Effect of Golden Apple Snail Liquid Organic Fertilizer (LOF) and Biosaka on the Growth and Production of Cucumber (*Cucumis melo* L.)

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Abstract

The decline in productivity of cucumber (Cucumis melo L.) caused by low soil fertility and the dominant use of synthetic chemical fertilizers has become a major problem requiring a sustainable solution. This study aimed to evaluate the effect of golden apple snail Liquid Organic Fertilizer (LOF) and Biosaka on the growth and production of cucumber plants. The study used a factorial Randomized Block Design (RBD) with two treatment factors, namely the concentration of golden apple snail LOF (M): control, 37.5 ml/liter, 75 ml/liter, and 112.5 ml/liter; and Biosaka (B): control, 15 ml/liter, 30 ml/liter, and 45 ml/liter, each replicated three times. The data were analyzed using analysis of variance (ANOVA), followed by a further test on significant treatments to examine the effect between treatment concentrations. The results showed that the application of golden apple snail LOF had a significant effect on the number of fruits per plant, fruit weight per plant, and fruit weight per plot at a concentration of 112.5 ml/liter. Biosaka application affected leaf chlorophyll content at 15 ml/liter and fruit weight per plant at 45 ml/liter. There was no interaction between the two treatments, indicating that both factors acted independently in influencing the observed parameters. This study underlines that golden apple snail LOF is more effective in improving yield components, whereas Biosaka supports the physiological aspects of the plant. These findings open opportunities for the development of biologically based liquid organic fertilization in environmentally friendly cucumber cultivation.

Keywords: *Biofertilizer, environmentally frendly, plant physiologi, sustainable.*

INTRODUCTION

Cucumber (Cucumis melo L.) is one of the potential horticultural commodities widely cultivated in Indonesia due to its high level of consumption, particularly during certain seasons such as the month of Ramadan. This fruit contains nutrients that are beneficial for health; every 100 grams of cucumber contains 16 calories, 1.3 mg of protein, 0.04 mg of fat, 2.08 mg of carbohydrate, 768 mg of calcium, 422 mg of phosphorus, 0.8 mg of fiber, 24.86 mg of vitamin C, 1,008 mg of potassium, and 96.32 g of water (Hayati et al., 2009). However, the productivity of cucumber at the farmer level remains suboptimal due to soil fertility degradation, dependence on synthetic chemical fertilizers, and a lack of innovation in organic-based fertilization. The intensive long-term use of inorganic fertilizers has been shown to reduce soil quality, disrupt microbial balance, and increase production costs. Therefore, the application of liquid organic fertilizer (LOF) has become a strategic alternative for supporting sustainable cucumber production.

One source of LOF that has begun to be utilized is the golden apple snail (Pomacea canaliculata). This snail has long been known as a major pest of rice plants; however, its high protein content and the presence of macro and micro nutrients make it a potential material for liquid organic fertilizer (Siregar et al., 2017) and it can serve as a source of beneficial microbes in the process of enriching the soil (Yao et al.,

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2024). The nutrient content of golden apple snail LOF includes 32.93% N, 17.48% P2O5, and 19.25% K2O. This high nutrient content is beneficial for plant growth. The application of a combination of golden apple snail LOF at 75 ml/L of water and SP-36 fertilizer at 7.5 g/plant showed a significant effect on all observed parameters of cherry tomato plants. The nitrogen, phosphorus, potassium, and amino acid content in golden apple snail LOF plays an important role in tissue formation and enhanced photosynthesis. The use of golden apple snail as fertilizer also contributes to reducing pest populations while converting biological waste into an economically valuable product.

On the other hand, Biosaka contains elicitor compounds derived from various healthy plants (Reflis et al., 2023), that can stimulate cell formation, strengthen the plant's immune system, and improve nutrient uptake. Biosaka also contains hormones, PGPR (Plant Growth Promoting Rhizobacteria), plant growth regulators, as well as ester and terpenoid compounds that help control pests and diseases (Zainab et al., 2023; Akbar et al., 2024). Biosaka has shown a positive effect in which farmers have not only succeeded in reducing losses due to pest attacks but have also been able to manage their expenses more efficiently by reducing their dependence on expensive synthetic chemical fertilizers. Soil treated with Biosaka becomes more fertile, leading to increased crop yields and improved quality of the plants grown (Melinda, et al., 2024).

Research on liquid organic fertilizer (LOF) derived from golden apple snails has been conducted on crops such as chili, eggplant, baby corn, and lettuce, yielding positive results regarding plant growth and yield (Borja et al., 2023; Yanti et al., 2025). This research is important given the need for an affordable, environmentally friendly, and easily applicable fertilizer alternative for farmers. The golden apple snail, which has long been a plant pest, can be transformed into a productive solution through processing into LOF (Siregar et al., 2017). A combination or comparison of the two has the potential to provide scientific data relevant to the development of horticultural cultivation systems. In addition, this research supports efforts to reduce dependence on synthetic chemical fertilizers and encourages sustainable organic farming practices.

