

Effects of Liquid Organik Fertilizer (JAKABA) Application on Growth and Yield of Kailan (*Brassica oleracea* var. *alboglabra*)

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ABSTRACT

The use of liquid organic fertilizer (LOF) derived from JAKABA (Jamur Keberuntungan Abadi) has gained attention as an environmentally friendly alternative to synthetic fertilizers in leafy vegetable production. This study evaluated the effects of different LOF concentrations on the growth and biomass of kailan. The experiment was conducted using a randomized block design with six treatments, including a control, four LOF concentrations (20, 40, 60, and 80 mL L⁻¹), and a mineral fertilizer control, with three replications. Growth parameters observed included plant height, number of leaves, leaf area, fresh plant weight, fresh shoot weight, and fresh root weight. The results showed that LOF application influenced vegetative growth and biomass accumulation, with moderate concentrations (20-40 mL L⁻¹) generally producing more favorable responses compared to the control. Higher concentrations did not consistently enhance growth, indicating a non-linear dose-response relationship. Overall, JAKABA-derived LOF demonstrated potential as a sustainable nutrient input for kailan cultivation under the experimental conditions. Further studies are recommended to explore wider dose ranges, longer cultivation periods, and different soil types to refine application guidelines for practical use.

INTRODUCTION

Vegetable crops such as kailan (*Brassica oleracea* var. *alboglabra*) play an important role in ensuring food and nutritional security, particularly in densely populated urban and peri-urban areas of Southeast Asia. Kailan is widely consumed due to its high nutritional value, including substantial concentrations of vitamins A and C, essential minerals, and dietary fiber (Muttaqin, 2025). Despite its economic and nutritional importance, kailan productivity is frequently constrained by declining soil fertility and suboptimal nutrient management practices, which are common in intensive vegetable production systems. Although the use of synthetic fertilizers can provide immediate yield benefits, their long-term and excessive application has been associated with adverse environmental impacts, including soil degradation, nutrient leaching, and the disruption of soil ecological balance (Fadilah et al., 2024).

In response to these challenges, the adoption of sustainable agricultural practices, particularly the use of organic fertilizers and bio-stimulants, has gained increasing global attention. Liquid organic fertilizer (LOF) derived from JAKABA (Jamur Keberuntungan Abadi, literally translated as "Everlasting Fortune Mushroom") represents a locally developed microbial-based biofertilizer with potential agronomic benefits. JAKABA-based formulations have been reported to enhance nutrient availability, stimulate plant growth, and improve soil biological activity (Bella et al., 2022). The microbial consortia present in JAKABA are suggested to promote root development, improve nutrient uptake efficiency, and increase plant tolerance to abiotic stress, thereby contributing to improved crop performance under suboptimal soil conditions (Ikeh et al., 2023).

Previous studies have demonstrated that liquid organic fertilizers, including those derived from JAKABA, can positively affect the growth and productivity of leafy vegetables through enhanced soil microbial activity, improved nutrient cycling, and favorable physiological responses in plants (Polakitan et al., 2024). However, the agronomic effectiveness of LOF is highly variable and depends on multiple factors, including the type of

organic substrates used, microbial composition, application rates, and crop species (Chowdhury et al., 2021; Triharyanto et al., 2022). Moreover, existing studies predominantly focus on short-term vegetative growth responses, while comprehensive evaluations of yield components and biomass production under controlled experimental conditions, particularly for high-value leafy vegetables such as kailan, remain limited (Ortega-Hernández et al., 2021).

This knowledge gap highlights the need for systematic and crop-specific assessments of JAKABA-derived LOF to establish its agronomic effectiveness and practical relevance in sustainable vegetable production systems. Therefore, the present study aims to evaluate the effects of different application rates of LOF (JAKABA) on the growth and yield of kailan (*Brassica oleracea* var. *alboglabra*). The findings are expected to provide empirical evidence to support the development of science-based recommendations for organic input management, contributing to environmentally sustainable nutrient management strategies and the sustainable intensification of leafy vegetable production in urban and peri-urban agroecosystems.

MATERIALS AND METHODS

The experiment was conducted in Julukanaya Village, Pallangga District, Gowa Regency, South Sulawesi, Indonesia, from June to July 2025. The study area represents a typical lowland vegetable production system commonly found in peri-urban agricultural zones.

The plant material used in this study was kailan (*Brassica oleracea* var. *alboglabra*) cv. Sakura F1. Materials for the preparation of liquid organic fertilizer (LOF) included bamboo roots, rice bran, shrimp paste, slaked lime ($\text{Ca}(\text{OH})_2$), monosodium glutamate (MSG), granulated sugar, and clean water. The equipment used comprised seedling trays, polybags, buckets, a digital balance, ruler, hoe, camera, and other standard horticultural tools.

