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The Effectiveness of Rice Washing Waste on the Growth of Stem Height and Leaf Width of Green Spinach Plants (*Amaranthus hybridus L.*)

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ABSTRACT

Rice washing waste can cause pollution if not treated, the waste can be used as liquid organic fertilizer. The fertilizer contains the nutrients needed by plants and is environmentally friendly. The purpose of the study was to determine the effectiveness of rice washing waste on the growth of stem height and leaf width of green spinach plants. This research was an experimental study with a factorial design. The factorial pattern was 2 x 3 with 3 repetitions. The first factor was rice washing waste and the second factor was variations in the concentration of liquid fertilizer. Variations in the concentration of liquid organic fertilizer from rice washing waste were 50%, 75% and 100%. The sample of this study was 100 stems of green spinach plants. Post hoc test found that the most effective concentration of liquid organic fertilizer on green spinach plant height was 50% (fermented) and 75% (without fermentation), while the leaf width concentration was 75%. There was no effect of giving liquid organic fertilizer from rice washing waste to the number of green spinach leaves. There was an effect of giving organic fertilizer from rice washing waste on stem height and leaf width of green spinach plants

Keywords: liquid organic fertilizer; rice washing waste; green spinach plant

INTRODUCTION

Background

Yellowish in color, rocky, and containing bauxite, is a characteristic of the soil found in the Tanjungpinang City area. The level of soil fertility in such conditions is quite low so it is not suitable for use as agricultural land. Based on the results of previous studies, it is known that characteristics of the soil studied in several areas were red with rounded particle sizes, soft (easy to knead), moderate plasticity, and dry soil conditions. Efforts are made by farmers to increase fertility or soil health by adding soil fertilizing agents(1).

The application of inorganic fertilizers is a method used by farmers to fertilize the soil, with the assumption that the use of inorganic fertilizers can accelerate the planting period and increase crop yields, without knowing the impact of long-term use. The impact of giving inorganic fertilizers continuously and with excessive doses can result in physical damage to the soil. If efforts are not made to maintain soil quality, it is feared that plant nutrient needs cannot be met.

Soil damage due to the use of inorganic fertilizers can be avoided by replacing inorganic fertilizers with organic fertilizers. The use of liquid organic fertilizer is one of the efforts to solve environmental problems, especially waste. Management of waste into liquid fertilizer can reduce the level of pollution in the environment. Organic fertilizers can quickly overcome nutrient deficiencies, do not damage soil humus and easily dissolve in the soil and carry essential nutrients for soil fertility. Organic fertilizers do not have an impact on the environment or soil if used for a long time, because the constituent materials consist of natural ingredients.

One type of organic fertilizer that is easily processed and applied to plants is liquid fertilizer. The raw materials for liquid fertilizer are easy to obtain and the method of manufacture is simple, but the benefits are very good for plants, one of which is liquid organic fertilizer from rice washing waste. Rice washing waste is a waste that is definitely generated from household activities and is a waste that is rarely reused. The volume of rice washing water waste that is simply thrown into the environment is increasing along with population growth. Rice washing waste is usually directly disposed of through sewerage, so it has the potential to cause environmental pollution and the emergence of various diseases.

Previous research, it is known that rice washing water waste contains abundant nutrients, including carbohydrates in the form of 85-90% starch, fat, gluten protein, cellulose, hemicellulose, sugar, and high vitamins. Rice washing water contains vitamins such as niacin, riboflavin, pyridoxine, and thiamin, as well as minerals such as Ca, Mg, and Fe which are necessary for fungal growth[(2)].

Previous research result, showed that giving rice washing water at a dose of 20 ml/liter of water had an effect on plant height and the number of green mustard leaves[(3)]. In another study using rice washing waste [(4)], it was found that liquid organic fertilizer from modified rice washing water was effective in the growth of green beans.

Based on the description of the background above, the researchers felt to research to see the effectiveness of the utilization of fermented rice waste with varying concentrations on the growth of green spinach plants.

Purpose

Purpose research to see the effectiveness of the utilization of fermented rice washing waste with varying concentrations on the growth of green spinach plants.

