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Integrating Organic Fertilizers from Fish Waste and Chicken Manure for Pakchoi *(Brassica chinensis)* Cultivation and Community Learning

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ABSTRACT

This study investigated the effect of fish waste fertilizer and chicken manure on the growth of pakchoi *(Brassica chinensis)*. The experiment was carried out in January 2020 at Puskopad Housing, Mojokerto, using a Randomized Block Design (RBD) with three treatments and nine replications, resulting in 27 experimental units. The treatments consisted of control (P1), fish waste fertilizer at 4.5% concentration (P2), and chicken manure at 25 g (P3). Plant height and number of leaves were observed as growth parameters. Data were analyzed using analysis of variance (ANOVA) followed by the Least Significant Difference (LSD) test. The findings indicated that both fish waste fertilizer and chicken manure significantly influenced plant height, whereas no significant differences were observed in the number of leaves. These results suggest that organic fertilizers derived from fish waste and chicken manure can effectively enhance vegetative growth of pakchoi, particularly plant height, while leaf development remains unaffected. The study provides practical insights into the use of organic fertilizers as an alternative to chemical inputs and highlights their potential as an educational medium for promoting sustainable agriculture within communities.

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1. INTRODUCTION

The continuous increase in population growth is accompanied by greater awareness of nutritional needs, which in turn leads to higher demand for vegetables. Vegetables play a vital role not only as complementary food to staple diets but also as essential sources of vitamins and minerals. Vegetables are important commodities that can fulfill nutritional requirements and serve as complements to a balanced diet, making them highly prospective for cultivation due to their relatively simple farming methods. Therefore, efforts to sustainably increase both the quantity and quality of vegetable production are necessary [1].

Indonesia's favorable agroclimatic conditions provide great potential for cultivating diverse vegetable crops . To enhance productivity, fertile soil and sufficient nutrient availability are required, which can be achieved through fertilization. Fertilizers play a crucial role in restoring soil nutrients

and maintaining soil fertility [2]. Plant growth such as height, leaf number, branching, and yield is strongly influenced by nutrient availability in the soil [3].

Although chemical (inorganic) fertilizers are widely used by farmers for their practicality and affordability, their continuous application can degrade soil fertility and reduce long-term agricultural productivity [4]. Therefore, the use of alternative fertilizers with more sustainable properties is needed to maintain soil quality and support agricultural productivity in the long run.

To reduce dependency on chemical fertilizers, the use of organic fertilizers is highly recommended. Organic fertilizers, derived from animal manure, plant residues, and agricultural or fishery waste, contain essential macro and micronutrients that support plant growth. Among them, liquid organic fertilizers produced through the fermentation of organic materials are particularly effective because they are easily absorbed by plants and can stimulate microbial activity in the rhizosphere [2].

Fishery waste, which is often discarded in traditional markets, has great potential as a raw material for organic fertilizer due to its high protein content and essential nutrients such as nitrogen, phosphorus, and potassium [5]. Likewise, chicken manure, one of the richest organic manures in terms of nutrient composition, is widely recognized for its ability to improve soil fertility, enhance water retention, and stimulate microbial activity [6].

Pakchoi (Brassica chinensis) is a leafy vegetable with high economic value that is widely consumed in Indonesia due to its pleasant taste and rich nutritional content, particularly vitamins A and C . It is relatively easy to cultivate, adaptable to various altitudes, and can be harvested year-round, making it an attractive crop for smallholder farmers [7].

Considering the increasing demand for vegetables and the environmental challenges posed by agricultural waste, this study aims to investigate the effect of fish waste fertilizer and chicken manure on the growth of pakchoi. In addition, the findings are expected to serve as educational material for local communities, thereby promoting greater awareness of sustainable agricultural practices.

2. METHOD

2.1 Research Design and Study Location

This study employed an experimental approach using a Posttest-Only Control Design to evaluate the effects of fish waste fertilizer and chicken manure fertilizer on the vegetative growth of pakchoi (Brassica chinensis). Fish waste fertilizer was prepared in Surabaya, Indonesia, while plant cultivation and experimental trials were conducted in Mojokerto, Indonesia. The experiment was carried out over a four-month period from December 2024 to March 2025. The selected design enabled objective comparison of treatment effects without pre-treatment measurement bias [8].