The experiment was arranged in a randomized block design (RBD) with six fertilizer treatments and three replications, resulting in a total of 18 experimental units, each consisting of three polybags with one plant per polybag. The treatments comprised different concentrations of liquid organic fertilizer (LOF) derived from JAKABA, namely a control without LOF application (T0), LOF at 20 mL L⁻¹ (T1), 40 mL L⁻¹ (T2), 60 mL L⁻¹ (T3), and 80 mL L⁻¹ (T4), as well as a positive control using NPK fertilizer at the recommended rate (T5). The collected data were analyzed using analysis of variance (ANOVA), and when significant treatment effects were observed ($p < 0.05$), mean comparisons were performed using the Honestly Significant Difference (HSD) test at the 5% significance level. In addition, regression analysis was employed to evaluate the dose-response relationship between LOF concentration and plant growth and yield parameters.

Liquid organic fertilizer (LOF) derived from JAKABA was prepared using a modified local fermentation protocol. Briefly, 2 kg of bamboo roots were soaked in 15 L of clean water for 48 h. In parallel, 2 kg of rice bran were boiled in 2 L of water for 10 min, followed by the addition of 8 g shrimp paste, 30 g slaked lime ($\text{Ca}(\text{OH})_2$), 10 g monosodium glutamate (MSG), and 200 g granulated sugar. The mixture was stirred until homogeneous and allowed to cool to room temperature. The bamboo root soaking solution was subsequently diluted with 15 L of clean water and evenly distributed into two containers (15 L per container). The cooled rice bran mixture was added to each container and thoroughly mixed. The containers were covered with breathable cloth to allow aerobic fermentation while preventing insect contamination and were incubated for four weeks at ambient temperature until visible fungal biomass developed, indicating that the LOF (JAKABA) was ready for application.

RESULTS AND DISCUSSION

1. Plant Height

Figure 1 presents the effect of different concentrations of JAKABA-derived liquid organic fertilizer (LOF) on the plant height of kailan plants.

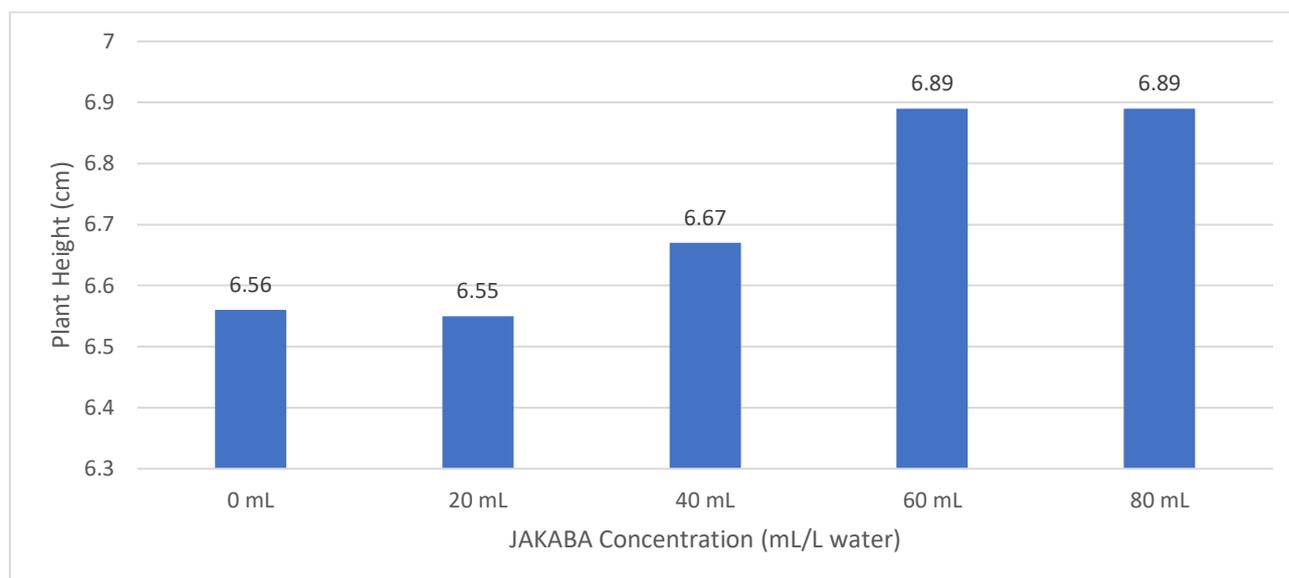


Figure 1. Average Height of Kailan Plants at 30 Days After Transplanting at Different JAKABA Concentrations

Based on the results presented in figure 1, the application of JAKABA-derived liquid organic fertilizer (LOF) at different concentrations, namely T1 (20 mL L⁻¹), T2 (40 mL L⁻¹), T3 (60 mL L⁻¹), and T4 (80 mL L⁻¹), as well as the application of NPK fertilizer as a positive control (T5), did not result in a statistically significant effect on the plant height of kailan compared with the untreated control (T0) ($p > 0.05$). Although a numerical trend of increased plant height was observed in some treatments, particularly at the highest concentration T4 (80 mL L⁻¹), these differences were not statistically significant. This indicates that, under the experimental conditions of this study, the range of LOF concentrations applied did not induce a distinct vegetative growth response in kailan.