The purpose of this study was to analyze the effect of golden apple snail LOF and Biosaka on the growth and production of cucumber plants. Specifically, this study aimed to evaluate the vegetative growth response of cucumber, assess the effect of both types of fertilizer on yield components, and compare the effectiveness of golden apple snail LOF and Biosaka in order to obtain the best treatment for improving plant yield. The novelty of this study lies in its focus on cucumber, which has not been widely studied in the context of golden apple snail LOF or Biosaka application. In addition, this study makes a scientific contribution by testing two liquid organic fertilizers with different characteristics that have not previously been directly compared. The results of this study are expected to provide new information on the effectiveness of local organic materials in improving horticultural productivity and to encourage the use of golden apple snail and Biosaka as part of environmentally friendly fertilization innovation. The urgency of this research is also related to the need to increase horticultural productivity without worsening soil ecosystem conditions. The use of liquid organic fertilizers such as golden apple snail LOF and Biosaka can be a strategic solution to address the challenges of soil degradation, high production costs, and climate change. The resulting findings are expected to be directly applicable by farmers and to serve as a reference for further research and agricultural extension. Thus, this study not only contributes to the development of agronomic science but also provides practical benefits in the management of local resources and the improvement of cucumber productivity. This study is expected to form the basis for the development of more efficient, ecological, and applicable cultivation technology.

MATERIALS AND METHODS

Place and Time

This research was conducted at the practical field of the Faculty of Agriculture, Universitas Muhammadiyah Sumatera Utara, Tuar street No. 65, Medan Amplas, at an altitude of ±27 meters above sea level, with coordinates 3°32'35.7^{o}N 98°43'23.5"E, from August to November 2024.

Materials and Tools

The materials used in this study included Goldy cucumber seeds (Indonesian Ministry of Agriculture Decree No. 146/Kpts/PV.240/DIV/2023), soil, golden apple snail LOF, Biosaka, and water. The tools used included a hoe, machete, bucket, scissors, scale, TDS meter, SPAD-502 Plus chlorophyll meter, funnel, sieve, and mobile phone.

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Research Method

The experiment was conducted using a two-factor factorial randomized block design (RBD). The first factor was the application of golden apple snail liquid organic fertilizer (LOF) (M), consisting of four levels: M0 (control), M1 (37.5 mL L^{-1}), M2 (75 mL L^{-1}), and M3 (112.5 mL L^{-1}). The second factor was Biosaka application (B), which also consisted of four levels: B0 (control), B1 (15 mL L^{-1}), B2 (30 mL L^{-1}), and B3 (45 mL L^{-1}). These two factors resulted in 16 treatment combinations: M_0B_0, M_0B_1, M_0B_2, M_0B_3, M_1B_0, M_1B_1, M_1B_2, M_1B_3, M_2B_0, M_2B_1, M_2B_2, M_2B_3, M_3B_0, M_3B_1, M_3B_2, and M_3B_3. Each treatment combination was replicated three times, resulting in 48 experimental units. Each experimental unit consisted of four plants, giving a total of 192 plants.

Land Preparation and Planting

Preparation included clearing the land of weeds and other materials that could potentially reduce soil fertility, such as synthetic materials previously present in the soil/land. Topsoil growing medium was manually placed into 35 × 40 cm polybags up to 2 cm from the rim of the polybag. Seeds were sown in trays until 4 leaves had grown (14 days old), after which they were transferred to the growing medium. Trellises were installed to allow the plants to climb, to facilitate maintenance and fertilization, and to support the fruit of the cucumber plants.

Preparation of Golden Apple Snail Liquid Organic Fertilizer (LOF)

Golden apple snail LOF was made by boiling the snails to separate the flesh from the shell. Next, 1 kg of the flesh was mashed finely and mixed with 1 liter of rice-washing water, 2 liters of coconut water, 400 g of palm sugar, and 160 ml of EM (effective microorganisms). The mixture was fermented for 20 days, with the jerry can lid opened each morning to release gas. After fermentation, the mixture was filtered and ready for use, characterized by a fresh aroma rather than a foul odor

Preparation of Biosaka

Biosaka was made from healthy, pest-free babadotan (goat weed), purple maman, kebo grass, and meniran (*Phyllanthus*) plants. Approximately 250 grams of leaves were mixed with 5 liters of water and then squeezed until homogeneous. The resulting extract was green, viscous, and glossy, without gas or particles. The density (TDS) applied in this study was 457 ppm.

