

The Effect of Organic Liquid Fertilizer of Rice Washing Water and Goat Urine on the Growth of Romaine Lettuce (*Lactuca sativa. Var. longifolia*) using the Hydroponic Method

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Abstract: Hydroponics, an emerging agricultural technology, allows the cultivation without soil, but using nutrient-rich water instead. This is promising for future agriculture, as it can be applied in various locations and yields higher-quality production results, thereby increasing market competitiveness. Additionally, waste materials such as rice washing water and goat urine can be repurposed as valuable organic fertilizers. Rice washing water is rich in nutrients such as vitamin B1, phosphorus, calcium, and nitrogen, and is a liquid organic fertilizer promoting superior plant growth. Goat urine, containing natural phytohormones, supports root and shoot development, making it a useful alternative to organic fertilizers. Research indicates that liquid organic fertilizers are often preferred over synthetic options in hydroponic systems due to their high content of bioactive compounds and environmental safety. This study focuses on Romaine Lettuce (*Lactuca sativa. Var. longifolia*) cultivation using various nutrient treatments, including rice washing water, goat urine, and AB Mix, with measured concentrations ranging from 1000 to 1400 parts per million (PPM). The results show significant differences in growth among the treatment groups, with AB Mix producing the highest in plant height, number of leaves, and leaf width, thus indicating the effectiveness of nutrient type on plant development.

Keywords: Hydroponic, Goat urine, Romaine lettuce, Rice washing water, AB Mix

I. INTRODUCTION

Hydroponics is one of the rapidly evolving agricultural technologies. Hydroponics is a method of cultivating plants without soil, by using water containing nutrients for plants. Hydroponics could be a future promise in agriculture, as it can be developed in villages, cities, and open fields. According to Ulfa et al. (2020), hydroponic crops produce better quality.

Waste is an unused material that tends to harm society. However, it can be processed and utilized to create something useful. One type of waste is rice washing water, which is often discarded without being fully utilized. It looks like dirty water and tends to be dirty, and people consider it useless. However, in fact, rice washing water contains nutrients that can support plant growth. Sari et al. (2020) reported that rice washing water contains vitamin B1, phosphorus, calcium, and nitrogen, which can be utilized as a liquid organic fertilizer to provide phosphorus nutrients to plants, thereby promoting faster and higher-quality growth.

The significance of the study is to provide useful information on the use of waste materials for the benefit of agriculture, especially in plant cultivation. The research question of the study is on what potential do Rice washing water and Goat urine in the cultivation of Romaine Lettuce (*Lactuca sativa. Var. Longifolia*).

II. LITERATURE REVIEW

Goat urine, a natural phytohormone containing auxin, gibberellin, and cytokinin, can support root, shoot, and other apical meristem growth, as well as cell development and differentiation. Processing goat urine is crucial because it is a highly beneficial organic material and can be used to make liquid organic fertilizers that are highly beneficial for plants, including increasing the amount of nitrogen in the soil that can be used by plants (Zoniagara et al., 2023). Goat urine can also be used as an alternative organic fertilizer and can help reduce livestock waste.

Research by Smiljana et al. (2019) found that liquid organic fertilizers are preferred in hydroponic systems because they contain more bioactive compounds, such as hormones, vitamins, and organic acids. In addition, organic liquid fertilizers do not leave inorganic residues that are harmful to the environment, such as changes in soil or water pH that can affect microorganisms and local ecosystems.

Romaine Lettuce is a vegetable belonging to the mustard greens family. Romaine Lettuce has the potential to be rich in nutrients and beneficial properties, but its production cannot be matched by community agriculture. Lettuces, including the romaine (cos) type (*Lactuca sativa var. longifolia*), are species adapted to hydroponic culture. These leafy vegetables have a relatively short growing period and a low requirement for nutritional medium (Lei and Engeseth, 2021). Madar et al. (2019) claimed that hydroponics shortens the growing time of lettuce up to 30 days, while conventional cultivation requires nearly 60 days. The research was conducted using an experimental method. From the research conducted, the results showed that the provision of AB mix nutrients provided a fairly good response to the growth of romaine lettuce plants (Migusnawati, 2023)

III. MATERIALS AND METHODS

Research Method

This research design uses a random sampling design with two factors/treatments:

1. The first factor/treatment is the nutrient treatment (N): N1 is the rice washing water nutrient, N2 is the goat urine nutrient, N3 is the rice washing water nutrient mixed with the goat urine nutrient, and N4 is the AB Mix nutrient fertilizer. These factors are the four experimental treatments used to cultivate the Romaine Lettuce plants. A total of 64 Romaine Lettuce plants were planted: 16 with rice washing water, 16 with goat urine, 16 with rice washing water mixed with goat urine, and 16 with AB Mix nutrient fertilizer.
2. The second factor/treatment is the concentration (K), the concentration of the four organic liquid fertilizers used, ranging from 1000 to 1400 ppm.

