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# The Effect of Liquid Organic Fertilizer Derived from Goat Manure and Banana Peel on the Growth of Pakcoy (*Brassica rapa* L.) Cultivated Using a Hydroponic System

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**Abstract:** This study aimed to examine the effects of liquid organic fertilizer (LOF) derived from goat manure and banana peels, applied either individually or in combination, on the growth and yield of pakcoy (*Brassica rapa* L.) cultivated in a hydroponic system as an alternative to the conventional AB mix nutrient solution. The experiment was conducted using a Randomized Block Design) with two treatment factors: goat manure LOF concentrations (0 ml, 30 ml, and 60 ml) and banana peel LOF concentrations (0 ml, 20 ml, and 30 ml). The observed parameters included number of leaves, plant height, leaf width, root length, and fresh weight. Data were analyzed using analysis of variance (ANOVA), followed by Duncan's Multiple Range Test at a 5% significance level to determine differences among treatments. The results showed that the best single treatment was obtained from the application of 30 ml banana peel LOF at 4 weeks after planting (WAP). Moreover, the combined treatment of 60 ml goat manure LOF and 30 ml banana peel LOF (P2K2) produced the highest and significantly superior results across all observed parameters at 4 WAP, particularly in leaf number, plant height, root length, and fresh weight. These findings indicate that the combined application of banana peel and goat manure LOF effectively enhances the growth and yield of hydroponically cultivated pakcoy. Therefore, this organic fertilizer combination has strong potential to serve as a more economical and environmentally friendly alternative nutrient source for hydroponic cultivation systems.
**Keywords**: Pakcoy; hydroponics; liquid organic fertilizer; goat manure; banana peels

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## INTRODUCTION

Pakcoy (*Brassica rapa* L.) is a leafy vegetable widely consumed by the public due to its high nutritional value. This vegetable contains various essential nutrients, including vitamins A, C, and K, dietary fiber, and important minerals that contribute to maintaining human health and supporting metabolic functions (Susilo, 2017; Khasanah et al., 2023). In addition to its nutritional benefits, pakcoy also possesses considerable economic value and a relatively short cultivation cycle, enabling it to be harvested within a few weeks after planting. These characteristics make pakcoy a promising horticultural commodity that can support household food security and small-scale vegetable production systems (Afrilia et al., 2025).

However, rapid population growth and the conversion of agricultural land into industrial and residential areas have significantly reduced the availability of productive farmland (Indra et al., 2024). This situation poses a serious challenge to sustainable vegetable production, particularly in urban and peri-urban areas where land resources are increasingly limited. Consequently, innovative cultivation techniques are required to maintain or even enhance vegetable productivity under conditions of restricted land availability.

One strategy that has gained increasing attention is the utilization of home gardens or urban farming systems. Urban agriculture enables communities to produce fresh vegetables in limited spaces while contributing to local food security and

environmental sustainability (Ninasari et al., 2024; Hamilton, 2004). Among the various urban farming techniques, hydroponic cultivation has become one of the most widely adopted systems because it allows plants to grow without soil by using nutrient-rich water solutions as the primary growth medium. Hydroponic systems are considered efficient in water use, require relatively small land areas, and can produce cleaner and more controlled agricultural products compared with conventional soil-based cultivation (Afrilia et al., 2025; Heinrich et al., 2004).

In hydroponic cultivation, the most commonly used nutrient source is AB mix, a synthetic nutrient solution containing a balanced composition of macro- and micronutrients required for plant growth. Macronutrients such as nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), and sulfur (S) are required in relatively large quantities, whereas micronutrients such as iron (Fe), manganese (Mn), zinc (Zn), copper (Cu), and boron (B) are needed in smaller amounts but remain essential for plant physiological processes (Anwar et al., 2025). Although AB mix has become the standard nutrient solution in hydroponic systems due to its effectiveness in supporting plant growth, its continuous use may lead to several challenges, including relatively high production costs and potential environmental impacts associated with the long-term use of synthetic nutrient inputs (Gustaman et al., 2022; Fabricant & Farnsworth, 2001).