Fertilizer Application

The liquid organic fertilizer and Biosaka were applied two weeks after planting, with golden apple snail LOF sprayed around the plants according to the concentration of each treatment. Biosaka was applied starting at 2 weeks after planting (WAP) at intervals of every 2 weeks. Biosaka application was carried out by mixing the Biosaka solution with water according to the treatment concentration. Spraying was applied to the plant leaves with the nozzle facing upward. Spraying was carried out in the morning.

Plant Maintenance

Plant maintenance included watering, replanting, weeding, and fertilizing. Tendril tying and pest and disease control were carried out until harvest.

Observed Variables

The measured parameters included: runner length (cm); chlorophyll content, measured using SPAD (Soil Plant Analysis Development) and expressed as a SPAD index (no standard unit); leaf area (cm^2); flowering age (days); number of fruits per plant (fruits); fruit weight per plant (g); and fruit weight per plot (g).

Data Analysis

The observational data for each parameter were interpreted using Analysis of Variance (ANOVA), $Yijk = \mu + \gamma i + \alpha i + \beta j + (\alpha\beta)jk + \varepsilon ijk$, to determine any differences resulting from the applied treatments. If the analysis showed a significant effect, a further test was carried out using Duncan's Multiple Range Test (DMRT) at the 5% significance level to examine further differences between treatments.

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RESULTS AND DISCUSSION

The results showed that golden apple snail LOF affected the yield components of cucumber plants, while Biosaka affected both the growth and yield of cucumber plants. Both factors had an impact on plant development. However, no significant interaction was found between golden apple snail LOF and Biosaka. The two factors acted independently without influencing each other. Thus, the effect produced by each factor was independent.

Table 1. F-Value Calculation Results for All Observed Variables

Observed Variables	F-Value Calculation		
	Golden Apple Snail LOF (M)	Biosaka (B)	Combination M*B
Runner Length at 5 WAP (cm)	2.10ns	2.43ns	0.82ns
Leaf Chlorophyll Content (unit/6 cm^2)	1.07ns	3.14*	0.52ns
Leaf Area at 5 WAP (cm^2)	0.89ns	1.29ns	1.00ns
Flowering Age (days)	0.52ns	0.58ns	1.06ns
Number of Fruits per Plant (fruits)	4.94*	0.53ns	1.15ns
Fruit Weight per Plant (g)	27.14*	3.25*	0.53ns
Fruit Weight per Plot (g)	37.42*	2.72ns	1.43ns
F Value 5%	2.92	2.92	2.21

Note: ns = not significant, * = significant

The results of the analysis of variance in Table 1 show that the application of golden apple snail LOF had a significant effect on the number of fruits per plant, fruit weight per plant, and fruit weight per plot, but had no significant effect on runner length at 5 WAP, leaf chlorophyll content and flowering age. Biosaka application only had a significant effect on leaf chlorophyll content and fruit weight per plant. Meanwhile, the simultaneous application of golden apple snail LOF and Biosaka did not produce a significant interaction effect.

Leaf Chlorophyll Content

The results of the analysis of variance showed that the application of golden apple snail LOF had no significant effect on leaf chlorophyll content, whereas Biosaka application had a significant effect. The interaction between the two treatment factors also showed no significant difference. This indicates that the increase in chlorophyll content was more strongly influenced by the use of Biosaka as a biostimulant, while golden apple snail LOF had not yet been able to make a meaningful contribution at the vegetative growth stage of the plant.

Table 2. Leaf Chlorophyll Content under Golden Apple Snail LOF and Biosaka Treatments

Golden Apple Snail LOF (ml/l)	Biosaka (ml/l)				Average
	B_0 (Control)	B_1 (15 ml/l)	B_2 (30 ml/l)	B_3 (45 ml/l)	
	……(units/6 cm^2)……				
M_0 (Control)	61.88	77.36	78.92	81.28	74.86
M_1 (37.5 ml/l)	73.39	94.28	94.71	75.48	84.46
M_2 (75 ml/l)	80.12	84.98	86.28	81.88	83.31
M_3 (112.5 ml/l)	69.51	79.40	94.03	81.82	81.19
Average	71.23b	84.00a	88.49a	80.11ab	

Note: Numbers followed by different letters in the same row are significantly different according to the 5% DMRT test

The leaf chlorophyll content measured at 5 WAP increased with golden apple snail LOF treatment; however, as the concentration of golden apple snail LOF increased (37.5–112.5 ml/l), the increase in chlorophyll content became progressively smaller. This condition may be caused by an optimal nutrient

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balance at medium doses, whereas at higher doses, an accumulation of certain nutrients may occur that actually suppresses chlorophyll formation. Increasing nutrient supply up to an optimal level raises chlorophyll content and photosynthetic efficiency. However, beyond a certain threshold, additional nutrients no longer significantly increase chlorophyll content and may even cause stress or toxicity (Hashmi et al., 2019; Veazie et al., 2020). The response to excess nutrients is also specific, depending on the type of element and plant species. For instance, nitrogen strongly affects chlorophyll content, but excess phosphorus or potassium does not always significantly increase chlorophyll (Widjaja, 2024).