METHODS

This type of research was experimental with a factorial design. The purpose of this study was to investigate the presence or absence of a causal relationship by giving certain treatments to several experimental groups and providing control as a comparison.

The basic design was a Completely Randomized Block Design with a 2 x 3 factorial pattern with 3 repetitions. The first factor was the type of liquid organic fertilizer (P), namely liquid fertilizer of rice washing waste with fermentation and liquid fertilizer of rice washing waste without fermentation. The second factor was the variation in the concentration of liquid fertilizer. Concentrations of variations in liquid fertilizer of rice washing waste were 50%, 75% and 100%.

Determination of the concentration of liquid organic fertilizer from rice washing waste in this study refers to a study conducted by Jemali which stated that the best concentration that could increase the rate of growth of plant height and dry weight of plants was at a concentration treatment of 90%. Furthermore, 70% concentration is the best treatment to increase the growth rate of plant stem diameter, and 80% concentration is the best concentration in increasing the growth rate of leaf number and wet weight of spinach (*Amaranthus tricolor L*). [(5)]

The population in this study were green spinach plants that grew after the nursery. The sample of this study was 100 stems of green spinach plants with the same size with three repetitions for each concentration. Measurement of spinach plant growth was carried out starting at the age of 7 days after growing. The measurement period was carried out for 28 days from the start of the measurement.

Descriptive analysis was carried out to determine the average and standard deviation of each variable in this study, namely the growth of red and green pulled spinach plants (stem height, number of leaves, and leaf width) with variations in the concentration of liquid fertilizer.

Analysis to determine the effectiveness of the utilization of fermented rice waste with various concentrations on the growth of green spinach plants. The data has been obtained based on observations of stem height, leaf width and number of leaves. To determine the effectiveness of the dose based on each type of fertilizer using the Annova test. Furthermore, the mean difference test (independent t test) was carried out to determine the difference in the growth of red and green pulled spinach plants based on stem height, the number of leaves, and leaf width.

RESULTS

Average Steam Height, Leaf Width, Number Leave of Green Spinach

Research conducted on spinach plants to determine the growth of spinach plants after being given liquid organic fertilizer treatment from rice washing wastewater can be seen in the following descriptive analysis. Based on table 1, it is known that there is a difference in the average height of green spinach stems in the treatment of fermented liquid organic fertilizer, not fermented with control. Stem height of green spinach plants was lower in

control compared to stem height of green spinach plants treated with liquid organic fertilizer (fermented and without fermentation).

Table 1. Average stem height of green spinach plants

Concentration (%)	Observations on spinach plants	
	Fermentation (cm)	No fermentation (cm)
Control	9.40	9.30
50	12.89	10.80
75	10.99	11.08
100	9.55	11.64
Average	10.71	10.70

Table 2. Average leaf width of green spinach plants

Concentration (%)	Observations on spinach plants	
	Fermentation (cm)	No fermentation (cm)
Control	3.58	3.53
50	4.35	3.40
75	4.40	3.83
100	3.70	4.08
Average	4.01	3.71

The growth of leaf width of spinach plants given liquid organic fertilizer from rice washing waste with fermentation had a higher average value than the control. While the average value of leaf width of spinach plants given liquid organic fertilizer of rice washing waste without fermentation at one concentration of leaf width had a smaller average value when compared to the control, namely at a concentration of 50%.

Table 3. Average number of leaves of green spinach plants

Concentration (%)	Observations on spinach plants	
	Fermentation (strands)	No fermentation (strands)
Control	8	8
50	10	9
75	9	8
100	9	7
Average	9	8

The average number of leaves given liquid organic fertilizer of rice washing waste with fermentation had more number of leaves than the control, while the average number of leaves on the application of liquid organic fertilizer of rice washing waste without fermentation had fewer leaves than the control on one of the concentration is at a concentration of 100%.

