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Optimizing the Growth and Yield of Kale (*Brassica oleracea* Var. Acephala) by providing Eggshell Liquid Fertilizer and Water Hyacinth Bokashi

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ABSTRACT

This study investigated the optimal concentration of liquid organic fertilizer from chicken eggshells and the effective dose of water hyacinth bokashi for enhancing kale (*Brassica oleracea* var. Acephala) growth and yield. Conducted in Bontomanai Village, Bungaya Subdistrict, Gowa Regency, the research utilized a factorial randomized block design with two factors: concentration of liquid fertilizer (0 ml, 100 ml/L, 300 ml/L) and bokashi dose (0 kg, 1 kg, 2 kg). The study included 9 treatment combinations, each replicated 3 times, resulting in 27 experimental units. Key parameters measured were plant height, number of leaves, fresh weight per plant, fresh weight per plot, consumable weight per plot, root weight per plot, and yield per hectare. Findings revealed that neither the interaction of liquid fertilizer concentration and bokashi dose nor their individual effects significantly influenced kale growth or yield. The concentration of 100 ml/L liquid fertilizer produced the highest number of leaves (23.29), fresh weight per plant (73.67 g), and yield per hectare (5.50 tons). The 2 kg/plot bokashi dose resulted in the highest number of leaves (23.81), fresh weight per plant (72.98 g), and yield per hectare (5.60 tons).

Keywords: Fertilizer Concentration, Organic Fertilizer, Plant Growth, Sustainable Agriculture

1. INTRODUCTION

The growth and yield of horticultural crops like kale (*Brassica oleracea* var. Acephala) are deeply influenced by the availability of nutrients in the soil. Nutrient levels and environmental stressors significantly impact crop yield and quality, highlighting the importance of adopting appropriate cultivation practices (Marino, 2021).

Organic fertilizers have long been used as an eco-friendly and sustainable alternative to chemical fertilizers in agriculture. These fertilizers enhance soil fertility, improve soil structure, and supply essential nutrients that support plant growth. Among the different types of organic fertilizers, those derived from chicken eggshells and water hyacinth bokashi are particularly promising. The effectiveness of these organic fertilizers can be influenced by various factors, such as planting distance and fertilizer concentration, which ultimately affect the growth and yield of kale plants (Su'ud et al., 2023). Revious studies have shown that the application of liquid organic fertilizers can significantly improve the growth and yield of kale. This research will study the benefits of liquid organic fertilizers for kale, focusing on how these fertilizers affect growth and yield (Dasumiati et al., 2023)

Chicken eggshells, often considered waste, are a rich source of calcium carbonate and several other minerals beneficial to plant growth. When properly processed, these eggshells can be converted into a liquid organic fertilizer that is easily absorbed by plants. Such eggshell-based fertilizers can have a profound impact on the growth, yield, and overall quality of kale plants (Natanael & Banjarnahor, 2021).

Organic matter content in the soil but also enhances the activity of soil microorganisms, which play a crucial role in decomposing organic matter. The application of water hyacinth bokashi can improve the lipid content and nutritional value of kale, making it a valuable component of sustainable agriculture (Vidal et al., 2018)

This study is designed to evaluate the effects of applying liquid organic fertilizer derived from chicken eggshells and water hyacinth bokashi on the growth and yield of kale plants. The primary goal is to provide farmers and agricultural practitioners with valuable insights into the effectiveness of these organic fertilizers. By assessing different concentrations of liquid organic fertilizer and doses of bokashi, the study aims to identify the optimal conditions for maximizing kale growth and yield.

The research will focus on a comparative analysis of various concentrations of liquid organic fertilizer and bokashi doses. Key growth parameters such as plant height, number of leaves, fresh weight per plant, fresh weight per plot, consumable weight per plot, root weight per plot, and yield per hectare will be measured and analyzed. This comprehensive evaluation will help determine the most effective fertilization strategies for enhancing kale production.

The study is expected to contribute to a better understanding of how organic fertilizers can be used to improve kale cultivation practices. It aims to offer practical recommendations for the use of environmentally friendly fertilization methods, benefiting both individual farmers and the broader agricultural industry. By providing actionable insights into the optimal use of these organic inputs, the research seeks to promote sustainable agricultural practices and improve overall crop productivity.

In summary, this study addresses a critical aspect of sustainable agriculture by exploring the potential of organic fertilizers derived from chicken eggshells and water hyacinth bokashi to enhance kale growth and yield. The findings are anticipated to guide the effective application of these fertilizers, offering valuable information that can lead to improved cultivation practices and greater agricultural sustainability.

