MST.

Planting rice husk charcoal media contributes to the growth of better than the media for planting the sand River and rice husk charcoal mixed the sand River. That is because of this rice husk charcoal has different characteristics with river sand or rice husk charcoal mixed with sand River that is its ability to retain water (including nutrient elements are dissolved in the water) and its Black so it can absorb the heat reduces the intensity of the Sun (Alviani, 2015).

Planting rice husk charcoal media has advantages as a hydroponics system of cultivation media substrate, i.e. a fairly porous media and has a sufficient kamampuan to hold water. The ability to retain water enough in meaning can also hold nutrients in the media. It supports so that the Treatment medium for planting rice husk charcoal and concentration of liquid fertilizer is 30% (M1P3) shows the average value of the wet weight of the plant as a result of the land Cress plant growth is highest.

Wet weight of a plant related to the abundance of water is absorbed, the compound required a large number of plants in each organ, but the moisture content of a network of plants can be changed or not stable in accordance with age, maximum capabilities absorption, and is also influenced by environmental factors (Salisbury and Ross, 1995).

Rice husk charcoal media has content of nutrient elements and are able to store water needed to grow crops, is supported by the results of the research of Bambang and Ninik (2011) that rice husk ash composition is dominated by silica as SiO_2 (94.4%),

Al_2O_3 (0.61 %), Fe_2O_3 (0.03%), CaO (0.83%), MgO (1.21%), K_2O (1.06%), Na_2O (0.77%). It is suspected, because the element nitrogen (N) is absorbed by the roots used for overall growth, particularly of the trunk, branches, and leaves on tomato plants.

The planting medium rice husk charcoal mixed sand River shows the mean values of wet weight decreases as shown in the second best Treatment namely Treatment media for planting rice husk charcoal mixed with river sand and liquid fertilizer concentration 30% (M3P3) due to the ability to retain water and nutrients is decreasing. The next decline shown in the third best Treatment namely Treatment media for planting the sand River and liquid fertilizer concentration 30% (M2P3). This is due to the ability to retain water and nutrients are not as good as rice husk charcoal or charcoal mixed cropping medium rice husk with river sand.

A plant will grow well when the required nutrient sufficient available in a form that is easily absorbed by rooting plants. Increasingly improving plant growth it will increase the weight of the plant (Dwidjosapoetro, 1985).

The availability of water and nutrients in the media grew influenced the development of rooting plants that reflect the process of absorption of nutrient elements so that will determine the outcome of the growth of a plant (Nyakpa et al., 1998).

Overall, the results of the production of sprouts the best land as seen from the number of strands of leaves, plant height, and weight of wet land Cress plants in hydroponics indicated on Treatment media for planting rice husk charcoal and concentration of liquid manure waste know 30% (M1P3) and did not differ markedly by Treatment media for planting rice husk charcoal and concentration of liquid manure waste know 40% (M1P4). It has similarities with the research results Aris et al., (2014) that planting rice husk charcoal media with a concentration of liquid fertilizer from waste know 40% give the best production for commodity green mustard (Brassica juncea var. Tosakan).

The results of this research are also in line with the results of research and Siswadi Yuwono (2015) stated that rice husk charcoal is one of the best growing medium for hydroponics in comparison of media sand and rice husk in particular for crops of lettuce (Lactuca sativa L).

CONCLUSSION

Based on the research results of research with the title the planting And the influence of Media Concentration Liquid Manure Waste Know towards growth & landline (Ipomoea Reptana Poir) In Hydroponics can be concluded that the use of planting and media concentration liquid fertilizer waste know give influence on the growth of sprouts in ground hydroponic. The real influence is shown by the results of the analysis of the number of parameters variety on yout strands of leaves (observation week II, III, and IV) and the weight of the wet land Cress plants also showed there is a real influence. Advanced test results using the Test Distance Duncan or Duncan Multiple Range Test (DMRT) shows that there is a real difference between Treatment. Treatment that shows the growth and production of the plant sprouts the best army shown in Treatment M1P3 (media planting rice husk charcoal and concentration of liquid manure waste know 30%) with the value of the average number of strands of leaves, plant height 10.83 33.85 cm, and heavy wet 14.33 grams.

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