Statistical Analysis

In this study used the Anova test with a completely randomized design (CRD). This analysis aims to determine the effect of liquid fertilizer application on green spinach plants. The presentation of Anova data can be seen in the following table:

Table 4. Effectiveness of fermented rice waste liquid fertilizer at 50%, 75%, and 100% concentrations on stem height

Concentration	Mean	Std. Deviation	95% CI	p-value
50%	26.6667	2.08167	21.4955 - 31.8378	0.026
75%	25.1633	0.56766	23.7532 - 26.5735	
100%	21.6867	0.05132	21.5592 - 21.8141	

Based on statistical tests, obtained p value = 0.026 (<0.05), this means that there is a significant difference in stem height between the 3 concentrations (50%, 75%, and 100%). The test results showed that the liquid organic fertilizer of rice washing waste with fermentation had an effect on the growth of green spinach stems.

Table 5. Effectiveness of liquid fertilizer for rice washing waste without fermentation at concentrations of 50%, 75%, and 100% against stem height

Concentration	Mean	Std. Deviation	95% CI	p-value
50%	230000	2000000	27.9683 - 27.9683	
75%	27.8000	0.98489	25.3534 - 30.2466	0.014
100%	27.5667	1.38684	24.1216 - 31.0118	

The results of the statistical test in Table 4.5 are known to have p value = 0.014 (< 0.05), so it can be seen that there are significant similarities in stem height between the 3 concentrations (50%, 75%, and 100%). Based on these tests, it was concluded that the liquid organic fertilizer of rice washing waste without fermentation was not effective on the growth of green spinach stem height

Table 6. Effectiveness of fermented rice laundry waste liquid fertilizer at 50%, 75%, and 100% concentrations on leaf width

Concentration	mean	Std. Deviation	95% CI	p-value
50%	8.6833	0.50083	7.4392 – 9.9275	
75%	10.0867	0.15044	9.7129 – 10.4604	0.001
100%	7.7633	0.20817	7.2462 – 8.2804	

Statistical test in table 6 obtained p value = 0.001 (<0.05), this means that there is a significant difference in leaf width between the 3 concentrations (50%, 75%, and 100%). It can be seen that the liquid organic fertilizer of rice washing waste with fermentation has an effect on the growth of green spinach leaf width.

Table 7. The effectiveness of liquid fertilizer for rice washing waste without fermentation at concentrations of 50%, 75%, and 100% against leaf width

Concentration	mean	Std. Deviation	95% CI	p-value
50%	7.0533	0.55003	5.6870 - 8.4197	
75%	8.3867	1.9630	7.8990 - 8.8743	0.001
100%	9.0833	0.16258	8.6795 - 9.4872	

Based on the data in table 7, it can be seen that the p value = 0.001 (<0.05), this means that there is a significant difference in leaf width between the 3 concentrations (50%, 75%, and 100%). It can be concluded that the liquid organic fertilizer of rice washing waste without fermentation has an effect on the growth of green spinach leaf width.

Table 8. The effectiveness of fermented rice laundry waste liquid fertilizer at 50%, 75%, and 100% concentrations on the number of leaves

Concentration	mean	Std. Deviation	95% CI	p-value
50%	15.6667	3.05505	8.0775 - 23.2558	
75%	14.6667	0.57735	13.2324 - 16.1009	0.582
100%	140000	1.0000	11.5159 - 16.4841	

The results of the statistical test table 8 obtained p value = 0.582 (> 0.05), this means that there are significant similarities in the number of leaves between the 3 concentrations (50%, 75%, and 100%). The conclusion of the test is that the liquid organic fertilizer of rice washing waste with fermentation has no effect on the growth of the number of green spinach leaves.

Table 9. Effectiveness of non-fermented rice laundry waste liquid fertilizer at 50%, 75%, and 100% concentrations on number of leaves

Concentration	Mean	Std. Deviation	95% CI	p-value
50%	130000	1.0000	10.5159 - 15.4841	
75%	13.3333	1.15470	10.4649 - 16.2018	0.813
100%	12.6667	1.52753	8.8721 - 16.4612	

Based on statistical tests obtained p value = 0.813 (> 0.05), this means that there are significant similarities in the number of leaves between the 3 concentrations (50%, 75%, and 100%), so it can be concluded that the liquid organic fertilizer of laundry waste unfermented rice has no effect on the growth of the number of green spinach leaves.

