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Growth Response of Ipomoea Reptans Poir. Against The Application of Liquid Fertilizer Leachate Organic Waste With Superior Nutrients

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ABSTRACT

The increase of freshwater aquaculture leads to the increasing demand for silkworms (Tubifex sp) as natural feed. Unfortunately, high demand of silkworm supply is not fully fulfilled yet because its availability is relied on natural catch. Cultivation of Tubifex sp. outside its natural habitats requires good information on substrates and feed. We aimed to study the effect of mud, sand and their combination use as substrates in supporting Tubifex sp growth. This study used complete randomized design with 5 treatments, namely K1 (100% sand), K2 (100% mud), P1 (combination75% mud-25%) sand, P2 (combination 50% mud-50% sand), and P3 (combination 25% mud-75% sand) with triplicates on each treatment. Research was conducted for 21 days using fermented chicken manure as feed. Tubifex sp growth was measured on biomass, number of individuals, and average body weight, while pH, temperature, dissolved oxygen and total organic matter were listed as measured environmental parameters. The use of sand and mud combination as substrate was better than a single sand or mud alone to support Tubifex sp growth. Combination of 75% mud and 25% sand showed the best growth of Tubifex sp as observed on biomass value of 13,244 g, 370 number of individuals, and average weight body of 2,741 mg. The application of a combination of sand and mud substrates has a potency to support the cultivation of Tubifex sp outside its native habitat.

INTRODUCTION

Piles of organic waste will produce leachate from dissolving organic compounds resulting from decomposition (Prinanda *et al*., 2017). The leachate will contaminate the soil and streams and cause unpleasant odors. In contrast, according to Zhang *et al*. (2013), leachate still contains macro and micronutrients that can be processed into fertilizers and affect plant growth. Some of the leachate liquid fertilizers made from kitchen waste still have macronutrients that do not meet the minimum nutrient standards from the Ministry of Agriculture. For example, research conducted by Wulandari & Winarsih (2022) using vegetable waste produced leachate liquid fertilizer with nitrogen (N) of 0.26%, phosphorus (P) of 0.14%, and potassium (K) of 0.13%, while research Lesmana & Apriyani (2019) which used fruit, vegetable, leaf waste produced 0.35% nitrogen (N) elements, 0.08% phosphorus (P) elements, and potassium (K) elements of 0.10% of the minimum standard set for N, P, K, which is 2%. Therefore, selecting organic waste materials with high nutrients or nutrients is expected to increase macronutrients in leachate liquid fertilizer. Several studies have stated that egg shells have high P and K elements (Putri *et al*., 2019), fish offal is high in N and P elements (Nur & Tjatoer, 2013), banana peels are high in C and K elements (Widyabudiningsih *et al*., 2021), stale rice is high in N elements (Sriyundiyati *et al*., 2013), and lamtoro leaves are high in organic N and C content (Pu'u & Mutiara, 2018). Mixing kitchen waste with superior nutrients has never been done and can potentially increase the nutrients in the leachate it produces.

The utilization of kitchen waste as an organic fertilizer has been widely applied, one of which is for *Ipomoea reptans* Poir. According to Rahmandhias & Rachmawati (2020), *Ipomoea reptans* (*Kangkung darat*) contains protein, calcium, iron, fiber, flavonoids, polyphenols, vitamins A, B2, and E, and has high antioxidants, so it is widely consumed and planted by society. However, several studies related to applying organic fertilizer to *Ipomoea reptans* have not been able to increase plant growth in all the parameters tested. Based on the results of research by Armandian (2022), it is known that the application of organic liquid fertilizer made from a single ingredient in the form of *Musa paradisiaca* L. peel only showed a significantly different growth response on the parameters of plant height and leaf length, but did not show a significant difference on the parameters of fresh weight, leaf color, as well as the number of leaves of *Ipomoea reptans*. Therefore, research on leachate liquid fertilizer from a mixture of several high-nutrient ingredients previously mentioned (egg shells, fish offal, banana peel, stale rice, lamtoro leaves) is expected to be able to optimize the growth of Ipomoea reptans. This study aimed to analyze the growth of Ipomoea reptans after applying liquid fertilizer leachate from kitchen waste with superior nutrition and to determine the optimal concentration of leachate liquid fertilizer for the growth of *Ipomoea reptans*.