2. MATERIAL AND METHODS

2.1 Location and Time of Research

This research was conducted in Bontomanai Village, Bungaya Subdistrict, Gowa Regency, geographically located at 05° 21' 48.4" S and 119° 43' 5.39" E, from May to July 2023. This location was chosen due to its supportive agronomic conditions for kale cultivation and support from the local farming community experienced in organic farming practices. During the research, various growth and yield parameters of kale plants were intensively observed to ensure the accuracy and reliability of the data obtained.

2.2 Material

The materials used in this experiment included: kale seeds, Effective Microorganism 4 (EM4), brown sugar, chicken eggshells, water, rice water, and water hyacinth bokashi. The equipment used included: hoes, measuring cups, digital scales, stationery, plastic bottles and camera.

2.3 Research Methods

This study employed a Randomized Complete Block Design (RCBD) with a factorial pattern to examine the effects of liquid organic fertilizer from chicken eggshell waste and water hyacinth bokashi on the growth and yield of kale (*Brassica oleracea* var. Acephala). The first factor was the liquid organic fertilizer from chicken eggshells, with three treatments: control, 100 ml/L of water, and 300 ml/L of water. The second factor was water hyacinth bokashi, with three treatments: control, 1 kg/plot, and 2 kg/plot.

The experiment consisted of 18 experimental units with three replications for each treatment combination. The land was prepared by mixing soil, compost, and sand. Liquid organic fertilizer and bokashi were applied according to the specified doses on each plot at regular intervals. Kale seedlings were planted at uniform spacing, and maintenance included watering, weeding, and pest and disease control.

Observations were made on plant height, number of leaves, stem diameter, and plant yield (fresh weight and dry weight of water spinach leaves). The results of this study are expected to provide useful information regarding the effectiveness of using liquid organic fertilizer derived from chicken eggshell waste and water hyacinth bokashi in enhancing the growth and yield of water spinach plants.

Production of Liquid Organic Fertilizer (LOF) Eggshells are cleaned, dried, and ground into a fine powder. A plastic bottle is filled with 500 ml of rice water and 100 ml of regular water. Palm sugar is dissolved in hot water and 45 ml (equivalent to 3 tablespoons) of the dissolved palm sugar is added to the bottle containing the mixture of water, eggshell powder, and rice water. Then, 200 ml of EM4 solution is added to the bottle, which is sealed tightly and left to ferment.

Land Preparation The land intended for planting is first prepared by hoeing and clearing it of weeds, plant residues and any other material present on the planting site.

Plot Preparation Research plots are prepared by creating 27 individual plots, each measuring 1m x 1m. The distance between replicates and plots is maintained at 35 cm x 35 cm.

Application of Water Hyacinth Bokashi Bokashi fertilizer made from water hyacinth is applied one week after land preparation is complete. At this stage, the soil is ready to receive organic fertilizer to improve its structure and enhance fertility. The fertilizer application is performed once to ensure that the nutrients contained in the fertilizer are optimally absorbed by the plants.

Planting is conducted after the seedlings have been germinated for 15 days or when they have grown 3-4 leaves. The seedlings are transplanted into 5 cm deep holes, with one seedling planted per hole.

Fertilization is done by applying liquid organic fertilizer made from chicken eggshell waste at 7 days after planting, followed by applications at 14, 21, 28, 35 and 42 days after planting. Data were analyzed using Analysis of Variance (ANOVA) to test the effects of treatments and their interactions, employing Excel for data management and analysis (Shendell et al., 2023), followed by post-hoc tests if significant differences were found.