Biosaka application was shown to significantly increase chlorophyll content. The highest mean chlorophyll value was obtained at a dose of 30 ml/l, with a value of 88.49 units/6 cm², significantly different from the control, which reached only 71.23 units/6 cm², because Biosaka, as a biostimulant, is able to improve plant physiology, increase photosynthetic efficiency, and promote the formation of green leaf pigment. This supports the formation of higher levels of green leaf pigment compared with untreated plants. This result is consistent with the findings of Apriliani et al. (2016) who reported that Biosaka application was able to increase chlorophyll content and the vegetative growth of horticultural plants.

At the higher dose (45 ml/l), a decrease in chlorophyll content actually occurred, indicating that the plant's response to Biosaka is optimum rather than linear, so that the use of an excessively high dose does not always produce a better effect. Biosaka, as an adaptive plant extract, improves plant health, soil fertility, and leaf appearance toward a greener color, indicating an increase in chlorophyll content and physiological health (Melinda, et al., 2024). There is as yet no evidence that a continuous increase in Biosaka dose would proportionally increase chlorophyll content. After reaching the optimum dose, further additions tend not to provide additional benefits and may even cause stress or physiological imbalancei (Sánchez-Moreiras, 2020; Moustaka & Moustakas, 2023).

The absence of a significant interaction between golden apple snail LOF and Biosaka indicates that the two act independently, without any synergistic or antagonistic effect on increasing leaf chlorophyll content. The relationship between chlorophyll content and Biosaka treatment can be seen in Figure 1.

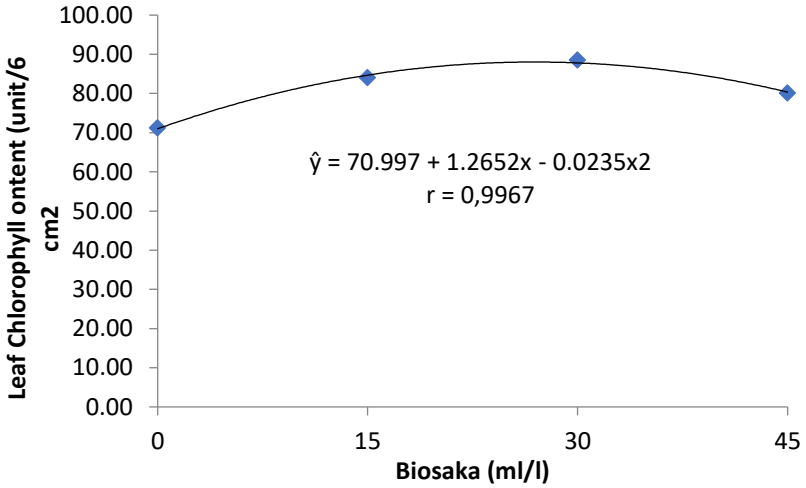


Figure 1. Relationship between Biosaka and Leaf Chlorophyll Content

The regression analysis showed a quadratic response pattern; increasing the Biosaka dose from 0 to approximately 27 ml/l (the calculated optimum point) increased leaf chlorophyll content up to approximately 88 units/6 cm² at 5 WAP. Beyond this dose, chlorophyll content decreased. The relationship was very close, with a correlation value of 99.67%. This phenomenon indicates the existence of a maximum threshold for Biosaka concentration. At low to moderate doses, the bioactive substances contained in Biosaka are able to stimulate an increase in chlorophyll synthesis, whereas at high doses, saturation or even a toxic effect occurs that inhibits plant metabolism.

Biosaka helps increase or maintain leaf chlorophyll content by protecting leaf cell structure from stress, improving photosynthetic efficiency, and regulating plant gene expression through biochemical signals (Twaij et al., 2022). The increase in chlorophyll content is in line with increased photosynthetic efficiency, thereby supporting optimal vegetative plant growth. This is consistent with the role of Biosaka, which contains various bioactive compounds derived from plant extraction, enabling it to stimulate an increase in leaf chlorophyll content.

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Number of Fruits per Plant (fruits)

The analysis of variance showed that golden apple snail LOF had a significant effect on the number of fruits per plant, while Biosaka application and the combination of the two had no significant effect. The number of fruits per plant resulting from the golden apple snail and Biosaka treatments can be seen in Table 3.