2.2 Experimental Design and Treatment Arrangement

The experiment was arranged using a Randomized Block Design (RBD) consisting of three fertilization treatments with nine replications per treatment, resulting in a total of 27 experimental units. Each unit consisted of one polybag containing 5 kg of sterilized soil media. Fertilizer treatments were applied according to the designated treatment groups. Randomization was applied to both treatment allocation and seed selection to minimize environmental and biological variability. The use of RBD improves experimental precision and enhances treatment comparison reliability in agricultural studies [8].

2.3 Plant Cultivation and Fertilization Procedure

Cultivation procedures included seed selection, seedling preparation, transplanting, fertilization, and routine plant maintenance. Maintenance activities included watering, weeding, and pest control. Fish waste fertilizer was applied in liquid form, while chicken manure fertilizer was applied in decomposed solid form. Fertilizer dosages were standardized based on nutrient equivalence to ensure fair comparison among treatments. Plant observations were conducted weekly for four consecutive weeks after transplanting [8].

2.4 Growth Parameter Measurement

Two vegetative growth parameters were measured:

1) Plant Height — measured in centimeters from the stem base to the tip of the longest leaf using a ruler.
2) Number of Leaves — counted based on fully expanded leaves only.

These parameters were selected as primary indicators of vegetative growth performance in pakchoi. To ensure measurement accuracy, plant height measurements were conducted in the morning to minimize leaf wilting effects, and leaf counting was performed only when leaves were fully photosynthetically active [9].

2.5 Statistical Analysis

Prior to hypothesis testing, data were evaluated for normality using the Shapiro–Wilk test and homogeneity of variance using Levene's test to confirm parametric test assumptions. After meeting these assumptions, statistical analysis was conducted using one-way Analysis of Variance (ANOVA) with a significance level of 5% ($\alpha = 0.05$). When significant differences among treatments were detected, a Least Significant Difference (LSD) post hoc test was performed to determine pairwise treatment differences. All statistical analyses were conducted using SPSS version 21 software [9].

3. RESULTS AND DISCUSSION

Based on the observation of the effect of fish waste fertilizer and chicken manure fertilizer on the growth of pakchoi (*Brassica chinensis*), as measured by plant height and the number of leaves, the data obtained are presented in the following table. These growth parameters serve as important indicators to evaluate the effectiveness of organic fertilizers derived from agricultural and fishery by-products in supporting sustainable vegetable cultivation.

3.1. Plant Growth Observation at Week 1

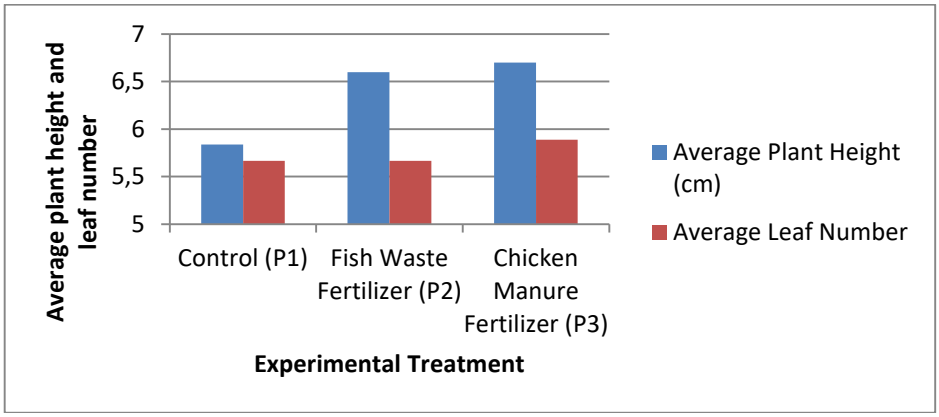


Figure 1. Bar Chart of Plant Height and Number of Leaves of Pakchoi (*Brassica chinensis*) in the First Week"

The analysis of the mean values indicated that, during the first week of observation, treatment P3 exhibited the most optimal growth performance compared to other treatments. Specifically, P3 achieved the highest mean plant height of 6.7 cm and the greatest mean number of leaves at 5.8.