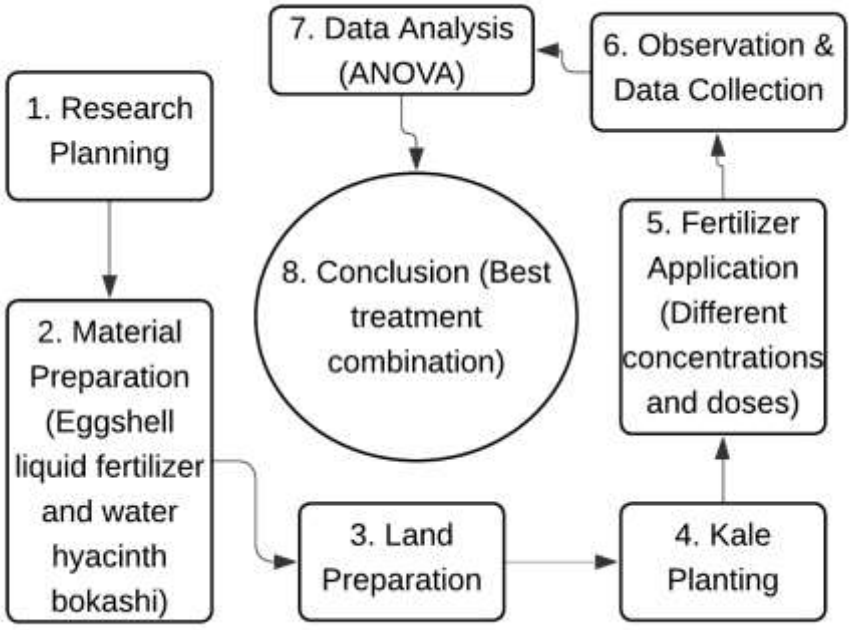

Figure 1. Figure of Research Flow

3. RESULT AND DISCUSSION

3.1 Plant Height

Figure 1 shows the average plant height (cm) of kale at different concentrations of liquid organic fertilizer from chicken eggshell waste (LOF) and water hyacinth bokashi.

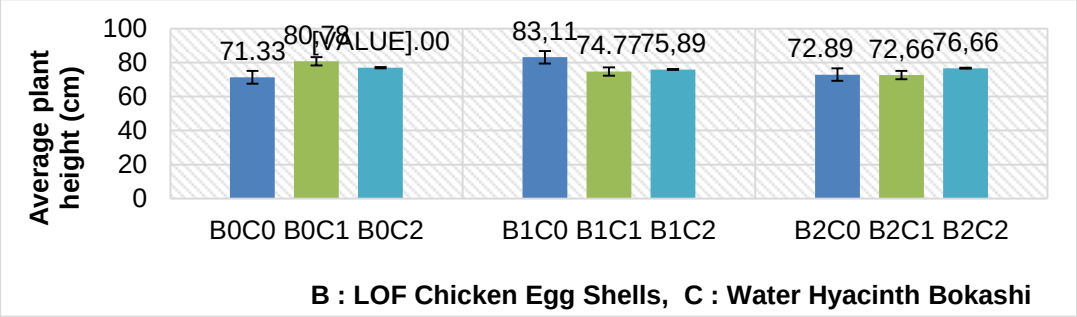

Figure 2. Average plant height (cm) of kale at different concentrations of liquid organic fertilizer from chicken eggshells and water hyacinth bokashi.

The analysis of variance revealed that neither the concentration of liquid organic fertilizer from chicken eggshells nor water hyacinth bokashi, nor their interaction, had a significant effect on plant height. However, variations in plant height were observed among the different treatments.

In the treatment with water hyacinth bokashi (C0) without LOF (B0C0), the average plant height was 71.33 cm. Adding LOF at the B0C1 level resulted in an average plant height of

80.78 cm, which was the highest among the B0 treatments, while at the B0C2 level, plant height decreased to 77.00 cm. For treatments with LOF at the B1 level (without bokashi), the average plant height was 83.11 cm at B1C0, which was the highest among all treatments, followed by B1C1 with a height of 74.77 cm and B1C2 with a height of 75.89 cm. For treatments with bokashi at the C2 level, the average plant height was 72.89 cm at B2C0, 72.66 cm at B2C1, and increased to 76.66 cm at B2C2.

Overall, the treatment B1C0 (LOF at 100 ml/L of water without bokashi) provided the best result with an average plant height of 83.11 cm, indicating that the use of LOF at this concentration without additional bokashi supports optimal kale plant height growth. The results of the study indicate that the concentration of liquid organic fertilizer (LOF) derived from chicken eggshell waste and water hyacinth bokashi. as well as their interactions. did not significantly affect the height of kale plants. However. variations in plant height were observed among the treatments. The treatment without LOF and bokashi (B0C0) resulted in the lowest plant height. at 71.33 cm. This suggests that kale plants require additional nutrients from LOF and bokashi for optimal growth. Bokashi and LOF provide essential nutrients such as nitrogen. phosphorus. and potassium that support plant growth.

Conversely. the treatment with LOF at level 1 (100 ml/L) without bokashi (B1C0) resulted in the highest plant height. at 83.11 cm. This indicates that the use of LOF at this level without additional bokashi supports optimal kale plant growth. LOF at this concentration may supply sufficient nutrients without causing imbalances that could occur if both treatments were used together. Although the interaction between LOF and bokashi did not significantly affect plant height. the use of LOF at level 1 without bokashi provided the best results. On the other hand. the absence of both LOF and bokashi resulted in the lowest plant growth. highlighting the importance of additional nutrients for supporting optimal kale growth. The combination of liquid organic fertilizer and growing media affects plant height after 28 days (Purba et al., 2021). Calcium carbonate from eggshells has been identified as an environmentally friendly fertilizer that enhances plant growth and soil health (Gulzar et al., 2024; Ma'mor et al., 2023). Water hyacinth compost has beneficial impacts on agronomic growth parameters such as plant height (Begum et al., 2021). Similarly. the application of water hyacinth organic fertilizer shows beneficial effects on vegetative growth. including plant height (Merry Gosal et al., 2022).