Table 3. Number of Fruits per Plant under Golden Snail LOF and Biosaka Treatments at 8 WAP

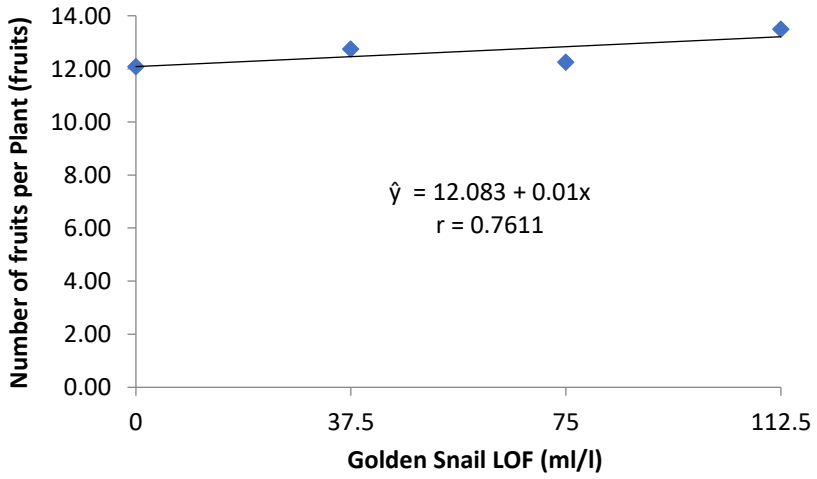
Golden Apple Snail LOF (ml/l)	Biosaka (ml/l)				Average
	B_0 (Control)	B_1 (15 ml/l)	B_2 (30 ml/l)	B_3 (45 ml/l)	
	……(Fruits)……..				
M_0 (Kontrol)	12.67	12.00	12.33	11.33	12.08b
M_1 (37.5 ml/l)	12.33	13.00	12.67	13.00	12.75ab
M_2 (75 ml/l)	12.00	12.67	12.00	12.33	12.25b
M_3 (112.5 ml/l)	12.33	13.33	14.00	14.33	13.50a
Average	12.33	12.75	12.75	12.75	

Note: Numbers followed by different letters in the same column are significantly different according to the 5% DMRT test.

The results showed that golden apple snail LOF treatment had a significant effect on the number of fruits per plant at 8 WAP. The highest number of fruits was obtained with the M3 treatment (112.5 ml/l), at 13.50 fruits, which was significantly different from the control (M0) and M2 (75 ml/l) but not significantly different from M1 (37.5 ml/l). This indicates that increasing the concentration of golden apple snail LOF can increase the number of fruits per plant up to a certain concentration. Golden apple snail LOF contains macronutrients such as nitrogen, phosphorus, and potassium, as well as essential nutrients and amino acids that support chlorophyll formation and photosynthesis, thereby promoting optimal plant growth and development (Nursanti et al., 2021; Borja et al., 2023; Asmono et al., 2026).

In contrast, Biosaka application at various concentration levels (15-45 ml/l) showed no significant difference in the number of fruits per plant. The mean number of fruits across all Biosaka levels was relatively similar, ranging from 12.33 to 12.75 fruits. This indicates that Biosaka, as a biological elicitor, does not directly increase the number of fruits but instead plays more of a role in maintaining plant metabolic balance and increasing resistance to environmental stress. Consequently, its effect on fruit formation is less apparent than the direct effect of the nutrients supplied by golden apple snail LOF.

The combined application of golden apple snail LOF and Biosaka showed no significant interaction; however, the combination of M3 with B2 (30 ml/l) and B3 (45 ml/l) produced the highest number of fruits, at 14.00 and 14.33 fruits per plant, respectively. This indicates that although Biosaka alone had no significant effect, in combination with a high dose of golden apple snail LOF it was able to support an increase in the number of fruits. It is suspected that Biosaka helps improve the efficiency of nutrient uptake available in golden apple snail LOF, thereby promoting more optimal fruit formation. The relationship between golden apple snail LOF and the number of fruits per plant can be seen in Figure 2.



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Figure 2. Relationship between Number of Fruits per Plant and Golden Snail LOF Treatment at8 WAP

The graphical analysis showed that increasing the concentration of golden apple snail LOF had a positive effect on the number of fruits per cucumber plant at 8 WAP. The linear relationship between the two variables is reflected in the regression equation $\hat{y} = 12.083 + 0.01x$, with a correlation coefficient of 76.11%. This value indicates that the contribution of golden apple snail LOF application to the increase in fruit number is fairly strong. The increase in fruit number along with increasing LOF concentration shows that the nutrients contained in the liquid organic fertilizer can be effectively absorbed by the plant and support fruit formation.