The absence of significant differences in plant height among treatments T1–T4 may be attributed to several agronomic and biological factors. The activity of microorganisms in biofertilizers is strongly influenced by environmental conditions and the physicochemical properties of the growth medium, which govern the effectiveness of nutrient mineralization and solubilization processes (Garcha et al., 2024). Under relatively fertile growing media conditions, additional nutrient inputs from LOF at concentrations of 20–80 mL L⁻¹ may not have produced sufficiently large contrasts in nutrient availability compared with the control (T0) or the mineral fertilizer treatment (T5). Moreover, plant responses to microbial biofertilizers are often gradual and may require longer periods to manifest cumulative effects through enhanced rhizosphere activity (Li et al., 2022).

Previous studies have reported that microbially based biofertilizers can enhance vegetative growth through increased nitrogen and phosphorus availability and the production of plant growth–promoting substances (Ntsefong et al., 2023). However, their agronomic effectiveness is highly context-dependent, influenced by application rate, crop species, and interactions between microorganisms and the soil environment (Siregar et al., 2025). Accordingly, the lack of significant differences in plant height across T1 (20 mL L⁻¹), T2 (40 mL L⁻¹), T3 (60 mL L⁻¹), and T4 (80 mL L⁻¹) suggests that the applied concentration range may not have reached the optimal threshold required to elicit a measurable physiological response in kailan.

Nevertheless, these findings provide important evidence that the application of JAKABA-derived LOF within the tested concentration range (20–80 mL L⁻¹) did not exert negative effects on kailan vegetative growth and may be considered safe for use as part of sustainable nutrient management strategies. This observation is consistent with previous reports highlighting the general safety and compatibility of biofertilizers in environmentally sound agricultural systems (Garcha et al., 2024). Further research employing a wider range of application rates, longer experimental durations, and additional assessments of soil biological indicators (e.g., microbial biomass and enzyme activities) is warranted to more comprehensively evaluate the agronomic potential of JAKABA-derived LOF.

2. Number of Leaves

Figure 2 presents the effect of different concentrations of JAKABA-derived liquid organic fertilizer (LOF) on the number of leaves of kailan plants.

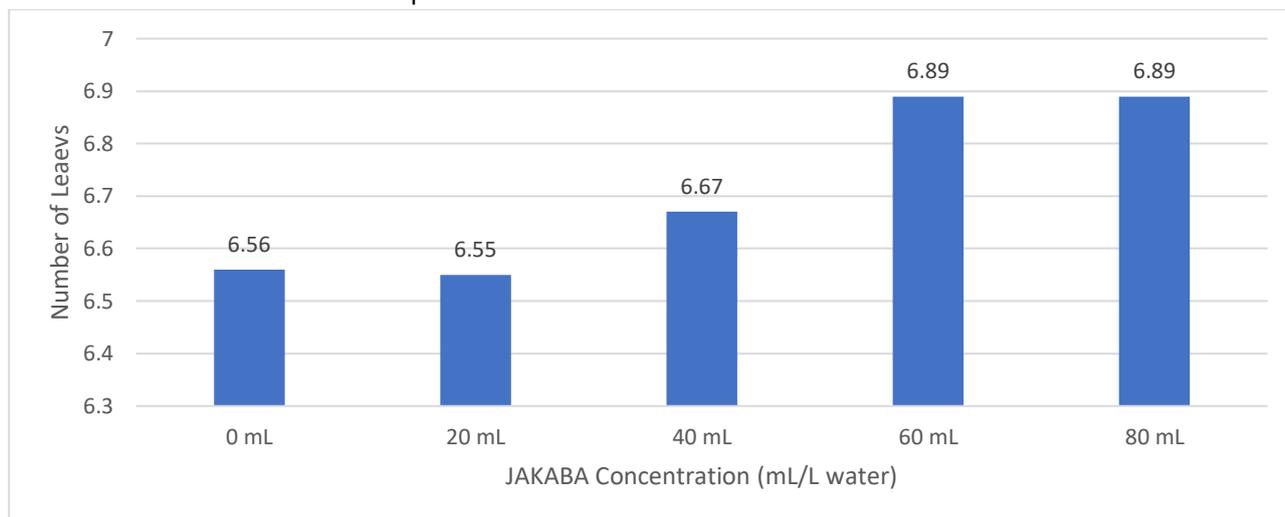


Figure 2. Average Number of Leaves of Kailan at 30 Days After Transplanting at Different JAKABA Concentrations