3.2 Number of Leaves

The results of the analysis of variance indicate that the concentrations of liquid organic fertilizer The results of the analysis of variance indicate that the concentrations of liquid organic fertilizer and water hyacinth bokashi had a highly significant effect, as shown in Table 1.

The data show that the combination of LOF concentration and bokashi significantly affects the number of leaves produced by kale plants. Generally, the treatment with bokashi C2 (2 kg/plot) produced the highest number of leaves across all LOF concentrations. At the LOF level B0 (0 ml/L), the highest number of leaves was achieved with bokashi C2, averaging 22.33 leaves. Treatments with bokashi C1 and C0 produced 20.22 leaves and 18.55 leaves, respectively. At the LOF level B1 (100 ml/L), the highest number of leaves was also achieved with bokashi C1, averaging 24.55 leaves, which was the best result among all combinations. Bokashi C2 and C0 produced 24 leaves and 21.22 leaves, respectively. At the LOF level B2 (300 ml/L), the highest number of leaves was achieved with bokashi C2, averaging 25.11 leaves. Treatments with bokashi C1 and C0 produced 24.44 leaves and 20.31 leaves, respectively.

Overall, the highest average number of leaves was achieved with the LOF B2 (300 ml/L) treatment, averaging 23.29 leaves, followed by the LOF B1 (100 ml/L) treatment, averaging 23.25 leaves, which were significantly different from the LOF B0 (0 ml/L) treatment, averaging 20.37 leaves. The best combination for producing the highest number of leaves was LOF B2 with bokashi C2, which resulted in an average of 25.11 leaves.

Table 1. Average Number of Kale Leaves (sheets) at Different Concentrations of Liquid Organic Fertilizer from Chicken Eggshells and Water Hyacinth Bokashi

Bokashi (kg/plot)	LOF (ml/L)			Rate-rate	LSD 0.05
	B0 (0 ml/L)	B1 (100 ml/L)	B2 (300 ml/L)		
C0 (0kg/plot)	18.55	21.22	20.31	20.03±0.64 [a]	1.61
C1 (1 kg/plot)	20.22	24.55	24.44	23.07±1.16 [b]	
C2 (2 kg/plot)	22.33	24.00	25.11	23.81±0.66 [b]	
Average	20.37±0.89 [x]	23.25±0.84 [y]	23.29±1.23 [y]		
LSD 0,05	1.61				

Note: Numbers followed by different letters (a, b, x, y) are significantly different based on the LSD 0.05 test.

The experimental results indicate that the treatment with LOF concentration B0 (0 ml/L) resulted in the lowest number of leaves. with an average of only 20.37 leaves. At this level. the treatment with bokashi C0 (no bokashi) recorded the lowest result with an average of 18.55 leaves. indicating a significant impact on the leaf production of kale plants. Conversely. the best results were obtained from the combination of LOF B2 (300 ml/L) with bokashi C2 (2 kg/plot). which resulted in an average of 25.11 leaves.

These results suggest that increasing the LOF concentration along with the use of bokashi C2 consistently produced better leaf growth in kale plants compared to other treatments. Additionally. the treatment with LOF B1 (100 ml/L) and bokashi C1 (1 kg/plot) also recorded very good results. with an average of 24.55 leaves. showing an effective alternative for significantly enhancing kale leaf production compared to the control. The increase in the number of leaves in kale plants is attributed to the nutrients present in the liquid organic fertilizer from chicken eggshells. Adding eggshell powder to compost improves the mechanical properties of the soil. such as impact strength and flexural modulus. This can benefit kale leaves by supporting the plant structure (Abdullah et al., 2021). Mixing compost with eggshell powder affects the nitrogen and calcium levels in the soil. which in turn affects growth (Madyaratri & Suntari, 2023).

3.3 Fresh Weight Per Plant

The results of the analysis of variance indicate that the concentrations of liquid organic fertilizer from chicken eggshells and water hyacinth bokashi have a highly significant effect on the fresh weight per kale plant, but their interaction does not have a significant effect.