Therefore, exploring alternative nutrient sources that are more economical and environmentally friendly is important for the sustainability of hydroponic cultivation. One potential alternative is liquid organic fertilizer (LOF), or *pupuk organik cair* (POC), which can be produced through the fermentation of organic materials such as banana peels, livestock manure, and other agricultural wastes. Liquid organic fertilizers contain various nutrients and organic compounds that can stimulate microbial activity, improve nutrient availability, and support plant growth (Salo et al., 2025; Kuntyastuti et al., 2022). Previous studies have reported that liquid organic fertilizers can enhance the growth performance of leafy vegetables. For example, Indriyani et al. (2025) reported that the application of banana-peel-based liquid organic fertilizer at a concentration of 20 mL $L^{-1}$ increased lettuce fresh weight to 121.16 g per plant. Similarly, Amalia (2024) found that goat-manure-based liquid organic fertilizer significantly increased plant height and leaf number in hydroponically grown vegetables.

Despite these findings, studies examining the effectiveness of liquid organic fertilizer as a substitute for or complement to AB mix in hydroponic pakcoy cultivation remain limited. Most previous studies have focused on other vegetable crops or have evaluated only a single type of organic fertilizer without directly comparing its performance with the standard AB mix nutrient solution. Consequently, a research gap exists regarding the evaluation of liquid organic fertilizer as an alternative nutrient source in hydroponic pakcoy production systems.

Therefore, this study aims to analyze the effect of liquid organic fertilizer (LOF), used either as a substitute for or in combination with AB mix, on the growth and yield of pakcoy plants cultivated in a hydroponic system. The findings of this study are expected to provide scientific insights into the potential development of more economical and environmentally sustainable hydroponic cultivation practices while maintaining optimal plant productivity.

## METHOD

### Research Location and Time

This study was conducted from 13 April to 28 May 2025. The production of liquid organic fertilizer (LOF) and its application to pakcoy plants (*Brassica rapa* L.) were

carried out in the researcher's front yard located at Pasar 3 Tembung, Percut Sei Tuan District, Deli Serdang Regency, North Sumatra, Indonesia.

**Tools and Materials**

The equipment used in this study included hydroponic containers, seedling trays, measuring cylinders, dosing syringes, net pots, wicks, jerry cans, a pH meter, a Total Dissolved Solids (TDS) meter, writing tools, and other supporting equipment required for the experiment. The materials used in this study consisted of goat manure, kepok banana peels, pakcoy seeds, EM4 microbial solution, sugar (molasses), rockwool growing medium, and other supporting materials required for the experimental procedures.

**Experimental Design**

This study investigated two experimental factors using a Randomized Block Design (RBD) with a factorial treatment structure (Sitepu et al., 2022).
The treatments consisted of:
Goat manure concentration treatments:
**K0** : Control (no treatment)
**K1** : 30 mL goat manure liquid organic fertilizer (LOF)
**K2** : 60 mL goat manure liquid organic fertilizer (LOF)
Banana peel concentration treatments:
**P0** : Control (no treatment)
**P1** : 20 mL banana peel liquid organic fertilizer (LOF)
**P2** : 30 mL banana peel liquid organic fertilizer (LOF)

**Table 1.** Experimental design

| P/K | P0 | P1 | P2 |
|---|---|---|---|
| K0 | K0P0 | K0P1 | K0P2 |
| K1 | K1P0 | K1P1 | K1P2 |
| K2 | K2P0 | K2P1 | K2P2 |