The application of JAKABA-derived liquid organic fertilizer (LOF) in Figure 2 shows a slight increase in the number of leaves per kale plant at all concentrations given. Control plants produced an average of 6.56 leaves, whereas LOF treatments at 20, 40, 60, and 80 mL L⁻¹ resulted in mean leaf numbers of 6.55, 6.67, 6.89, and 6.89 leaves per plant, respectively. Although a numerical increase in leaf number was observed, the differences among treatments were relatively small, indicating that the response of leaf production to JAKABA-derived LOF under the present experimental conditions was modest (Azrial, 2024). These results suggest that LOF application may contribute to vegetative growth; however, its effect on leaf formation was not pronounced.

The relatively modest increase in leaf number can be explained by improvements in nutrient availability associated with liquid organic fertilizer application. JAKABA, a biofertilizer produced through the fermentation of organic substrates, has been reported to improve soil nutrient profiles and nutrient availability, which are critical for optimizing plant growth, the fermentation process generates a microbial consortium capable of enhancing nutrient solubilization and mineralization, particularly of essential macronutrients such as nitrogen and phosphorus (Nafis et al., 2023). These nutrients play a central role in leaf development by supporting photosynthetic capacity and biomass accumulation.

In addition to nutrient-mediated effects, microbial metabolites produced during the fermentation of JAKABA may function as plant growth-promoting substances. These metabolites can stimulate root development and increase the effective root surface area, thereby improving the uptake efficiency of water and nutrients required for leaf formation (Bajwa et al., 2025). However, as observed in this study, the magnitude of these benefits appears to be influenced by the applied LOF concentration, suggesting that plant responses to biofertilizers may not increase linearly with dose.

The evaluation of different LOF concentrations further revealed that higher application rates (60 and 80 mL L⁻¹) did not substantially outperform intermediate doses in terms of leaf production. This non-linear dose-response pattern suggests the presence of an optimal concentration range for LOF application, beyond which additional inputs do not translate into proportional gains in growth. Such findings are consistent with previous reports emphasizing the importance of optimizing liquid organic fertilizer concentrations to avoid nutrient imbalances and transient osmotic stress in the rhizosphere, which can constrain nutrient uptake and plant performance (Norhalimah et al., 2022).

Excessively high LOF concentrations may induce osmotic stress in the root zone, potentially limiting water and nutrient uptake and, consequently, leaf development. Therefore, identifying an optimal LOF application rate is essential to maximize agronomic benefits while minimizing potential adverse effects on plant growth (Nafis et al., 2023).

3. Leaf Area

Figure 3 illustrates the effect of different concentrations of JAKABA-derived liquid organic fertilizer (LOF) on the leaf area of kailan plants.