Table 2 shows the results of the study regarding the average fresh weight per kale plant at various concentrations of Liquid Organic Fertilizer (LOF) from chicken eggshells and water hyacinth bokashi. There are three bokashi treatments: C0 (0 kg/plot), C1 (1 kg/plot), and C2 (2 kg/plot). At the LOF

concentration B0 (0 ml/L), the average fresh weights for kale plants with bokashi C0, C1, and C2 were 56.11 g, 64.22 g, and 56.77 g, respectively, with an overall average of 59.03 g. For the LOF concentration B1 (100 ml/L), the fresh weights of kale plants were 57.33 g, 81.11 g, and 82.55 g, respectively, with an overall average of 73.67 g. At the LOF concentration B2 (300 ml/L), the fresh weights were 57.99 g, 69.22 g, and 79.66 g, respectively, with an overall average of 68.95 g.

Table 2. Average Fresh Weight per Kale Plant at Different Concentrations of Liquid Organic Fertilizer from Chicken Eggshells and Water Hyacinth Bokashi

Bokashi (kg/plot)	LOF (ml/L)			Rate-rate	LSD 0.05
	B0 (0 ml/L)	B1 (100 ml /L)	B2 (300 ml /L)		
C0 (0kg/plot)	56.11	57.33	57.99	57,14±0.45[a]	10.50
C1 (1 kg/plot)	64.22	81.11	69.22	71,51±4.09[b]	
C2(2 kg/plot)	56.77	82.55	79.66	72,98±6.66[b]	
Rate-rate	59.03±2.12[x]	73.67±6.68[y]	68.95±5.11[y]		
LSD 0,05	10.50				

Note: Numbers followed by different letters (a, b, x, y) are significantly different based on the LSD 0.05 test.

The research results indicate significant variation in the fresh weight of kale plants based on the combination of liquid organic fertilizer (LOF) concentrations and types of bokashi used. The lowest fresh weight for kale plants was recorded with LOF concentration B0 (0 ml/L). where the treatment without bokashi (C0) had an average fresh weight of 56.11 g. while the treatment with bokashi C2 only reached 56.77 g. The bokashi C1 treatment at this concentration showed a significant increase. with an average of 64.22 g. Overall. LOF concentration B0 showed an average fresh weight of kale plants at 59.03 g. which was the lowest compared to other treatments.

The best results for the fresh weight of kale plants occurred with the combination of LOF B1 (100 ml/L) with bokashi C1 (1 kg/plot) and C2 (2 kg/plot). At this concentration. the average fresh weight of kale plants for bokashi C1 reached 81.11 g. while the treatment with bokashi C2 recorded an average of 82.55 g. Both treatments were significantly different from other treatments at the same concentration. Overall. LOF concentration B1 showed an average fresh weight of kale plants at 73.67 g indicating a significant increase compared to LOF concentration B0.

From these results. the combination of LOF concentration B1 with bokashi C1 and C2 provided optimal results in increasing the fresh weight of kale plants. while the treatment without bokashi (C0) at LOF concentration B0 showed the lowest results. The application of liquid eggshell fertilizer can increase the fresh weight of plants such as kale (Asie et al., 2023). Similarly. the use of organic fertilizers such as water hyacinth compost has been shown to positively affect growth parameters of plants such as plant height and fruit weight per plant (Situmeang et al. 2019).

3.4 Fresh Weight Per Plot

The results of the analysis of variance indicate that the concentrations of liquid organic fertilizer from chicken eggshells and water hyacinth bokashi have a highly significant effect on the fresh weight per plot.

Table 3. Average Fresh Weight per Plot (kg) of Kale at Different Concentrations of Liquid Organic Fertilizer from Chicken Eggshells and Water Hyacinth Bokashi

Bokashi (kg/plot)	LOF (ml/L)			Rate-rate	LSD 0.05
	B0 (0 ml/L)	B1 (100 ml/L)	B2 (300 ml/L)		
C0 (0kg/plot)	0.48	0.47	0.48	0.48±0.00[a]	0.08
C1 (1 kg/plot)	0.52	0.57	0.58	0.56±0.02[b]	
C2 (2 kg/plot)	0.46	0.62	0.59	0.56±0.04[b]	

Note: Numbers followed by different letters (a, b, x, y) are significantly different based on the LSD 0.05 test.

Table 3 shows the average fresh weight per plot (kg) of kale at various concentrations of Liquid Organic Fertilizer (LOF) from chicken eggshells and water hyacinth bokashi. There are three bokashi treatments: C0 (0 kg/plot). C1 (1 kg/plot). and C2 (2 kg/plot). At the LOF concentration B0 (0 ml/L). the average fresh weights per plot for bokashi C0. C1. and C2 were 0.48 kg. 0.52 kg. and 0.46 kg. respectively. with an overall average of 0.48 kg. For the LOF concentration B1 (100 ml/L). the fresh weights per plot were 0.47 kg. 0.57 kg. and 0.62 kg. respectively. with an overall average of 0.56 kg. At the LOF concentration B2 (300 ml/L). the fresh weights per plot were 0.48 kg. 0.58 kg. and 0.59 kg. respectively. with an overall average of 0.56 kg.