METHODS

Research procedure

The research was carried out at the Laboratory of Ecology and Systematics and the greenhouse of Universitas Ahmad Dahlan, Yogyakarta, on November 2021 to April 2022. The study used a Completely Randomized Design (CRD) with four treatments and five replications, namely the provision of 0% concentration of leachate liquid fertilizer (control), 10% (P1), 20% (P2), and 30% (P3). Liquid leachate fertilizer is made by mixing kitchen waste leachate (2 kg of egg shells, 2 kg of stale rice, 2 kg of banana peels, 2 kg of fish offal, 2 kg of lamtoro leaves) with a mixture of EM4 solution, and brown sugar using a ratio of 1:4 and fermented anaerobically for one month (Setyorini & Mujiburohman, 2017).

The provision of liquid fertilizer leachate from kitchen waste is carried out after the seeds of *Ipomoea reptans* are 14 DAP (Days after planting) as much as 100 mL with a concentration of P0 0%, P1 10%, P2 20%, and P3 30% and is carried out once a week (Parintak, 2018). Treatment of *Ipomoea reptans* is done by watering the plants once a day (in the morning around 08.00-10.00 WIB) with as much as 100 mL of water, and if there are pests and weeds, they are removed manually. Abiotics in the planting media include soil moisture, soil temperature, and soil pH, and abiotics in the environment, including air temperature, humidity, and light intensity, are measured once a week before the plants are treated. Data collection on plant growth included plant height, stem diameter, number of leaves, leaf area, number of shoots, root length, fresh weight, and dry weight.

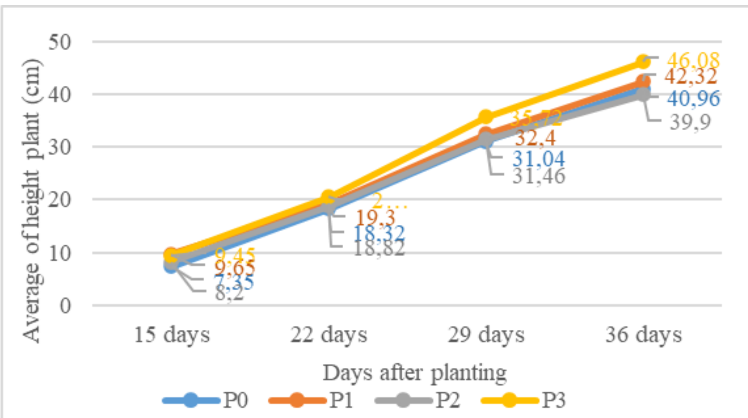
Data analysis

The growth data of Ipomoea reptans was analyzed descriptively by comparing each parameter, especially on the 36 DAT. The data were also analyzed inferentially to test four groups of plant growth data through the ANOVA test (parametric) at a significance level of 5% or the Kruskal Wallis test (non-parametric). If the test results are significantly different, proceed with the Duncan Multiple Range Test (DMRT) further test.