**Note:** Treatment: 9 treatments; Number of replications: 3 replications; Total number of plant: 27 plants

**Experimental Procedures**

1. **Preparation of Banana Peel Liquid Organic Fertilizer (LOF):** The preparation of banana peel liquid organic fertilizer involved cutting 10 kg of *kepok* banana peels into small pieces. The chopped peels were then mixed with 250 mL of EM4 solution, 10 L of water, and 250 mL of molasses. The mixture was thoroughly stirred and placed in a jerrycan, which was then carefully sealed. The mixture was subsequently allowed to ferment for two weeks (Sitepu et al., 2022).
2. **Preparation of Goat Manure Liquid Organic Fertilizer (LOF):** The liquid organic fertilizer derived from goat manure was prepared by first removing any mixed debris or impurities from the manure. Five kilograms of clean goat manure were weighed and mixed with 10 L of water and 250 mL of molasses. The mixture was stirred thoroughly and placed in a container, which was then tightly closed. The fermentation process was carried out for two weeks (Rizkia, 2021).
3. **Seed Germination and Transplanting:** Pakcoy seeds were sown in rockwool media that had been perforated and pre-soaked with water. After germination, the Pakcoy seedlings were transferred to an area receiving adequate sunlight. When the seedlings developed four true leaves, they were transplanted into net pots placed in nutrient-filled holes within a wick hydroponic system (Rizkia, 2021).
4. **Plant Maintenance and Harvesting:** The maintenance of Pakcoy plants included the periodic application of liquid organic fertilizer according to the designated

treatments. If the nutrient solution became contaminated or diluted due to rainwater, it was replaced with a new solution. If the solution remained clean, only additional nutrient solution corresponding to the treatment was added. Pakcoy plants were harvested at four weeks after planting (4 WAP) (Rizkia, 2021).

5. **Observation Parameters**: Growth parameters of Pakcoy plants were measured weekly and included plant height, number of leaves, and leaf width. These measurements were conducted at 1, 2, 3, and 4 weeks after planting (WAP). Root length and fresh weight were measured at 4 WAP (Rizkia, 2021).

**Data Analysis**

The collected data were analyzed using SPSS (Statistical Product and Service Solutions) version 22. The data were examined using one-way analysis of variance (ANOVA). When significant differences were detected among treatments, Duncan's Multiple Range Test (DMRT) was applied to determine differences between treatment means (Rizkia, 2021).

## RESULTS AND DISCUSSION

### Number of Leaves

The observations of pakcoy plants over a four-week period after planting (4 weeks after planting/WAP) treated with liquid organic fertilizer (LOF) derived from goat manure and banana peels under different treatments showed a significant effect on the number of leaves. The results are presented in Table 2.

**Table 2.** Average number of leaves (leaves) in pakcoy plants (*Brassica rapa* L.)

| Treatment | Observation Time | | | |
|---|---|---|---|---|
| | 1WAP | 2WAP | 3WAP | 4WAP |
| P0K0 | 3,3333c | 3,6667f | 6,3333d | 7,6667d |
| P0K1 | 4,3333bc | 4,3333f | 8,0000c | 9,3333c |
| P0K2 | 5,0000b | 6,6667bcd | 9,0000bc | 10,3333bc |
| P1K0 | 5,3333b | 6,0000de | 10,0000ab | 11,0000ab |
| P1K1 | 4,6667bc | 5,6667e | 10,0000ab | 11,3333ab |
| P1K2 | 4,6667bc | 7,0000bc | 10,3333ab | 11,0000ab |
| P2K0 | 4,6667bc | 6,3333cde | 11,0000a | 11,0000ab |
| P2K1 | 4,0000bc | 7,3333b | 8,6667bc | 10,3333bc |
| P2K2 | 7,0000a | 8,6666a | 11,3333a | 12,3333a |

**Note:** Values in the same column followed by the same letter are not significantly different at the 5% significance level (Duncan's Multiple Range Test, α = 0.05).