Table 10. Post hoc analysis comparison of stem height between concentrations

Concentration	Difference mean	p-value
50% vs 75%	1.503	0.570
50% vs 100%	4.98	0.008
75% vs 100%	3.47	0.043

Post hoc analysis proved that the concentrations that were significantly different were concentrations of 50% with 100% and 75% with 100%. Meanwhile, between 50% and 75% were not proven to be significant, which means that the concentrations of 50% and 75% were statistically proven to have almost the same average on stem height growth. However, based on the mean value, it can be concluded that 50% concentration is the most effective concentration on stem height growth

Table 11. Post hoc analysis comparison of leaf width between concentrations

Concentration	Difference mean	p-value
50% vs 75%	1.40	0.006
50% vs 100%	0.92	0.040
75% vs 100%	2.32	0.000

Post hoc analysis proved that the concentrations that were significantly different were concentrations of 50% with 100%, 75% with 50%, and 75% with 100%. Based on this analysis, it was also known that the 75% concentration was significantly proven to be the most effective concentration on leaf width, with a mean value of 10.0867.

DISCUSSION

Plant growth can be influenced by several factors, there are internal factors consisting of genetics and hormones from the plant itself and external factors consisting of the plant's growing environment. The plant growing environment has a factor that is closely related to the success of plant growth. An optimal growing environment is necessary to maximize plant development. Several environmental factors affect plant growth, including air, water, light, soil, climate, and nutrients. Nutrients have an important role in plant growth metabolism, if plants lack nutrients then their growth and development can be disrupted and susceptible to plant diseases. Nutrient levels can vary from one land to another, This causes the growth of similar plants to differ in different regions. There are several ways to meet plant nutrient needs, one of which is through the fertilization process.

Fertilization is an activity that is widely known by the community, especially in the agricultural sector. Various types of fertilizers have been circulating in the community. The types of fertilizers that are common in the community are organic fertilizers and inorganic fertilizers. Organic fertilizers are fertilizers without the addition of chemicals, while inorganic fertilizers are fertilizers with a mixture of chemicals. Excessive use of inorganic fertilizers can cause disturbances in the natural balance. Some examples of natural damage that can be caused by excessive use of inorganic fertilizers are soil damage and reduced crop production. The high price and amount of use of inorganic fertilizers in agricultural activities encourage farmers to use organic fertilizers.

Organic fertilizers circulating in the market can be in liquid and solid forms. Organic fertilizers can be produced from the rest of the results of human activities that are no longer used. One of the residual sources of

human activities is household activities. The rest of human activities can be reused as fertilizer after going through the processing process. Waste from human activities so far is still underutilized and is directly dumped into the sewer. One example of the waste that is produced every day from daily activities is rice washing water.

According to the results of previous studies, it is known that rice washing water contains very important soil nutrients, namely carbohydrates, nitrogen, phosphorus, potassium, magnesium, sulfur, iron, and vitamin B1[(6)]. Efforts to increase the main nutrients such as phosphorus, Soil nitrogen, and potassium can be done by using rice washing water waste as water for watering plants, in addition to the above content, it can also increase N, P, and K nutrients [(7)]. The purpose of selecting the main raw material for rice washing water is to utilize the rest of the daily activities.

Based on the results of previous research, it is know that the NPK content of glutinous rice water fertilizer which was fermented anaerobically was higher than that of unfermented glutinous rice water. The fermentation process in the composting process aims to increase the development of microbial decomposers. Based on these results, in this study two groups of fertilizers were made, there were fermented and unfermented liquid ertilizers. Making liquid organic fertilizer from fermented rice washing wastewater by adding brown sugar and coconut [(8)].