This finding suggests that the application of treatment P3 provided more favorable growth conditions for pakchoi seedlings at the early stage of development. Such results highlight the potential effectiveness of fish waste and chicken manure fertilizers in enhancing early vegetative growth, which is crucial for subsequent plant development and yield [6]

3.2. Plant Growth Observation at Week 2

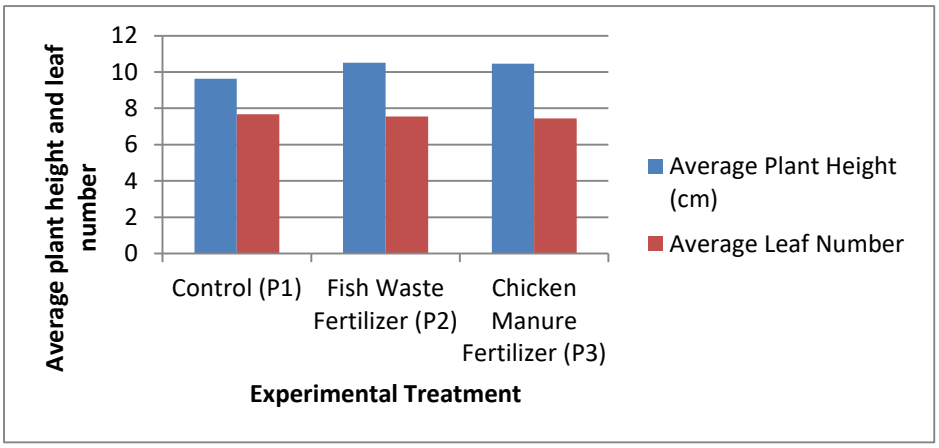


Figure 2. Bar Chart of Plant Height and Number of Leaves of Pakchoi (*Brassica chinensis*) in the Second Week

Based on the bar chart of the mean plant height and mean number of leaves, the observation of pakchoi (*Brassica chinensis*) growth in the second week showed that treatment P2 recorded the highest mean plant height of 10.86 cm. This indicates that the application of fish waste fertilizer in treatment P2 was more effective in stimulating vertical growth compared to other treatments.

Meanwhile, the highest mean number of leaves was observed in treatments P1 and P2, both reaching 7.66 leaves. This result suggests that these treatments not only supported plant elongation but also promoted leaf development, which plays an essential role in photosynthesis and subsequent growth performance [10]

3.3. Plant Growth Observation at Week 3

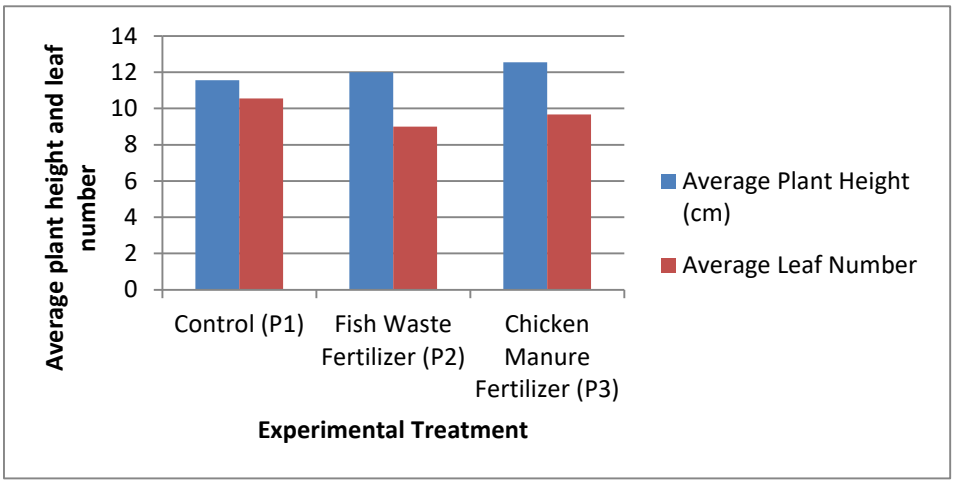


Figure 3. Bar Chart of Plant Height and Number of Leaves of Pakchoi (*Brassica chinensis*) in the Third Week

Based on the bar chart of the mean plant height and mean number of leaves, the observation of pakchoi (*Brassica chinensis*) growth in the third week showed that treatment P2 achieved the highest mean plant height of 13.48 cm. This indicates that the application of fish waste fertilizer in treatment P2 continued to promote significant vertical growth compared to the other treatments.

In contrast, the highest mean number of leaves was recorded in treatment P3, reaching 9.55 leaves. This suggests that treatment P3 was more effective in stimulating leaf development, which is crucial for enhancing photosynthetic activity and overall vegetative growth.