The data obtained are analyzed using a statistical analysis of variance procedure with a completely randomized design (CRD).

Tools and Materials

The equipment used includes net pots as planting containers, electricity to supply the pump, TDS and pH meters to measure the solubility and pH of the growing medium, plastic tubs for storage, panel wicks for nutrient absorption, a water pump for channeling water to higher elevations, a bucket for holding the medium, and a ruler for measuring leaf height and width.

The materials used in this study were water as a nutrient solvent, Romaine Lettuce plant seeds, rice washing water, goat urine, AB Mix fertilizer, and rockwool as a seeding medium.

Collection and Fermentation of Rice Washing Water

Rice washing water was collected from the UNAI Cafeteria Kitchen. The rice washing water used was the first rinse water. The fermentation process of rice washing water is carried out by mixing 2 liters of rice washing water with brown sugar and EM4 (Effective Microorganism 4) into a bucket slowly, pouring and then stirring until dissolved in the rice washing water, then the bucket is tightly closed and left for 7 days.

Hydroponic Nutrient Solution

This study uses four types of nutrients: rice washing water, goat urine, a mixture of rice washing water and goat urine, and AB mix. The AB Mix nutrient solution was prepared by dissolving AB Mix in 2 liters of water and stirring thoroughly. Ten liters of each nutrient solution were prepared.

Romaine Lettuce Plant Seeding

The hydroponic seeding system used was 2 x 2 cm rockwool. The seeds were sown in the pre-drilled rockwool, placed in a container, covered with black plastic to protect them from direct sunlight, and kept moist.

Hydroponic Wick

A hydroponic wick system was used in small pots for planting Romaine Lettuce. The wick or cloth was cut and inserted into the holes to allow the wick to absorb nutrients and water.

Water Concentration Adjustment

Measuring the concentration of the hydroponic solution is necessary to maintain healthy and strong plants. The concentration of the solution is adjusted according to the type and age of the plant. Concentration measurements were performed using a TDS (Total Dissolved Solids) instrument to determine the amount of dissolved solids. The measurement was performed by dipping the tip of the TDS meter into the stirred nutrient solution mixed with water, and the reading was displayed in PPM (Parts Per Million). The required PPM for the type and age of Romaine Lettuce plants ranges from 1050 to 1400 (Malik and Hartono, 2021).

Dosage Treatment

Nutrient fertilizer dosages for Romaine Lettuce plants were as follows:

1. On the 1st of cultivation, the four fertilizers: rice washing water, goat urine, a mixture of rice washing water and goat urine, and AB mix used were the 1000 PPM (Parts Per Million) dose.
2. On the 6th day, the plant height, leaf number, and leaf surface area were measured (first data collection). And on the 7th day, the fertilizer dose was increased to 1100 PPM.
3. On the 13th day, the plant height, number of leaves, and leaf surface width were measured (second data collection), and on the 14th day, the fertilizer dose was increased to 1200 PPM.

4. On the 20th day, the plant height, number of leaves, and leaf surface width were measured (third data collection), and on the 21st day, the fertilizer dose was increased to 1300 PPM.
5. On the 27th day, plant height, number of leaves, and leaf surface width were measured (fourth data collection). On the 28th day, the fertilizer dose was increased to 1400 PPM.
6. On the 34th day, plant height, number of leaves, and leaf surface width were measured (fifth and last data collection).

Observation and Data Collection

The data of the study are the number of leaves, plant height, and leaf width. The data were collected weekly. The height was measured from the base to the tip of the plant, the width of the leaf, measured using a measuring tape, starting from the base of the leaf to the tip, and on both sides, and the number of leaves was counted starting one week after planting, and was counted at weekly intervals. The leaves were those that had fully developed or opened.

Statistical Analysis

The statistical calculation procedure in this study used a completely randomized design (CRD) with an ANOVA pattern.

IV. RESULTS AND DISCUSSION

Romaine Lettuce Plant Height

Data in Table 1 shows that AB Mix fertilizer produced the highest average plant height (average 21.01 cm), the mixture of rice washing water and goat urine produced the lowest average plant height (average 8.21 cm), and the Goat urine and Rice washing water fertilizers produced the average of 14.84 cm and 10.23 cm, respectively. The results indicate a significant difference in average plant height between the AB Mix treatment and the other treatments.