Fertilization is carried out on plants that are given fertilizer treatment. The control plants were not given fertilizer. The fertilizer used in spinach plants is liquid organic fertilizer from rice washing wastewater with concentrations of 50%, 75%, and 100%. Fertilizer was applied to spinach plants with different polybags. Fertilizer treatment was repeated three times for each fertilizer variation and spinach type. The growth of spinach plants was assessed by measuring the height of the stem, counting the number of leaves, and measuring the width of the leaves.

Stem Height Growth

The stem height of the green spinach plant at the age of 7 days after sowing with the average stem height was relatively the same, namely 4 cm from the soil surface. During the observation period, the height of the green spinach stems grew. During the observation period, the growth of Batam height of green spinach plants began to vary, starting to see differences between the growth of groups of various concentrations in both the fermented fertilizer group and the unfermented fertilizer group.

Based on table 4.1, it is known that the growth of stem height in green spinach plants at each concentration has a different growth. From the table, it can be seen that for the group of liquid organic fertilizers from fermented rice washing wastewater, the most significant concentration in stem height growth was a concentration of 50%. The concentration of 50% is the lowest in this study. This is in line with other studies, that rice washing water has the potential to be used on celery plants but at a more dilute concentration (third rinse rice washing water) [(9)].

In the group of liquid organic fertilizers from rice washing wastewater without fermentation, the growth of stem height on green spinach plants was different. For a concentration of 100%, the stem height of green spinach plants experienced significant growth. This is in line with previous research, namely the application of 20 ml of rice washing water fertilizer has the most significant effect on the height of mustard plants[(3)]. This can be caused because this treatment contains a lot of Pseudomonas fluorescent nutrients which are microbes that play a role in triggering plant growth. In addition, the nutrients contained in liquid organic fertilizer from rice washing wastewater without fermentation are still lacking to meet the growing needs of green spinach plants. The content of N, P, and K in glutinous rice water fertilizer that is fermented anaerobically is higher than that of unfermented glutinous rice water. Good nutrient content will provide maximum growth to plants[(8)].

One of the nutrients needed by plants to support plant growth is Nitrogen (N) and Phosphorus (P). Each of these elements has a very good role and function for plant growth which can later have an impact on increasing plant productivity [(10)]. Vitamin B1 contained in rice washing water has a role in converting high carbohydrate content into energy to drive plant activity. Convective carbohydrates also act as an intermediary for the formation of the hormones auxin and gibberellins which can stimulate root growth [(11)].

In general, growth and development in plants begin with the zygote stage which is the result of fertilization of female sex cells with males. The division of the zygote produces a meristematic tissue that will continue to divide and differentiate. The growth of plant stem height occurs in the intercalary meristems of the stem segments.

Green spinach plants are one of the plants that have a short harvest life, ranging from 21 days to 35 days after sowing[(12)]. This is in line with the results of the research conducted, namely, on the 28th day, the height of the green spinach tree trunk reached 28.80 cm at a concentration of 75% for the liquid organic fertilizer group from rice washing wastewater without fermentation. This could be because the nutrients contained in liquid organic fertilizer from rice washing wastewater were able to meet the needs of spinach plants.

Leaf Width Growth

The process of leaf width growth at the time of observation experienced several variations. The average leaf width when first observed was 0.5-0.7 cm. Over time, the width of the leaves of green spinach plants has developed. Observations in this study were carried out every two days for 28 days. The growth of leaf width in this study can be said to be relatively fast. The growth and development of leaf width can reach 0.3 - 0.4 cm per observation.

Based on the results, the observation group of liquid organic fertilizer from fermented rice washing wastewater at a concentration of 75% had the highest average growth value, while for the liquid organic fertilizer group from rice washing wastewater without fermentation the concentration was 100%. This is because liquid organic fertilizer from rice washing wastewater can meet the nutrient needs of plant growth. The results of this study are inversely proportional to theprevious studies which stated that the lack of rice washing water on Pak Choy plants and errors in determining the dose would make growth less than optimal[11].