Fruit Weight per Plant (g)

The analysis of variance showed that golden apple snail LOF had a significant effect on fruit weight per plant, while Biosaka application and the combination of the two had no significant effect. Fruit weight per plant resulting from the golden apple snail and Biosaka treatments can be seen in Table 4.

Table 4. Fruit Weight per Plant under Golden Snail LOF and Biosaka Treatments at 8 WAP

Golden Apple Snail LOF (ml/l)	Biosaka (ml/l)				Average
	B_0 (Control)	B_1 (15 ml/l)	B_2 (30 ml/l)	B_3 (45 ml/l)	
	……(g)……				
M_0 (Kontrol)	1,873	1,779	1,954	1,909	1,879cd
M_1 (37.5 ml/l)	1,785	2,342	2,315	2,354	2,199bc
M_2 (75 ml/l)	2,108	2,390	2,357	2,580	2,358b
M_3 (112.5 ml/l)	2,749	3,318	3,558	3,535	3,290a
Average	2,129cd	2,457abc	2,546ab	2,594a	

Note: Numbers followed by different letters in the same row and column are significantly different according to the 5% DMRT test

The results showed that golden apple snail LOF treatment had a significant effect on fruit weight per plant at 8 WAP. The heaviest fruit weight was obtained with the M_3 treatment (112.5 ml/l), at 3,290 g, which was significantly different from the M_0 (control), M_1 (37.5 ml/l), and M_2 (75 ml/l) treatments. This indicates that the higher the concentration of golden apple snail LOF, the greater the resulting fruit weight. Golden apple snail LOF is known to contain macronutrients (N, P, K) as well as the micronutrient Fe, which play an important role in chlorophyll synthesis, photosynthesis, and overall vegetative plant growth. Nitrogen content plays a key role in leaf area expansion and chlorophyll formation, phosphorus in energy transfer and root development, while potassium supports stomatal regulation, osmotic balance, and carbohydrate accumulation, thereby increasing total plant biomass and dry weight (Borja et al., 2023; Asmono et al., 2026). The nutrients contained in LOF assist plant metabolic processes, including the formation of RNA and DNA and enzyme activation (Barus et al., 2014).

Biosaka treatment also had a significant effect on fruit weight. The heaviest fruit weight was obtained with the B_3 treatment (45 ml/l), at 2,594 g, which was significantly different from the control (B_0) and tended to be higher than the other Biosaka concentration. This indicates that Biosaka application at a certain concentration can support an increase in fruit weight. As a biological elicitor, Biosaka functions to stimulate plant physiological mechanisms, increase nutrient-uptake efficiency, and strengthen plant resistance to abiotic stress. Thus, although Biosaka is not a primary nutrient source, its role in improving the efficiency of nutrient use from golden apple snail LOF supports more optimal fruit formation.

The combination of the two treatments showed no significant interaction, but produced the best results in the combination of M_3 with B_2 (30 ml/l) and B_3 (45 ml/l), which produced fruit weights of 3,558 g and 3,535 g per plant, respectively. These values were higher than either single treatment, whether golden apple snail LOF alone or Biosaka alone. This indicates a positive synergy between the nutrient availability from golden apple snail LOF and the role of Biosaka as a biostimulant that increases plant physiological efficiency. This combination was able to promote photosynthesis and translocation of assimilates more effectively, thereby increasing biomass accumulation in the fruit. The relationship between golden apple snail LOF application and fruit weight per plant can be seen in Figure 3. The relationship between biosaka application and fruit weight per plant can be seen in Figure 4.

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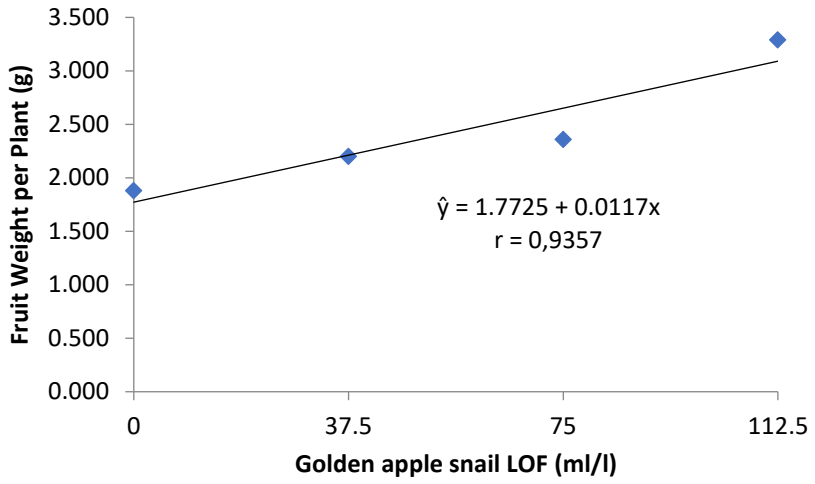