Based on Table 3. it can be observed that the fresh weight per plot of kale varies significantly depending on the combination of liquid organic fertilizer (LOF) concentrations and the type of bokashi used in the treatments. The lowest fresh weight per plot of kale was recorded with LOF concentration B0 (0 ml/L). where the treatment without bokashi (C0) had an average of 0.48 kg. In contrast. the treatment with bokashi C1 at the same concentration showed a significant increase with an average of 0.52 kg. while bokashi C2 reached 0.46 kg. Overall LOF concentration B0 resulted in the lowest average fresh weight per plot of kale at 0.48 kg compared to other treatments.

The best results for fresh weight per plot of kale were observed with the combination of LOF B2 (300 ml/L) with bokashi C1 (1 kg/plot) and C2 (2 kg/plot). At this concentration. the average fresh weight per plot of kale for bokashi C1 reached 0.58 kg. while the treatment with bokashi C2 recorded an average of 0.59 kg. Both treatments showed a significant increase compared to other treatments at the same concentration. Overall LOF concentration B2 showed an average fresh weight per plot of kale at 0.56 kg. indicating a significant increase compared to LOF concentration B0. Water hyacinth can absorb nutrients such as nitrogen and phosphorus. which benefits the surrounding plants (Otieno et al., 2022). A concentration of 10 mL/L of liquid organic fertilizer has a significant effect on the root length of kale plants (Dasumiati et al., 2023).

3.5 Consumption Weight Per Plot

The results of the analysis of variance indicate that the concentrations of liquid organic fertilizer from chicken eggshells and water hyacinth bokashi have a significant effect on the weight of consumption per kale plant. but there is no interaction between them affecting the weight of consumption per plot. The results of the average values can be seen in Table 4.

Table 4 shows the average weight of consumption per plot (g) of kale at different concentrations of Liquid Organic Fertilizer (LOF) from chicken eggshells and water hyacinth bokashi. There are three bokashi treatments: C0 (0 kg/plot).

C1 (1 kg/plot). and C2 (2 kg/plot). At the LOF concentration B0 (0 ml/L). the average weight of consumption per plot for bokashi C0. C1. and C2 were 444.33 g. 487.00 g. and 412.67 g. respectively. with an overall average of 448.00 g. At the LOF concentration B1 (100 ml/L). the weights were 440.33 g. 529.33 g. and 571.33 g. respectively. with an overall average of 513.66 g. At the LOF concentration B2 (300 ml/L). the weights were 440.33 g. 531.67 g. and 537.00 g. respectively. with an overall average of 503.00 g.

Table 4. Average Weight of Consumption per Plot (g) of Kale at Different Concentrations of Liquid Organic Fertilizer from Chicken Eggshells and Water Hyacinth Bokashi

Bokashi (kg/plot)	LOF (ml/L)			Rata-rata	LSD 0.05
	B0 (0 ml/L)	B1 (100 ml/L)	B2 (300 ml/L)		
C0 (0kg/plot)	444.33	440.33	440.33	441.66±1.09^{a}	71.34
C1 (1 kg/plot)	487.00	529.33	531.67	516.00±11.85^{a}	
C2 (2 kg/plot)	412.67	571.33	537.00	507.00±39.35^{ab}	
Rata-rata	448.00±17.58^{x}	513.66±31.53^{y}	503.00±25.62^{y}		
LSD 0.05	71.34				

Note: Numbers followed by different letters (a, b, x y) are significantly different based on the LSD 0.05 test.

Based on Table 4. it can be observed that the consumption weight per plot of kale is significantly influenced by the combination of liquid organic fertilizer (LOF) concentrations and the type of bokashi used in the treatments. The lowest consumption weight per plot of kale was recorded with LOF concentration B0 (0 ml/L). where the treatment with bokashi C2 had an average of 412.67 g. while treatments with bokashi C0 and C1 reached 444.33 g and 487 g. respectively. Overall LOF concentration B0 resulted in the lowest average consumption weight per plot of kale at 448 g compared to other treatments.