Table 2 shows that the highest increase in the number of pakcoy leaves for goat manure liquid organic fertilizer occurred at a concentration of 60 ml at 4 WAP, reaching 10.3333 leaves. In contrast, the Duncan test indicated no significant difference in the banana peel liquid organic fertilizer treatments at concentrations of 20 ml and 30 ml at 4 WAP, both producing 11.0000 leaves. Overall, the best results among the two liquid organic fertilizers were obtained from the banana peel fertilizer. Based on the NPK analysis presented in Appendix 1, the nitrogen content in banana peel LOF (0.07%) was slightly higher than that in goat manure LOF (0.06%).

Nitrogen plays an important role in facilitating the translocation of photosynthetic products from leaves to other plant tissues. According to Hulu et al. (2026), nitrogen availability contributes to chlorophyll formation and leaf tissue development. Nitrogen components also influence leaf color and the development of organs associated with photosynthesis during the vegetative growth stage. Nitrogen is an essential macronutrient for plants and a fundamental component of amino acids that function as

building blocks for enzymes and proteins. Moreover, nitrogen is a constituent of chlorophyll molecules, which are crucial for photosynthesis in capturing solar energy, thereby promoting plant growth and yield (Zayed et al., 2023).

Regarding the combined application of both liquid organic fertilizers, the highest leaf number at 4 WAP was observed in treatment P2K2 (30 ml banana peel LOF and 60 ml goat manure LOF), producing 12.3333 leaves. This result is likely due to the higher nitrogen content in banana peel LOF (0.07%) and the higher potassium content in goat manure LOF (6.09%). The vegetative growth of pakcoy plants is strongly supported by nitrogen availability, which contributes to increased leaf area and chlorophyll content. Nitrogen facilitates chlorophyll formation, an essential component of the photosynthetic process, and promotes overall plant growth, particularly in stems, branches, and leaves (Nurfadilah et al., 2024).

In the context of leafy vegetable growth such as pakcoy, potassium contained in liquid organic fertilizers also plays a crucial role. Potassium assists in the transport of photosynthates from leaves to other plant tissues. According to Lubis (2021), potassium deficiency may result in inhibited growth and reduced leaf quality, whereas adequate potassium supply can enhance leaf greenness and firmness in pakcoy plants. This finding indicates that the combined application of liquid organic fertilizers derived from banana peels and goat manure effectively increases the number of leaves in pakcoy plants. Furthermore, Alham & Elfarisna (2018) reported that potassium contributes to improving plant quality by preventing leaf chlorosis.

**Plant Height**

The results of observations on pakcoy plants over a period of four weeks after planting (WAP) treated with liquid organic fertilizer (LOF) derived from goat manure and banana peels at different concentrations showed significant effects on plant height. The results are presented in Table 3.

**Table 3.** Mean plant height (cm) of pakcoy (*Brassica rapa* L.)

| Treatment | Observation Time | | | |
|---|---|---|---|---|
| | 1WAP | 2WAP | 3WAP | 4WAP |
| P0K0 | 3,1000e | 3,6667d | 4,6667d | 6,0667d |
| P0K1 | 3,1333e | 4,3333cd | 4,6667d | 7,0667d |
| P0K2 | 3,8000cd | 4,3333cd | 5,1000d | 8,2000c |
| P1K0 | 3,7000d | 5,0000c | 5,2000d | 7,4667d |
| P1K1 | 3,9667bcd | 4,8000c | 7,4000c | 8,7333c |
| P1K2 | 4,1333bc | 4,6667c | 9,1333b | 10,5333b |
| P2K0 | 4,3000b | 4,9667c | 9,0000b | 8,2667c |
| P2K1 | 4,9667a | 5,7667b | 8,3333bc | 10,2000b |
| P2K2 | 5,0667a | 6,7000a | 11,0000a | 13,1333a |

**Note:** Values in the same column followed by the same letter are not significantly different at the 5% significance level based on Duncan's Multiple Range Test (DMRT 0.05).

Based on Table 3, the application of goat manure–based liquid organic fertilizer produced the best plant height at a concentration of 60 ml, reaching 8.2000 cm, while the application of banana peel liquid organic fertilizer showed the best result at a concentration of 30 ml with a plant height of 8.2667 cm. The Duncan test indicated that the differences between the two types of LOF were not statistically significant.