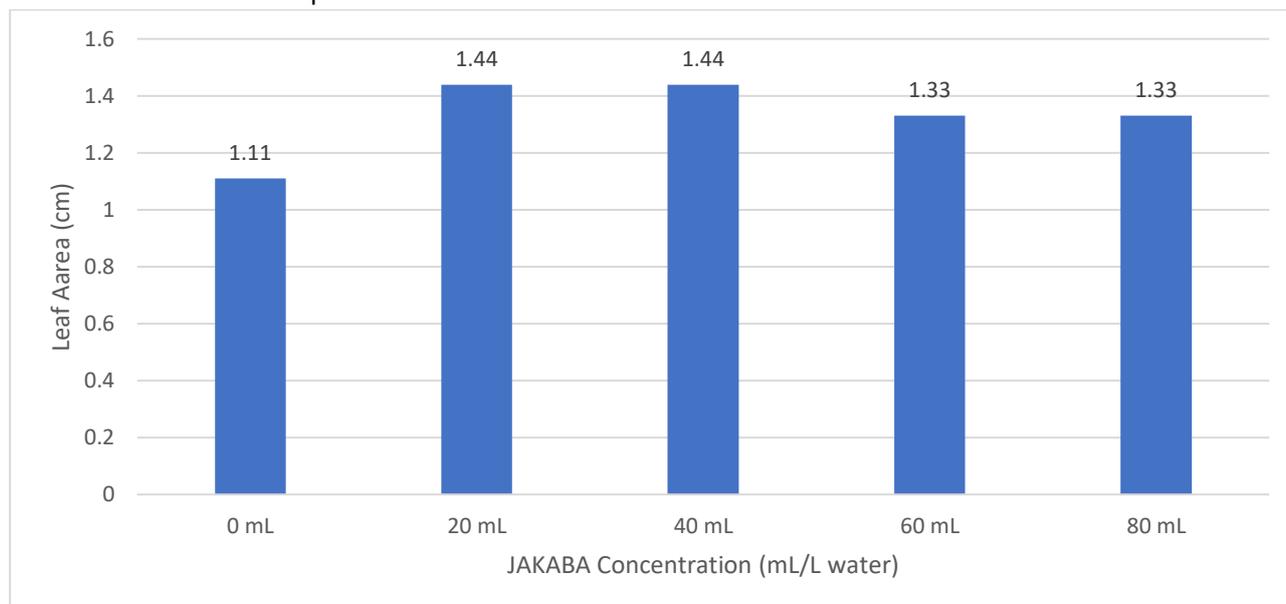


Figure 3. Effect of JAKABA-derived liquid organic fertilizer (LOF) concentration on leaf area of kailan.

The response of kailan leaves to the application of JAKABA-derived liquid organic fertilizer (LOF) indicates an effect on leaf area expansion, particularly at moderate concentrations. The results show that LOF treatments elicited variable responses depending on the applied concentration. Specifically, the control treatment (0 mL L^{-1}) produced a mean leaf area of 1.11 cm^2 , which was markedly lower than that obtained at 20 mL L^{-1} and 40 mL L^{-1} , both of which resulted in a higher mean leaf area of 1.44 cm^2 . This relationship suggests that moderate doses are more favorable for optimizing leaf development, consistent with previous studies emphasizing the effectiveness of organic fertilizers in promoting plant growth and the importance of selecting appropriate concentrations to maximize outcomes (Samidjo, 2025).

As the LOF concentration increased to 60 mL L^{-1} and 80 mL L^{-1} , a slight decline in mean leaf area was observed, decreasing to 1.33 cm^2 . This finding indicates the presence of a concentration threshold beyond which the benefits of LOF begin to diminish, underscoring the importance of applying fertilizers within an optimal dosage range to achieve maximum growth. Previous studies support this observation by demonstrating that plant growth is highly sensitive to nutrient application rates, and inappropriate or excessive fertilization can lead to nutrient imbalances that adversely affect plant health (Nendissa et al., 2023). Different fertilizer types have also been shown to produce varying outcomes in kohlrabi cultivation, highlighting the need for careful formulation and application rates to improve growth parameters (Aydın et al., 2021).

The reduction in leaf area at higher LOF concentrations may also be associated with phytotoxic effects or nutrient saturation, which can inhibit growth rather than promote it. Similar phenomena have been reported in previous studies, where excessive nitrogen or liquid organic fertilizer inputs resulted in reduced plant vigor and compromised physiological performance, these findings underscore the need for further systematic research to determine optimal fertilizer application rates by considering not only fertilizer type and formulation but also the species-specific biological responses of crops, thereby enabling more context-specific and effective agronomic practices (Samidjo, 2025).

This study confirms a meaningful relationship between fertilizer concentration and plant growth parameters and recommends the application of LOF at moderate rates ($20\text{-}40 \text{ mL L}^{-1}$) to optimize leaf area development. These insights may inform more effective cultivation practices not only for kailan but also for other leafy vegetables, supporting improved productivity through more precise and sustainable nutrient management strategies.

4. Fresh Plant Weight

Figure 4 presents the effect of different concentrations of JAKABA-derived liquid organic fertilizer (LOF) on the fresh plant weight of kailan.