Table 1. Plant Height Descriptive Analysis of Romaine Lettuce

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Min.	Max.
					Lower Bound	Upper Bound		
Rice washing water	16	10.23	5.001	1.250	7.56	12.89	3	16
Goat urine	16	14.84	3.644	.911	12.90	16.79	6	19
Mixture of Rice washing water and Goat urine	16	8.21	2.333	.583	6.97	9.46	5	14
AB Mix	16	21.01	2.150	.538	19.87	22.16	16	24
Total	64	13.57	6.010	.751	12.07	15.07	3	24

Romaine Lettuce Plant Leaf Count

Table 2 shows that AB Mix fertilizer produced the highest average number of leaves (13.31 leaves on average), significantly higher than the other treatments. A mixture of rice washing water and goat urine gives the lowest average number of leaves (6.56 leaves on average), and Goat urine and Rice washing water average leaf numbers are 11.38 and 10.08 numbers respectively.

Table 2. Leaf Numbers Descriptive Analysis of Romaine Lettuce.

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Min.	Max.
					Lower Bound	Upper Bound		

Rice washing water	12	10.08	3.029	.874	8.16	12.01	2	12
Goat urine	16	11.38	2.391	.598	10.10	12.65	6	16
Mixture of Rice washing water and Goat urine	16	6.56	3.098	.774	4.91	8.21	2	12
AB Mix	16	13.31	2.182	.546	12.15	14.48	8	16
Total	60	10.35	3.658	.472	9.40	11.30	2	16

Leaf Width

The data in Table 3 shows that AB Mix fertilizer gives the largest average leaf width (average 11.73 cm), the Rice washing water gives the lowest average leaf width (average of 5.42 cm), and the Goat urine and mixture of Rice washing water and Goat urine are between with average leaf width of 8.98 cm and 7.32 cm, respectively.

Table 3. Leaf Width Descriptive Analysis of Romaine Lettuce.

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Min.	Max.
					Lower Bound	Upper Bound		
Rice washing water	156	5.42	.814	.065	5.29	5.55	3	7
Goat urine	182	8.98	.733	.075	9.73	9.36	1	12
Mixture of Rice washing water and Goat urine	104	7.32	.611	.060	7.20	7.44	6	8
AB Mix	223	11.73	1.312	.088	11.55	11.90	2	16
Total	665	17.17	25.018	.970	15.27	19.08	1	123

Analysis of Variance Results

The data in Table 4 shows the results of the ANOVA analysis, which shows a high F-value of 42.759, with a *p*-value of 0.000 (*p* < 0.05). This indicates that the difference in mean value between the groups is statistically significant at the 95% confidence level ($\alpha = 0.05$).

Table 4. Statistical Analysis Result of Plant Heights

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1550.480	3	516.827	42.759	.000
Within Groups	725.224	60	12.087		
Total	2275.705	63			

The data in Table 5 of the ANOVA analysis results show a high F value of 17.997 and a significant difference between the group means for the number of leaves variable with a *p*-value of 0.000 (*p* < 0.05). This analysis indicates that the mean difference between groups (plant height) is statistically very significant at the 95% confidence level ($\alpha = 0.05$).

Table 5. Statistical Analysis Result of Leaf Numbers

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	387.608	3	129.203	17.997	.000
Within Groups	402.042	56	7.179		
Total	789.650	59			

The data in Table 6 shows the results of the ANOVA analysis, showing a very high F value of 99.549, and a p value of 0.000 ($\alpha < 0.05$). This indicates that the mean difference of leaf number between groups is significant at the 95% confidence level ($\alpha = 0.05$).

Table 6. Statistical Analysis Result in Leaf Width

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	129340.668	3	43113.556	99.549	.000
Within Groups	286272.669	661	433.090		
Total	415613.337	664			

V. CONCLUSION

Based on the results of the ANOVA analysis on plant height, leaf number, and leaf width, it can be concluded that different nutrient types have a very significant impact on plant growth. Descriptively, the AB Mix nutrient fertilizer treatment consistently gives the best results in all of the data parameters, with an average plant height of 21.01 cm, an average number of leaves of 13.31, and an average leaf width of 11.73 cm. The order of other nutrient fertilizer treatment effectiveness is Goat urine, Rice washing water, and the mixture of Rice washing water and Goat urine, respectively.

The statistical Analysis of Variance shows that all four nutrient fertilizers give a significant mean difference with a p -value of 0.000 ($< \alpha = 0.05$).

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