Rice washing water contains elements of carbohydrates, nitrogen, phosphorus, potassium, magnesium, sulfur, iron, and vitamin B1 which are needed for plant growth. The dose of fertilizer given to plants must be right, giving excessive doses of fertilizer will make plant growth less than optimal. Leaf width is closely related to the process of photosynthesis, where the intake of nutrients is less it will affect the productivity of plants in producing oxygen. The wider the width of the leaf, the rate of photosynthesis will increase, and the absorption of sunlight can be carried out optimally. If the photosynthesis process is carried out optimally, then the assimilation from the photosynthesis process can be optimally accumulated in the growth organs of plants such as roots, stems, and leaves which describe plant biomass.

The application of liquid fertilizer with a high concentration will provide more optimal plant growth, this can happen because the nutrients provided are also more and more sufficient for plant growth. Giving fertilizer in liquid form can also facilitate absorption by plant roots so that the supply of stems and leaves is also more optimal. In this study, the application of liquid organic fertilizer with a high concentration gave the most optimal leaf growth results in both the fermented and non-fermented fertilizer groups, this could be due to the lack of nutrients in the soil used for plant growth. The results of previous studies stated that the application of organic fertilizer of 20 ml of rice washing water affects the growth of the leaves of the mustard plant, the leaves are the site of the photosynthesis process of the plant which is assisted by the provision of liquid organic fertilizer so that the number of leaves is more. According to other research results, the leaf area of a plant is influenced by the number of leaves on the plant, the more the number of leaves, the wider the leaf area of a plant[13].

Growth Number of Leaves

The process of growing the number of leaves at the time of observation experienced several variations. The average number of leaves when first observed was 3-4 pieces. Over time, the number of green spinach leaves has grown. Observations in this study were carried out every two days for 28 days. The growth of the number of leaves in this study can be said to be relatively fast. The growth of the number of leaves can reach 1-2 leaves per observation.

In this study, the highest average leaf number growth for the 50% concentration group with fermented liquid fertilizer and the lowest average leaf growth rate was at 100% concentration with unfermented liquid fertilizer. The incubation period of giving rice washing fertilizer did not significantly affect the number of leaves, leaf area, dry weight, and the number of carotenoids in mustard greens[13]. In this study, the application of organic fertilizer for rice washing wastewater with fermentation showed the highest average growth of the number of leaves. In mustard plants given organic fertilizer of rice washing water as much as 20 ml/liter of water, the more dominant influence on the number of leaves[3]. Leaves are the site of plant photosynthesis and are assisted by this liquid organic fertilizer so that the number of leaves is more than the control. Rice washing water organic fertilizer also contains 80% vitamin B1, 70% vitamin B3, 90% vitamin B6, and nitrogen content which can trigger the growth of the number of leaves.

Leaves are a very important part of plant growth because leaves have a role in the process of photosynthesis. If the number of leaves on a plant is quite a lot, the photosynthesis process will take place optimally. Leaves are plant organs where synthesizing food occurs for plant needs or as food reserves[14].

Nutrients have an important role in the formation of leaves, especially the element N. Rice washing waste contains many nutrients needed for plants, including carbohydrates, nitrogen, phosphorus, calcium, sulfur, iron, vitamin B1, and magnesium[16]. The magnesium contained in rice washing water helps the process of forming green leaves or chlorophyll and plays a role in helping the process of transporting phosphate in plants. In addition to nutrient content, water also has an important role in plant growth, because water can dissolve nutrients so that they are easily absorbed by plant roots.

The results of the study were in line with the growth of stem height, a concentration of 50% in the organic fertilizer group of unfermented rice washing water had the highest stem height growth. This can be due to the

higher the plant, the more the number of leaves that grow. The results of photosynthesis in the leaves are used by plants to reproduce. Plant growth can be an increase in the size of the stem height and the formation of new branches and leaves. The results of this study indicate that there is a close relationship between the growth of stem height and the growth of the number of leaves, which can produce optimal photosynthetic activities.

CONCLUSION

There was a significant effect of giving fermented and unfermented liquid organic fertilizer on the growth of stem height and leaf width of green spinach. The application of liquid organic fertilizer for fermented and unfermented rice washing had no effect on the growth of the number of green spinach leaves.

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