Figure 3. Relationship between Fruit Weight per Plant and Golden Snail LOF Treatment at 8 WAP

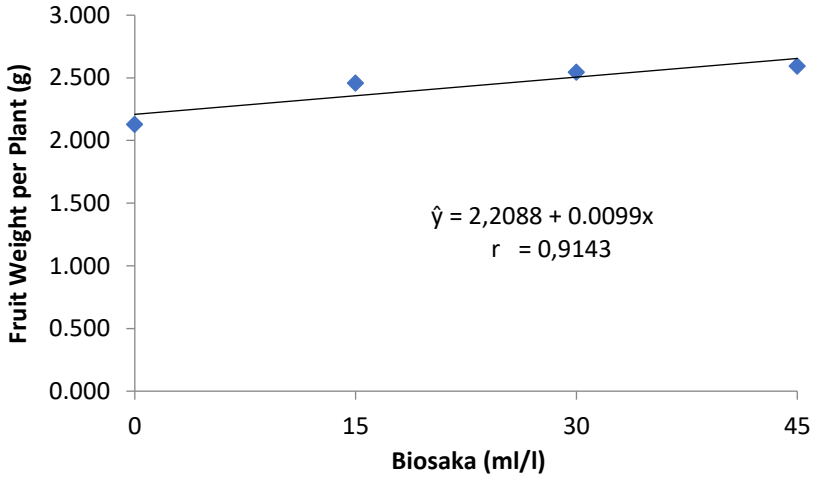


Figure 4. Relationship between Fruit Weight per Plant and Biosaka Treatment at 8 WAP

Figure 4 shows that Biosaka application formed a positive linear relationship with fruit weight, with the regression equation ŷ = 2,2088 + 0.0099x, meaning that fruit weight per plant at the first to fourth harvest was 2,2088 g and increased by 0.0099 times for each increase in Biosaka concentration, with a correlation between Biosaka and fruit weight per plant of 91.43%. Statistical analysis showed that Biosaka had a significant effect on increasing fruit weight. This is presumably because Biosaka is able to supply important nutrients and act as a biological stimulant that accelerates nutrient uptake. Biosaka supports leaf expansion and harvest quality by improving the efficiency of plant nutrient uptake (Jayadi, et al., 2025; Huda et al., 2026).

Fruit Weight per Plot (g)

The analysis of variance showed that golden apple snail LOF had a significant effect on fruit weight per plot, while Biosaka application and the combination of the two had no significant effect. Fruit weight per plot resulting from the golden apple snail and Biosaka treatments can be seen in Table 5.

The M_3 treatment (112.5 ml/l) produced the heaviest fruit weight per plot, at 23,163 g, significantly higher than that produced by M_2 (75 ml/l), because the nutrients required for optimal plant growth were met at that concentration. This optimal growth is supported by the availability of nutrients, particularly phosphorus, which stimulates the initiation and elongation of primary roots as well as the branching of lateral roots to maximize the uptake of nutrients and soil water (Ma et al., 2021; Fathi & Afra, 2023). Adequate soil phosphorus availability serves as a vital pillar of metabolism, from early root formation through to successful flowering and optimal fruit ripening (Chen et al., 2023).

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Table 5. Fruit Weight per Plot under Golden Snail LOF and Biosaka Treatments at 8 WAP

Golden Apple Snail LOF (ml/l)	Biosaka (ml/l)				Average
	B_0 (Control)	B_1 (15 ml/l)	B_2 (30 ml/l)	B_3 (45 ml/l)	
	……(g)……				
M_0 (Kontrol)	8,191	7,927	7,815	9,047	8,245d
M_1 (37.5 ml/l)	9,621	14,045	12,555	14,200	12,603c
M_2 (75 ml/l)	13,912	15,861	15,144	19,476	16,098b
M_3 (112.5 ml/l)	18,791	22,252	29,248	22,360	23,163a
Average	12,629	15,021	16,190	16,271	

Note: Numbers followed by different letters in the same column are significantly different according to the 5% DMRT test

Nitrogen helps form vegetative tissue that supports photosynthesis, while phosphorus and potassium play a role in flowering, fruit enlargement, and filling of the fruit flesh; this is consistent with findings reporting that the application of biologically based liquid organic fertilizer increases enzymatic activity and photosynthate translocation in Cucumis melo. The potassium content in liquid organic fertilizer can accelerate fruit filling and increase the generative yield ratio in horticultural plants. An optimal LOF dose (100 ml/l water) produced the best results for fruit number, fruit weight, and other yield parameters (Warisa et al., 2022; Afrendi, 2024).