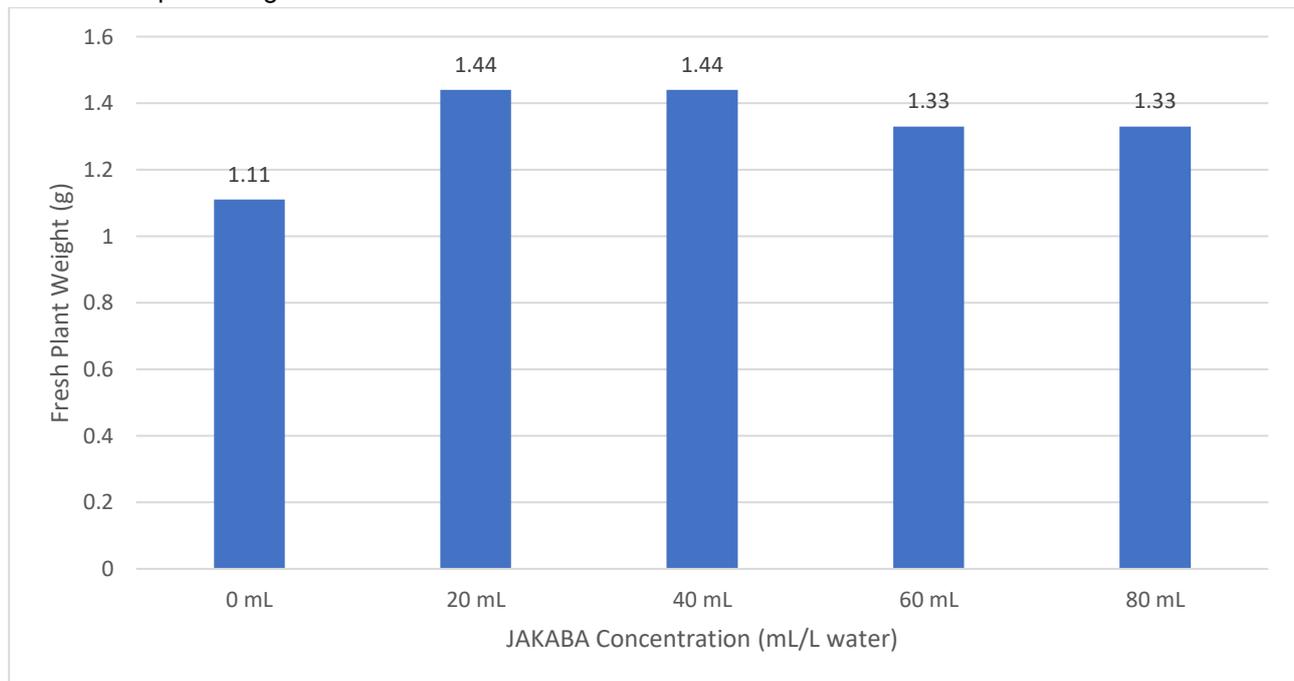


Figure 4. Effect of JAKABA-derived liquid organic fertilizer (LOF) concentration on fresh plant weight of kailan.

The application of JAKABA-derived liquid organic fertilizer (LOF) in Figure 4 affected the fresh weight of kailan plants, as indicated by increased biomass accumulation at moderate LOF concentrations. The control treatment (0 mL L⁻¹) recorded a relatively low mean fresh weight of 1.11 g, whereas treatments at 20 mL L⁻¹ and 40 mL L⁻¹ showed a substantial increase in fresh weight, reaching 1.44 g. These findings are consistent with the literature highlighting the benefits of organic fertilizers in improving plant growth parameters. A positive correlation between liquid biofertilizer dosage and kailan growth further supports the assertion that organic amendments can substantially enhance biomass production compared to the control treatment (Lahay et al., 2024).

The decline in fresh weight observed at higher LOF concentrations, namely 60 and 80 mL L⁻¹, with a mean fresh weight of 1.33 g, indicates the presence of an optimal concentration range for maximizing plant growth. This phenomenon is consistent with previous studies reporting that excessive fertilizer application can reduce plant growth performance due to nutrient imbalances or phytotoxic effects. Although liquid organic fertilizers can enhance nutrient uptake, inappropriate dosages may lead to suboptimal growth responses in other crops such as sorghum (Sari et al., 2022). This underscores the importance of adhering to recommended application rates to minimize potential negative effects associated with over-fertilization.

The tendency for biomass accumulation to decline beyond a certain threshold has been widely reported in the literature, emphasizing the need for balanced fertilization strategies. Precise fertilization practices are essential to avoid adverse impacts on plant health and productivity (Pangaribuan et al., 2022). These observations suggest that while increased nutrient availability may initially stimulate growth, maintaining nutrient balance is critical to prevent toxicity or imbalances that could ultimately constrain the desired growth rate. Overall, this study supports the conclusion that moderate LOF application rates (20–40 mL L⁻¹) are effective in optimizing the fresh weight of kailan, highlighting the importance of dosage precision in organic farming practices.

5. Fresh Shoot Weight

Figure 5 illustrates the effect of different concentrations of JAKABA-derived liquid organic fertilizer (LOF) on the fresh shoot weight of kailan plants.