Plant height is influenced by both genetic and environmental factors. Rapid cell division occurs when plants receive sufficient nutrients to meet their physiological needs, which ultimately promotes an increase in plant height (Afdila et al., 2021). Conversely, plant growth will slow down when essential nutrients are not adequately

available. Optimal environmental conditions also influence plant growth, meaning that increasing fertilizer dosage beyond the optimal level does not necessarily stimulate further significant growth. Pakcoy plants require adequate macronutrients, particularly nitrogen (N), phosphorus (P), and potassium (K), to support overall growth, especially in leaves and stems, as vegetative growth predominates in this species. Therefore, the P2K2 treatment produced the best growth performance.

Liquid organic fertilizer derived from goat manure and banana peels supplies essential nutrients such as potassium and nitrogen to plants. According to Ardianto et al. (2024), plant height in treatment P6 (60 ml $L^{-1}$) at four weeks after planting reached 126.61 cm, indicating the strong effect of goat manure–based liquid organic fertilizer application. Similarly, Mazlina et al. (2024) reported that the application of 30 ml of banana peel liquid organic fertilizer significantly increased plant height at four weeks after planting, reaching 122.39 cm at harvest.

These findings are supported by Bolly and Jeksen (2021), who reported that plant growth and development are strongly influenced by the availability of balanced nutrients, particularly nitrogen (N), phosphorus (P), and potassium (K). In pakcoy, potassium plays a crucial role in stem elongation, enzyme activation, and overall plant development, while its deficiency can inhibit growth. Additionally, nitrogen is an essential component of proteins and protoplasm in plant tissues such as stems and leaves, which function as primary sites for photosynthesis and assimilate production required for plant growth (Santana et al., 2021).

**Leaf Width**

The results of observations on pakcoy plants over four weeks after planting (WAP) treated with liquid organic fertilizer (LOF) derived from goat manure and banana peels under different treatment combinations showed significant effects on leaf width, as presented in Table 4.

**Table 4.** Average leaf width (cm) of pakcoy plants (*Brassica rapa* L.)

| Treatment | Observation Time | | | |
|---|---|---|---|---|
| | 1WAP | 2WAP | 3WAP | 4WAP |
| P0K0 | 3,0333d | 3,3000f | 4,1000d | 6,1000e |
| P0K1 | 4,1000bc | 4,5000e | 5,1000cd | 7,3000d |
| P0K2 | 4,2000bc | 5,7000cd | 6,4000abc | 8,0000d |
| P1K0 | 3,6667cd | 5,1333de | 5,6333abcd | 7.7000d |
| P1K1 | 5,3000a | 6,4000abc | 7,4000a | 9,6000c |
| P1K2 | 4,6000ab | 6,1000bc | 7,1667ab | 9,8333c |
| P2K0 | 4,1333bc | 4,9000e | 5,2667bcd | 10,2000c |
| P2K1 | 5,2333a | 6,6333ab | 7,5333a | 11,2000b |
| P2K2 | 4,9667a | 6,9000a | 7,0667abc | 12,2000a |

**Note:** Values in the same column followed by the same letter are not significantly different at the 5% significance level according to Duncan's Multiple Range Test (DMRT 0.05).

Based on Table 4, the application of goat manure liquid organic fertilizer produced the best leaf width at a concentration of 60 mL at 4 WAP, reaching 8.0000 cm. Meanwhile, the application of banana peel liquid organic fertilizer produced the best result at a concentration of 30 mL at 4 WAP, reaching 10.2000 cm. Among the two types of liquid organic fertilizers, the best results were obtained from banana peel LOF. This result is consistent with the NPK analysis presented in Appendix 1, which shows that the nitrogen content in banana peel LOF (0.07%) is slightly higher than that of goat manure LOF (0.06%).