3.4. Plant Growth Observation at Week 4

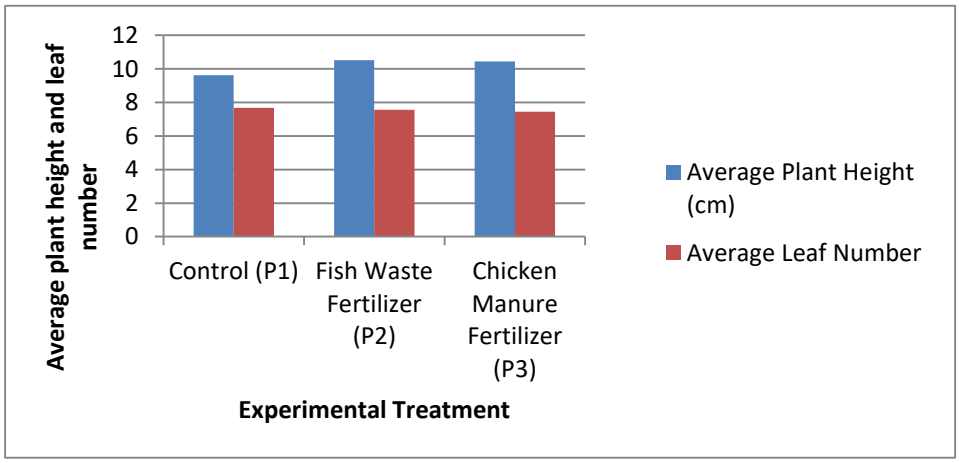


Figure 4. Bar Chart of Plant Height and Number of Leaves of Pakchoi (*Brassica chinensis*) in the Fourth Week

Based on the bar chart of the mean plant height and mean number of leaves, the observation of pakchoi (*Brassica chinensis*) growth in the fourth week showed that treatment P2 achieved the highest mean plant height of 16.64 cm. This finding confirms the consistent effectiveness of fish waste fertilizer in supporting vertical growth across the observation period.

Meanwhile, the highest mean number of leaves was equally observed across treatments, with an average of 11.66 leaves. This indicates a relatively uniform leaf development at the fourth week, suggesting that by this stage of growth, the effect of different treatments on leaf production had reached a comparable level.

3.5. Data Analysis

The results of the analysis showed that during the first and second weeks, there were no significant differences in plant height or leaf number among the treatments of fish waste fertilizer, chicken manure fertilizer, and control, as indicated by p-values greater than 0.05. This finding suggests that, in the early growth stages, the application of organic fertilizers had not yet exerted a significant influence on the vegetative development of pakchoi (*Brassica chinensis*). Thus, initial growth performance appeared relatively uniform across all treatments [11]. nutrient application often requires time before observable effects on plant morphology appear, as early vegetative growth is primarily supported by seed reserves. Similarly, noted that in the initial stages, plant growth is more influenced by internal physiological factors rather than external nutrient availability, which explains the lack of significant differences in the first two weeks [12].

However, in the third and fourth weeks, significant differences were observed in plant height, with p-values of 0.021 and 0.045, respectively, indicating that fish waste fertilizer had a stronger effect compared to other treatments. The LSD test confirmed that fish waste fertilizer contributed more effectively to vertical growth, while chicken manure fertilizer did not show a significant effect. In contrast, leaf number remained statistically insignificant across all treatments throughout the four weeks. These results imply that fish waste fertilizer has greater potential in enhancing stem elongation, particularly in the later stages of vegetative growth, whereas leaf production tended to be stable regardless of treatment. This is consistent with the findings of Marschner [13], who stated that nitrogen availability strongly stimulates stem elongation and biomass accumulation during the vegetative stage. Emphasized that plant height is a sensitive indicator of nutrient availability, particularly nitrogen, while leaf number often remains stable because it is genetically regulated and less responsive to short-term fertilizer application [14].

3.6 . Discussion

The findings of this study indicate that fertilizer type significantly influenced plant height at the third and fourth weeks, while no significant effect was observed on the number of leaves. The application of fish waste fertilizer demonstrated slightly better performance compared to chicken manure and the control in enhancing plant height. This can be attributed to its relatively high nitrogen content, which is readily available for plant uptake and plays a central role in stimulating apical growth and nutrient assimilation. Nitrogen is known to promote cell division, elongation, and chlorophyll formation, thereby accelerating vegetative growth and stem elongation. Moreover, phosphorus contributes to energy transfer and photosynthetic processes, while potassium regulates the balance of nitrogen and phosphorus and supports protein and carbohydrate synthesis. Nitrogen, phosphorus, and potassium are the three primary macronutrients that directly determine vegetative growth and yield potential, with nitrogen serving as the most limiting factor in leaf and stem development [15]. emphasized that nitrogen deficiency often results in stunted growth and chlorosis, whereas adequate supply enhances photosynthesis and biomass accumulation, explaining the superior effect of fish waste fertilizer observed in this study[16].