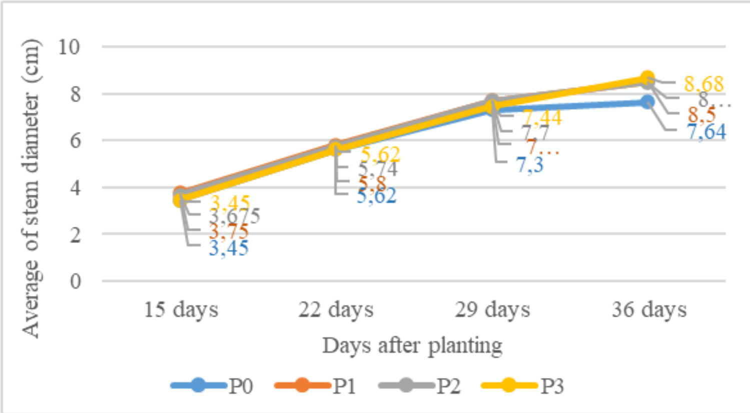
RESULTS AND DISCUSSIONS

The growth response of *Ipomoea reptans* in this study was observed through eight predetermined growth parameters. Based on the results of descriptive analysis, treatment P3 had the highest mean value at 36 DAP for the height plant, stem diameter, and the number of shoots (Figure 1a, 1b, 1c). Treatment P0 had the highest average value on the parameter number of leaves (Figure 1d), while P2 treatment had the highest mean for the parameters of leaf area (Figure 1e), root length, dry weight, and fresh weight. Based on the graph of the increase in plant height of *Ipomoea reptans*, the highest plant at 36 DAP was found in treatment P3, while the lowest average was in treatment P2 (Figure 1a). Although the P3 treatment showed the highest mean main stem length, the growth of *Ipomoea reptans* between treatments did not show a significant difference. The inferential analysis results showed that the ANOVA test exceeded the significance value of 0.05, to be exact, at 0.437 (Table 1).

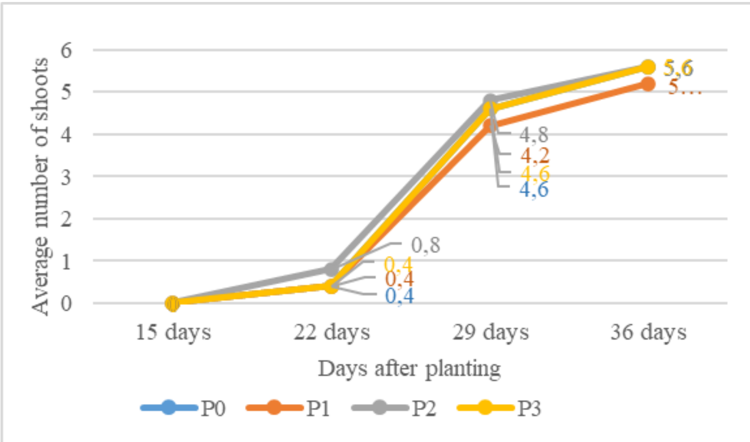
a)



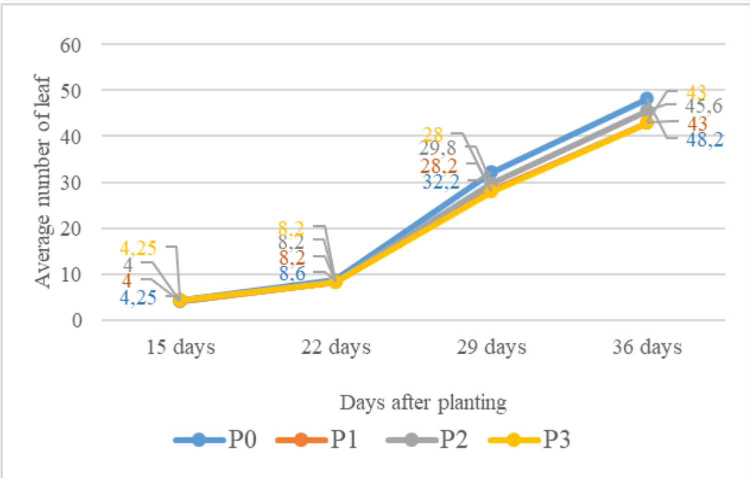
b)


Average of stem diameter (cm)
10
8
6
4
2
0
15 days
22 days
29 days
36 days
Days after planting
P0
P1
P2
P3

c)


Average number of shoots
6
5
4
3
2
1
0
15 days
22 days
29 days
36 days
Days after planting
P0
P1
P2
P3

d)