Nitrogen plays a crucial role in plant growth by supporting the transport of photosynthetic products from leaves to other tissues. As the primary site of photosynthesis, mature leaves contain numerous chloroplasts that facilitate this process (Andrian et al., 2022). Nitrogen availability significantly influences chlorophyll formation and leaf tissue development, thereby affecting leaf color and the growth of photosynthetic organs during the vegetative phase (Hulu et al., 2026). As an essential macronutrient, nitrogen is a key component of amino acids, proteins, enzymes, and chlorophyll molecules, which are fundamental for photosynthesis and plant productivity (Zayed et al., 2023).

For the combination of both liquid organic fertilizers, the highest leaf width at 4 WAP was observed in treatment P2K2 (30 mL banana peel LOF and 60 mL goat manure LOF), which reached 12.2000 cm. This result may be attributed to the complementary nutrient composition of the two fertilizers, where banana peel LOF contains a higher nitrogen content (0.07%), while goat manure LOF has a higher potassium content (6.09%). The vegetative growth of pakcoy plants is strongly supported by nitrogen availability, which contributes to increased leaf area and chlorophyll content. Nitrogen facilitates chlorophyll synthesis, which is essential for photosynthesis, and also promotes overall plant growth, particularly in stems, branches, and leaves.

Potassium in liquid organic fertilizers plays an important role in leafy vegetables such as pakcoy by facilitating the transport of photosynthetic products from leaves to other plant tissues. Adequate potassium supply enhances leaf greenness and firmness, whereas deficiency can inhibit growth and reduce leaf quality (Mendrofa & Lase, 2025). In addition, potassium helps prevent leaf chlorosis and improves overall plant quality (Yosephine et al., 2020). These findings suggest that liquid organic fertilizers derived from goat manure and banana peels have potential to support optimal leaf development in pakcoy.

**Root Length**

Observations of pakcoy plants over four weeks after planting (4 WAP) treated with goat manure liquid organic fertilizer (LOF) and banana peel liquid organic fertilizer under different treatments showed a significant effect on root length. The results are presented in Table 5.

**Table 5.** Average root length (cm) of pakcoy plants (*Brassica rapa* L.)

| Treatment | Observation Time - 4WAP |
|---|---|
| P0K0 | 3,6000f |
| P0K1 | 4,3333e |
| P0K2 | 4,9667d |
| P1K0 | 4,2000e |
| P1K1 | 4,8333d |
| P1K2 | 4,8333d |
| P2K0 | 5,4667c |
| P2K1 | 6,1000b |
| P2K2 | 7,1333a |

**Note:** Values in the same column followed by the same letter are not significantly different at the 5% significance level according to Duncan's Multiple Range Test (DMRT 0.05).

Based on Table 5, the best treatment for goat manure liquid organic fertilizer was observed at a concentration of 60 mL, resulting in a root length of 4.9667 cm. For banana peel liquid organic fertilizer, the optimal result was obtained at a concentration of 30 mL, producing a root length of 5.4667 cm. A comparison between the two liquid

organic fertilizers indicates that banana peel fertilizer yielded superior results. According to the NPK analysis presented in Appendix 1, banana peel liquid organic fertilizer contains 0.11% phosphorus, which is higher than that of goat manure liquid organic fertilizer, which contains only 0.07%.

Root length indicates a plant's ability to absorb water and nutrients from deeper soil layers (Mangansige et al., 2018). Nutrient availability, particularly nitrogen (N), phosphorus (P), and potassium (K), plays a crucial role in plant growth, with phosphorus specifically promoting root development. In this study, the P2K2 treatment produced the longest roots (7.13 cm), suggesting that adequate NPK availability enhances root growth in pakcoy. In contrast, the control treatment (P0K0), which received no liquid organic fertilizer, showed lower root development due to limited nutrient availability.

**Fresh Weight**

The results of observations on pakcoy plants over a period of four weeks after planting (4 WAP) treated with goat manure liquid organic fertilizer (LOF) and banana peel LOF under different treatment combinations showed significant effects on fresh weight, as presented in Table 6.