The best results for consumption weight per plot of kale were observed with the combination of LOF B2 (300 ml/L) with bokashi C1 (1 kg/plot) and C2 (2 kg/plot). At this concentration. the average consumption weight per plot of kale for bokashi C1 reached 531.67 g. while the treatment with bokashi C2 recorded an average of 537 g. Both treatments showed a significant increase compared to other treatments at the same concentration. Overall LOF concentration B2 showed an average consumption weight per plot of kale at 503 g. indicating a significant increase compared to LOF concentration B0. Bokashi from water hyacinth can enhance plant growth. including height. number. leaf width. and fresh weight of plants (Rahmawati, 2020). There is an interaction effect between the type and concentration of liquid organic fertilizer on the fresh weight of plants. with the highest harvest weight achieved using a concentration of 30 mL/L (Mustofa et al., 2022). The use of water hyacinth extract on tomato plants showed that treatment with 100% water hyacinth extract (P4) produced the best values for plant height. fresh weight. and dry weight (Khansa et al., 2022).

3.6 Root Weight Per Plot

The concentrations of liquid organic fertilizer from chicken eggshells and water hyacinth bokashi have a significant effect on the weight of consumption per plot of kale. but their interaction does not. The results of the average values can be seen in Table 5.

Table 5. Average Weight of Roots per Plot (g) of Kale at Different Concentrations of Liquid Organic Fertilizer from Chicken Eggshells and Water Hyacinth Bokashi

Bokashi (kg/plot)	LOF (ml/L)			Rate-rate	LSD 0.05
	B0 (0 ml/L)	B1 (100 ml/L)	B2 (300 ml/L)		
C0 (0kg/plot)	122.00	143.00	129.00	43.78±5.04[a]	8.18
C1 (1 kg/plot)	132.00	168.00	155.00	50.56±8.59[b]	
C2 (2 kg/plot)	145.00	167.00	163.00	52.78±5.52[b]	
Rata-rata	44.33±5.44[x]	53.11±6.67[y]	49.67±8.38[y]		
LSD 0.05	8.18				

Note: Numbers followed by different letters (a, b, x, y) are significantly different based on the LSD 0.05 test.

Table 5 shows the average root weight per plot (g) of kale influenced by the concentrations of Liquid Organic Fertilizer (LOF) from chicken eggshells and water hyacinth bokashi. The study involved three levels of bokashi application no bokashi (C0). 1 kg/plot bokashi (C1). and 2 kg/plot bokashi (C2). as well as three levels of LOF concentration: no LOF (B0). 100 ml/L LOF (B1). and 300 ml/L LOF (B2). At the bokashi application level with no LOF (B0). the root weight of kale was 122.00 g for C0. 132.00 g for C1. and 145.00 g for C2. with an average of 133.67 g. At the LOF concentration of 100 ml/L (B1). the root weight was 143.00 g for C0. 168.00 g for C1. and 167.00 g for C2. with an average of 159.33 g. At the LOF concentration of 300 ml/L (B2). the root weight was 129.00 g for C0. 155.00 g for C1. and 163.00 g for C2. with an average of 149.00 g. Overall. the average root weight increased with the addition of bokashi and LOF. with the highest result achieved at the combination of 2 kg/plot bokashi and 100 ml/L LOF (C2B1). with a root weight of 167.00 g.

Based on Table 5. the study results show significant variation in root weight per plot of kale depending on the combination of liquid organic fertilizer (LOF) concentrations and bokashi application. The lowest root weight per plot of kale was recorded with no LOF (B0). where the treatment without bokashi (C0) had an average root weight of 122 g. while the treatment with bokashi C2 reached only 145 g. The bokashi C1 treatment at this concentration showed a significant increase with an average of 132 g. Overall LOF concentration B0 resulted in the lowest average root weight per plot of kale at 144.33 g compared to other treatments.

The best results for root weight per plot of kale were observed with the combination of LOF B1 (100 ml/L) and bokashi C2 (2 kg/plot). At this concentration. the average root weight per plot of kale reached 167 g. which is the highest value in this experiment. The treatment with bokashi C1 at the same LOF concentration also showed good results with an average of 168 g. This combination indicates a significant increase compared to other treatments at the same concentration. Overall LOF concentration B1 showed an average root weight per plot of kale at 53.11 g. indicating a significant increase compared to LOF concentration B0. The addition of eggshells in liquid fertilizer formulations can affect plant growth parameters such as root weight (Umadji et al., 2023). Additionally the utilization of agricultural waste. including water hyacinth. has shown significant improvements in root fresh weight and overall yield in curly kale (Sembiring et al., 2023). The application of bokashi made from water hyacinth has shown improvements in plant growth parameters. including plant height. root

weight. and fresh weight (Raksun et al., 2024).

3.7 Production Per Hectare

The observation results indicate that the weight of roots per plot is significantly influenced by the concentrations of liquid organic fertilizer from chicken eggshells and water hyacinth bokashi. The results of the average values can be seen in Table 6.