Average number of leaf
60
50
40
30
20
10
0
15 days
22 days
29 days
36 days
Days after planting
P0
P1
P2
P3

e)

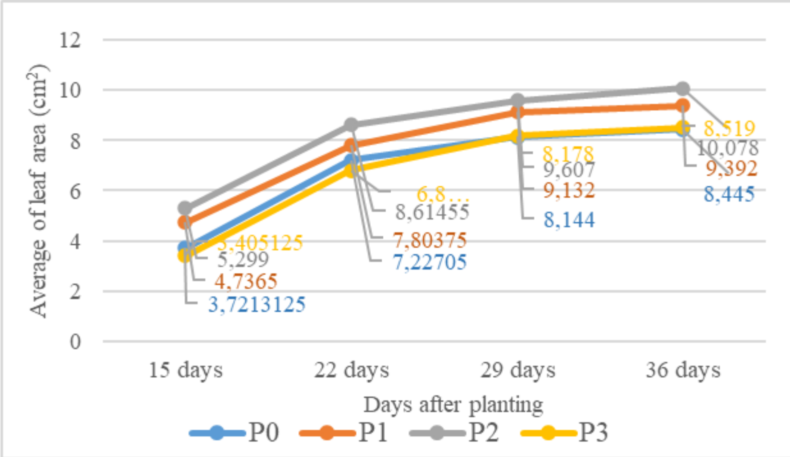


Figure 1. Graph of growth of *Ipomoea reptans* Poir. on parameters of plant height (a), stem diameter (b), number of shoots (c), number of leaves (d), leaf area (e)

Table 1. Results of ANOVA or Kruskal Wallis test significant of liquid fertilizer leachate on growth parameters of *Ipomoea reptans* Poir.

Parameters	ANOVA	Kruskal Wallis
Plant height (cm)	0.437	-
Stem diameter (cm)	0.117	-
Number of shoots	-	0.887
Number of leaves	-	0.634
Leaf area (cm^2)	0.760	-
Primary root length (cm)	0.009	-
Fresh weight (gram)	0.410	-
Dry weight (gram)	-	0.708

Likewise, with the diameter of the plant stem, the application of liquid leachate fertilizer did not give significant results between treatments, where the ANOVA test results obtained were 0.117 (Table 1). Even based on the growth chart per week also does not show a significant difference between treatments. Based on the data in Figure 1b, P0 (control) had the lowest average value compared to other treatments. In addition, it was also known that the mean stem diameter of *Ipomoea reptans* was 36 DAP in treatments P1, P2, and P3 were almost equal, but P3 showed a higher diameter increase compared to other treatments, especially at the age of 29 DAP to 36 DAP.

The following growth parameter of *Ipomoea reptans* is the number of shoots based on Figure 1c. The average number of shoots of *Ipomoea reptans* at 36 DAP in all treatments tended to be the same. This condition means no significant difference in plant growth response between treatments. These results align with the inferential test (Kruskal-Wallis), which is known to exceed the 0.05 significance level to be exact at 0.887, so there is no significant difference between treatments (Table 1).

The results of data analysis showed that P2 at 36 DAP tended to have the highest mean number of leaves and leaf area compared to other treatments. The number of leaves in the P2 treatment was the second highest mean after the control

(P0) (Figure 1d). Still, in the leaf area parameter, the control treatment had the lowest average, and the P2 treatment had the highest average leaf area (Figure 1e). If it is observed based on Figures 1d and 1e, it is known that the growth of *Ipomoea reptans* leaves between treatments is not too significant. These results align with the inferential analysis on the parameters of leaf number and leaf area, which have a significant value of 0.634 and 0.760, respectively (Table 1).

Table 2 shows that P2 has the highest primary root length, while treatment P0 (control) has the lowest mean value. This result shows that the application of leachate liquid fertilizer positively impacts the growth of *Ipomoea reptans* on the primary root length parameters. Furthermore, the significant ANOVA test results, namely, 0.009 (Table 1).