**Table 6.** Mean fresh weight (g) of pakcoy plants (*Brassica rapa* L.)

| Treatment | Observation Time - 4WAP |
|---|---|
| P0K0 | 104,6167d |
| P0K1 | 104,6000d |
| P0K2 | 105,4667d |
| P1K0 | 108,4667d |
| P1K1 | 113,7333c |
| P1K2 | 206,6333b |
| P2K0 | 207,9667b |
| P2K1 | 213,4667a |
| P2K2 | 213,4667a |

**Note:** Values within the same column followed by the same letter are not significantly different at the 5% significance level according to Duncan's Multiple Range Test (DMRT 0.05).

Based on Table 6, the average fresh weight of pakcoy plants indicates that goat manure LOF at concentrations of 30 mL and 60 mL produced statistically similar results in the Duncan test, with a value of 105.4667 g. Meanwhile, for banana peel LOF, the best result was obtained at a concentration of 30 mL, yielding a fresh weight of 207.9667 g. The highest fresh weight for the combined application of goat manure LOF and banana peel LOF was observed in treatments P2K2 (30 mL + 60 mL) and P2K1 (30 mL + 20 mL).

Plant fresh weight is influenced by the availability of water and mineral nutrients, as well as the accumulation of photosynthetic products in plant tissues. The balance between photosynthesis and respiration plays an important role in determining fresh weight. Photosynthesis increases fresh weight through $CO_2$ assimilation, whereas respiration reduces it through $CO_2$ release (Wahono et al., 2018). Higher plant growth rates generally enhance photosynthetic activity, thereby increasing fresh weight accumulation. In addition, adequate nutrient supply from fertilizers contributes to greater plant biomass. Liquid organic fertilizers contain essential nutrients such as nitrogen (N), phosphorus (P), and potassium (K), which support cell growth and expansion. According to Santos et al. (2025), plant fresh weight is closely related to tissue development, including the number, size, and expansion of leaves, which are strongly affected by water and nutrient availability.

According to Hermawan et al. (2023), banana peel LOF contains several nutrients, including nitrogen (0.01%), phosphorus (0.02%), potassium (0.46%), organic carbon (0.49%), and sulfur (0.05%). Meanwhile, goat manure contains approximately 0.52% potassium, 0.05% phosphorus, and 0.10% nitrogen (Rizkia, 2021). The fresh weight of pakcoy plants is also influenced by plant height and leaf number. Both plant height and leaf number contribute significantly to the overall fresh weight of the plant. Measurement of fresh weight after harvest provides an indication of the effectiveness of treatments in improving plant growth and yield quality.

This finding is consistent with the study of Wijiyanti et al. (2019), which reported that the total fresh weight of mustard plants includes all plant components. As the number of leaves increases, the fresh weight of the plant also increases. In addition, plant height plays an important role in determining fresh weight. Both plant height and leaf number contribute to increasing the fresh weight of pakcoy plants.

## CONCLUSION

Based on the results of this study, it can be concluded that the best outcome among the two types of liquid organic fertilizers (LOF) was obtained from banana peel LOF at a concentration of 30 mL, with the average values recorded at four weeks after planting. This result was observed in the application of goat manure LOF and banana peel LOF across several growth parameters, including the number of leaves, plant height, leaf width, root length, and fresh weight. Conversely, the P2K2 treatment (30 mL + 60 mL), which combined banana peel LOF and goat manure fertilizer, demonstrated notably superior results for all observed parameters, with the highest averages recorded four weeks after planting.

## RECOMMENDATION

Future research is recommended to examine various concentrations and combinations of liquid organic fertilizers (LOF) with AB mix nutrient solutions to obtain a more optimal nutrient formulation for hydroponically grown pakcoy. In addition, an analysis of the nutrient content in liquid organic fertilizers (LOF) should be conducted to ensure the suitability of their nutrient composition compared with the AB mix solution.

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