These complementary roles of macronutrients explain why fish waste fertilizer is more effective in promoting plant elongation than chicken manure [17]. Nitrogen is a key determinant of plant growth because it is a structural component of amino acids, proteins, nucleic acids, and chlorophyll, making it indispensable for vegetative development [18]. Emphasized that phosphorus enhances root development and energy transfer, while potassium improves water regulation and enzymatic activity, all of which are essential for optimal crop performance[19].

Nutrient composition also plays a critical role in determining the efficiency of fertilizer use. Fish waste fertilizer, which is in liquid form, is generally more rapidly absorbed by plant roots compared to solid chicken manure, thus increasing nutrient-use efficiency. Previous studies have reported that fish waste fertilizer contains higher levels of nitrogen, phosphorus, and potassium than chicken manure, and these nutrients are more readily available in soluble forms. However, in this study, the concentration of fish waste fertilizer used (4.5%) may not have been optimal, potentially limiting its effectiveness. Incomplete decomposition of organic material may also reduce the availability of nitrogen, thereby slowing down its impact on plant growth. Therefore, further optimization, either by adjusting concentration or improving decomposition processes, could enhance the potential of fish waste fertilizer in supporting pakchoi growth. As stated by Lingga and liquid organic fertilizers are generally more efficient than solid fertilizers because nutrients are more easily dissolved and directly absorbed by plant roots. Similarly, noted that fertilizers that are not fully decomposed may

reduce nutrient availability, particularly nitrogen, since the decomposition process continues in the soil and competes with plant uptake[20].

In contrast, the number of leaves did not exhibit significant differences among treatments, despite minor variations in mean values. This can be explained by the fact that leaf number alone does not always correspond to photosynthetic capacity, as leaf size, morphology, and chlorophyll density contribute more directly to photosynthesis. Some plants may produce a higher number of smaller leaves, while others develop fewer but larger leaves, leading to comparable photosynthetic outputs. Additionally, nutrient allocation may have been prioritized for stem elongation rather than leaf formation when nutrient availability exceeded certain thresholds. This finding highlights the need for broader growth indicators, such as leaf area, stomatal density, and chlorophyll concentration, to better capture the physiological responses of pakchoi to different fertilizer treatments [21]. leaf area and chlorophyll content are more accurate indicators of photosynthetic capacity than leaf number, as they directly determine light absorption and carbon assimilation. Similarly, Lambers emphasized that plants often adjust leaf morphology and resource allocation to optimize photosynthesis under varying nutrient conditions, which may explain why differences in leaf number are not always significant across treatments [9].

The results of this study were disseminated to the community in the form of a brochure. In addition to serving as a promotional tool, brochures can also function as an educational medium to convey information about a product [14]. The brochure developed in this study contains step-by-step guidelines for producing organic fertilizer from fish waste as an alternative to conventional fertilizers, highlighting its safety and environmentally friendly characteristics. Furthermore, the brochure provides information on the nutrient content of fish waste organic fertilizer as well as chicken manure, thereby offering practical knowledge for the community to adopt sustainable agricultural practices [18]. brochures are an effective communication tool because they combine visual and textual elements, making complex information more accessible to the public. Similarly, emphasized that educational brochures can increase community awareness and encourage behavioral change, particularly in the adoption of environmentally friendly agricultural practices [21].

4. CONCLUSION

The results of this study demonstrate that the application of fish waste fertilizer and chicken manure fertilizer produced significant differences in plant height but did not significantly affect the number of leaves. At the fourth week of observation, the mean plant height was 14.54 cm in the control treatment (P1), 16.64 cm in the fish waste fertilizer treatment (P2), and 11.35 cm in the chicken manure fertilizer treatment (P3). In contrast, the mean number of leaves at the fourth week was similar across all treatments, with an average of 11.66 leaves. Among the treatments, fish waste fertilizer (P2) was identified as the most effective in promoting plant height.

Furthermore, the results of this research were disseminated to the community in the form of a brochure. The brochure not only served as a medium of information but also as an educational tool to introduce the use of organic fertilizers derived from fish waste and chicken manure. Through this effort, the study contributes to raising awareness about the potential of safe and environmentally friendly organic fertilizers as sustainable alternatives in agricultural practices.

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