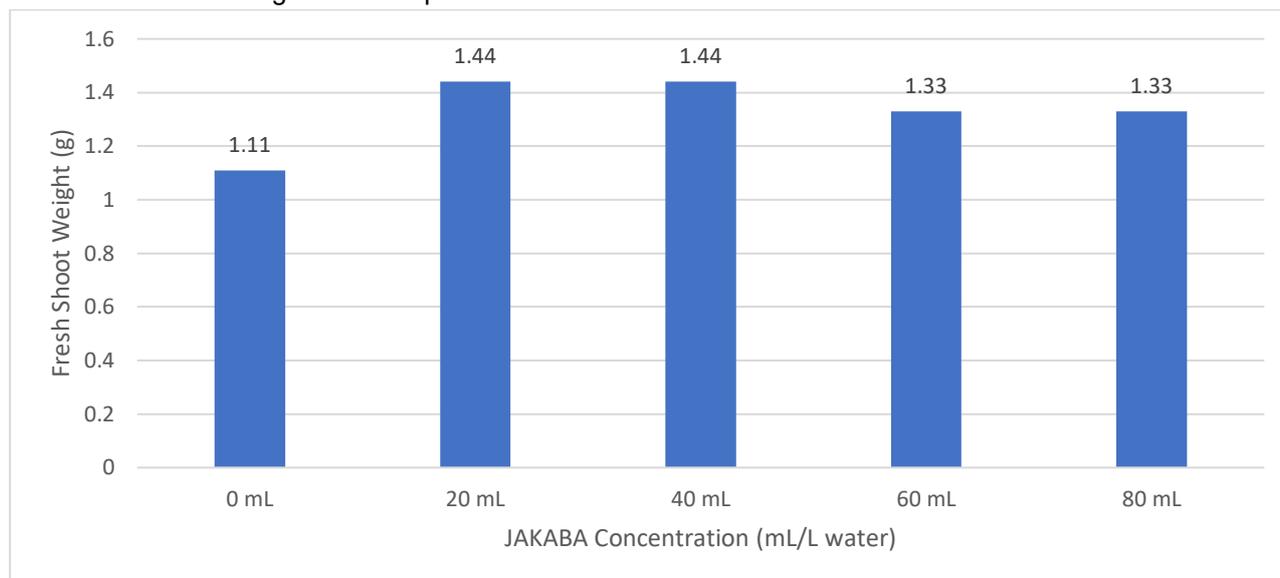


Figure 5. Effect of JAKABA-derived liquid organic fertilizer (LOF) concentration on fresh shoot weight of kailan

The application of JAKABA-derived liquid organic fertilizer (LOF) in Figure 5 significantly promoted fresh shoot biomass accumulation in kailan, as evidenced by consistent increases in biomass at moderate concentrations. The control treatment (0 mL L^{-1}) produced a mean fresh shoot weight of 1.11 g, in contrast to the higher fresh shoot weights of 1.44 g observed at 20 mL L^{-1} and 40 mL L^{-1} . This indicates a strong positive response of kailan to LOF application at moderate doses, whereas a slight decline to 1.33 g at 60 mL L^{-1} and 80 mL L^{-1} suggests the presence of a concentration threshold beyond which the fertilization benefits begin to diminish.

These findings are consistent with numerous studies reporting that organic fertilizers can enhance plant growth parameters, primarily due to their ability to supply essential nutrients in more bioavailable forms. Previous studies have shown that liquid organic fertilizers significantly increase plant biomass compared to control treatments. The effectiveness of organic fertilizer applications in improving plant height and biomass in Brassica crops further supports the observation that organic amendments can stimulate biomass production (Janah et al., 2023). Moreover, the nutritional benefits associated with Brassica species reinforce the notion that increased shoot biomass may be linked to favorable biochemical properties in this plant group (Rosés et al., 2023).

Although moderate concentrations were found to be optimal, the reduction in fresh shoot weight at higher LOF concentrations likely reflects nutrient excess that may induce phytotoxic effects. This phenomenon has been widely documented in the agricultural literature, where excessive nutrient supply can trigger adverse physiological responses and inhibit plant growth due to osmotic and ionic imbalances (Gocal, 2021). A balanced microbial environment fostered by organic amendments plays a critical role in nutrient uptake efficiency and overall plant health (Chen & Naqvi, 2023). Therefore, while increasing nutrient concentrations may initially support growth, identifying an optimal application range is essential to sustain plant vigor without incurring negative effects.

Understanding the biochemical pathways underlying plant responses to fertilization is also crucial. Specialized metabolites in Brassica species, such as glucosinolates, contribute substantially to both plant growth and health benefits, which may help explain the enhanced shoot biomass observed following LOF application (Barreda et al., 2024; Scepankova et al., 2021). The relationship between nutrient application and metabolite accumulation is complex, underscoring the importance of effective nutrient management in optimizing plant performance.

This study demonstrates that moderate LOF application rates ($20\text{--}40 \text{ mL L}^{-1}$) are effective for maximizing fresh shoot weight in kailan, while caution is warranted at higher concentrations due to the potential attenuation of growth benefits.

6. Fresh Root Weight

Figure 6 illustrates the effect of different concentrations of JAKABA-derived liquid organic fertilizer (LOF) on the fresh root weight of kailan plants.