Table 6. Average Production Weight per Hectare (ton) of Kale at Different Concentrations of Liquid Organic Fertilizer from Chicken Eggshells and Water Hyacinth Bokashi

Bokashi (kg/plot)	LOF (ml/L)			Rate-rate	LSD 0.05
	B0 (0 ml/L)	B1 (100 ml/L)	B2 (300 ml/L)		
C0 (0 kg/plot)	4.8	4.67	4.8	4.76±0.04[a]	0.77
C1 (1 kg/plot)	5.23	5.73	5.83	5.60±0.15[b]	
C2 (2 kg/plot)	4.63	6.03	5.87	5.51±0.36[b]	

Note: Numbers followed by different letters (a. b) are significantly different based on the LSD 0.05 test.

Table 6 shows the average production weight per hectare (ton) of kale influenced by different concentrations of Liquid Organic Fertilizer (LOF) from chicken eggshells and water hyacinth bokashi. The study involved three levels of bokashi application: no bokashi (C0). 1 kg/plot bokashi (C1). and 2 kg/plot bokashi (C2). as well as three levels of LOF concentration: no LOF (B0). 100 ml/L LOF (B1). and 300 ml/L LOF (B2). At the bokashi application level with no LOF (B0). kale production was 4.8 ton/ha for C0. 5.23 ton/ha for C1. and 4.63 ton/ha for C2. with an average of 4.89 ton/ha. At the LOF concentration of 100 ml/L (B1). production was 4.67 ton/ha for C0. 5.73 ton/ha for C1. and 6.03 ton/ha for C2. with an average of 5.48 ton/ha. At the LOF concentration of 300 ml/L (B2). production was 4.8 ton/ha for C0. 5.83 ton/ha for C1. and 5.87 ton/ha for C2. with an average of 5.50 ton/ha. Overall. the average production weight per hectare increased with the addition of bokashi and LOF. with the highest result achieved at the combination of 2 kg/plot bokashi and 100 ml/L LOF (C2B1). with a production of 6.03 ton/ha.

Based on Table 6. the research results indicate significant variation in the weight of kale production per hectare depending on the combination of liquid organic fertilizer (LOF) concentrations and bokashi application. The lowest weight of production per hectare of kale was recorded with no LOF (B0). where the treatment with bokashi C2 (2 kg/plot) had an average of 4.63 tons/ha. while treatments with bokashi C0 and C1 achieved 4.8 tons/ha and 5.23 tons/ha. respectively. Overall. LOF concentration B0 resulted in the lowest average weight of kale production per hectare at 4.89 tons/ha compared to other treatments.

The best results for kale production per hectare were observed with the combination of LOF B1 (100 ml/L) and bokashi C2 (2 kg/plot). At this concentration. the average weight of kale production per hectare reached 6.03 tons/ha. which is the highest value in this experiment. The treatment with bokashi C1 at the same LOF concentration also recorded very good results with an average of 5.73 tons/ha. This combination shows a significant increase compared to other treatments at the same concentration. Overall LOF concentration B1 showed an average weight of kale production per hectare at 5.48 tons/ha. indicating a significant increase compared to LOF concentration B0. It was found that the concentration of Morinsa LOF significantly affects the growth and production of kale (Hanum & Jazilah, 2021). The use of water hyacinth bokashi with two types of activators significantly increased plant production

(Asrijal et al., 2019). Bokashi compost can enhance agricultural land and plant production (Lasmini et al., 2018)(Lasmini et al. 2018). Additionally. water hyacinth is effective in processing water contaminants. reducing pollutants such as heavy metals and other harmful substances (Gupta et al., 2012) Organic and organomineral fertilizers can produce kale with adequate physicochemical composition. free from contaminants and heavy metals (Verruma-Bernardi et al., 2021). The application of liquid organic fertilizers containing nutrients beneficial to plant growth has been associated with increased growth and production in various plant species (Santrum et al., 2023; Yanti & Kaimuddin, 2023) Fertilizers made from water hyacinth enhance plant performance by increasing nutrient availability in the soil (Elida Novita et al., 2023).

4. CONCLUSION

Findings revealed that neither the interaction of liquid fertilizer concentration and bokashi dose nor their individual effects significantly influenced kale growth or yield. The concentration of 100 ml/L liquid fertilizer produced the highest number of leaves (23.29), fresh weight per plant (73.67 g), and yield per hectare (5.50 tons). The 2 kg/plot bokashi dose resulted in the highest number of leaves (23.81), fresh weight per plant (72.98 g), and yield per hectare (5.60 tons).

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