Based on the data in table 2, the highest fresh weight of *Ipomoea reptans* was found in treatment P2, while the lowest fresh weight was shown in treatment P3. These results are in line with the average results of the previous parameters, which indicate that P3 treatment tends to increase plant diameter and height but is insufficient to optimize other growth parameters so that it affects the average fresh weight of *Ipomoea reptans*. Likewise, the P2 treatment showed a high fresh weight of *Ipomoea reptans* because, in all parameters, it was found that growth was quite optimal. Based on the inferential test (ANOVA) of fresh weight parameters, it was also known that the application of liquid leachate fertilizer gave a significantly different response between treatments with a significance of 0.041 (Table 1). The results of the DMRT test, as shown in table 3, also show that treatments P1 and P2 showed a significant difference from treatment P3. In contrast, treatment P0 (control) did not show a significant difference in effect between treatments.

Based on the data in table 2, the highest mean dry weight of *Ipomoea reptans* was in treatment P2, and the lowest average was in treatment P3. The average dry weight value of the plant followed the order of the average fresh weight, where the average fresh weight from highest to lowest was found in treatments P2, P1, P0 (control), and P3. Although the average value of the fresh weight and dry weight of *Ipomoea reptans* in each treatment had the same order of highest to lowest values, the dry weight parameter showed inferential test results that were not significantly different with a significance of 0.708 (Table 1).

Table 2. DMRT test results of leachate liquid fertilizer concentration on growth parameters of *Ipomoea reptans* Poir.

Parameters	P0 (control)	P1	P2	P3
Plant height (cm)	40.96	43.32	39.90	46.08
Stem diameter (cm)	7.64	8.50	8.48	8.68
Number of shoots	5.60	5.20	5.60	5.60
Number of leaves	48.20	43.00	45.60	43.00
Leaf area (cm^2)	8.45	9.39	10.08	8.52
Primary root length (cm)	3.52^{b}	3.81^{ab}	4.36^{a}	4.34^{a}
Fresh weight (gram)	68.30^{ab}	71.87^{a}	72.98^{a}	64.76^{b}

Dry weight (gram)	7.12	7.25	7.49	6.90

Table 3. Comparison of the macronutrient of leachate liquid fertilizer with Ministry of Agriculture standards

No	Parameters	Unit	Standard	Leachate liquid fertilizer
1.	C-Organic	% (w/v)	min 10	1.07
2.	pH	-	4-9	5
3.	Macronutrient:			
	N N-Organic	% (w/v)	min 0.5	0.09
	$N\text{-}NH_4$			0.06
	$N\text{-}NO_3$			0.01
	N total			0.16
	P_2O_5 total	% (w/v)	2-6	0.03
	K_2O total			0.22
	Macronutrient total			0.41

CONCLUSSION

This study concluded that the *Ipomoea reptans* Poir. between treatments showed a significant growth response after applying liquid fertilizer leachate from kitchen waste on the parameters of the length of the primary root and the fresh weight of the plant. Furthermore, the application of leachate liquid fertilizer shows the most optimal growth response of *Ipomoea reptans* at a concentration of 20%.

Based on these conclusions, it is known that further research is needed, especially regarding the determination of the amount of selected kitchen waste composition, considering that leachate is a by-product of composting, so it is expected that when processed into liquid fertilizer, the nutrients will remain high. In addition, further research is needed to determine the ratio of leachate to solvent (sugar solution and EM4) and the proper fermentation process, so that leachate liquid fertilizer can be obtained by Ministry of Agriculture standards and can optimize plant growth in all parameters. Another suggestion is that it is necessary to test samples of leachate and liquid fertilizer leachate from kitchen waste as a whole, both from abiotic (temperature, pH, solutes), macronutrients, micronutrients, and pollutants, including levels of microorganisms, so that liquid fertilizers can be obtained that are safe and have known functions specifically for plants.

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