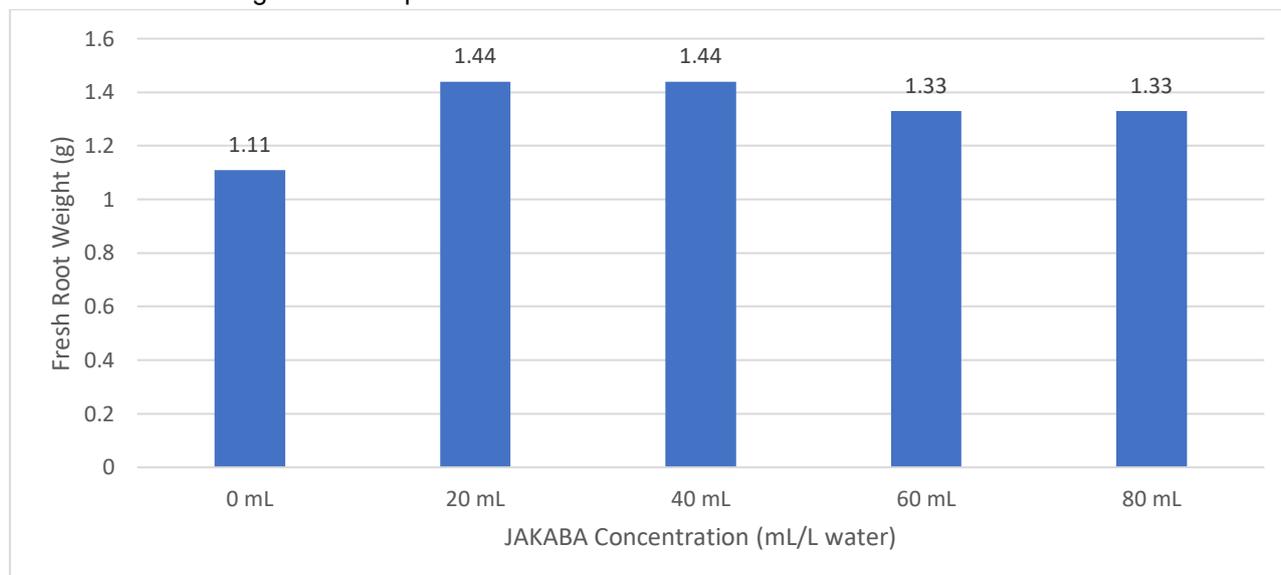


Figure 6. Effect of JAKABA-derived liquid organic fertilizer (LOF) concentration on fresh root weight of kailan.

The application of JAKABA-derived liquid organic fertilizer (LOF) in Figure 6 showed a significant effect on the fresh root weight of kailan plants, with the results indicating that moderate concentrations were the most effective for enhancing root biomass accumulation. In the control treatment (0 mL L^{-1}), the mean fresh root weight recorded was 1.11 g, which was substantially lower than that observed at 20 mL L^{-1} and 40 mL L^{-1} (1.44 g). However, at higher concentrations, namely 60 mL L^{-1} and 80 mL L^{-1} , a slight decline in fresh root weight to 1.33 g was observed, although the values remained higher than those of the control treatment. These findings indicate the presence of an optimal concentration range ($20\text{--}40 \text{ mL L}^{-1}$) for promoting root development under the experimental conditions.

The positive correlation between LOF application and fresh root weight is consistent with the scientific literature highlighting the advantages of organic fertilizers in stimulating root system development. The use of liquid organic fertilizers derived from agricultural waste has been reported to not only improve the yield and quality of leafy vegetables but also contribute positively to root biomass accumulation (Sembiring et al., 2023). These findings suggest that organic amendments can improve soil health and nutrient availability, which are critical factors for robust root development.

Furthermore, moderate nutrient applications have been reported to enhance root growth through increased microbial activity in the rhizosphere, facilitating nutrient uptake and maintaining root health (Samidjo, 2025). In contrast, excessive fertilization can lead to nutrient imbalances that inhibit root development and compromise plant health (Kamińska & Śliwińska, 2023). Although high nutrient availability may initially stimulate growth, such conditions can induce toxicities that ultimately constrain overall plant performance (Remigio et al., 2024).

The structural integrity and health of the root system are essential for nutrient acquisition and overall plant vigor. Root development is closely linked to phytochemical production in Brassica species, contributing to both growth enhancement and plant health benefits (Reda et al., 2021). This highlights the complex interactions among nutrient availability, root biomass, and phytochemical synthesis, indicating that well-calibrated nutrient management, including LOF application, can optimize root system development in kailan. Overall, moderate LOF application not only enhances root growth but also confers broader ecological benefits through improvements in soil microbial

health and nutrient cycling.

CONCLUSIONS

The application of JAKABA-derived liquid organic fertilizer (LOF) influenced kailan growth and biomass accumulation, with moderate concentrations (20-40 mL L⁻¹) providing the most favorable vegetative responses, while higher concentrations did not consistently enhance growth. LOF shows potential as a sustainable nutrient input under the experimental conditions. Future studies should assess broader dose ranges and longer cultivation periods across soil types, and farmers are advised to apply LOF at moderate concentrations to improve kailan growth while avoiding excessive application.

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