Liquid organic fertilizer at a concentration of 80-120 ml/l applied to honey pumpkin (Cucurbita moschata) was able to increase fruit weight per plant through improved nutrient uptake and soil microorganism activity. This result reinforces the finding that golden apple snail LOF at high doses continues to produce a positive response without causing saturation or a decline in yield. This LOF plays a role in supplying the organic nutrients required by the plan (Munar et al., 2018). LOF application to cucumber and cucumber generally increased the number of fruits, fruit weight, and harvest yield compared with no LOF application (Warisa et al., 2022; Afrendi, 2024). From an agronomic perspective, the increase in cucumber fruit weight resulting from golden apple snail LOF application can also be linked to the role of organic fertilizer in improving soil structure and increasing microorganism activity. A comparison shows that cucumber fruits appear larger when the highest concentration of golden apple snail LOF (112.5 ml/l) is applied together with Biosaka (Figure 5).

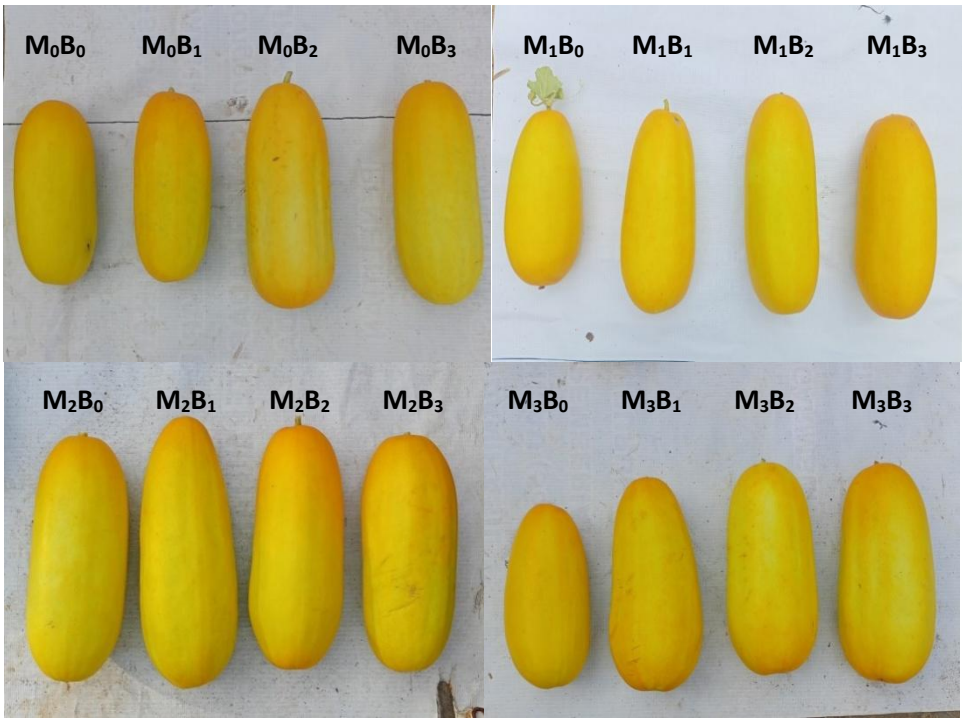


Figure 5. Comparison Showing the Relationship between Fruit Weight per Plot and Biosaka Treatment

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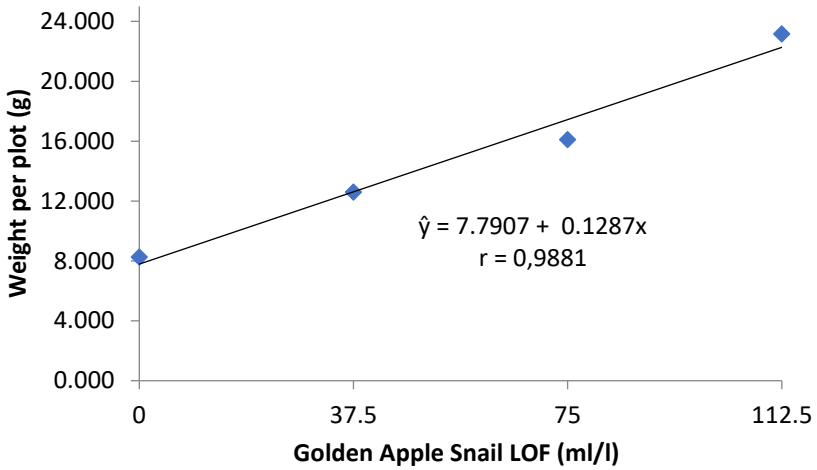


Figure 6. Relationship between Fruit Weight per Plot and Golden Snail LOF Treatment at 8 WAP

It can be seen that fruit weight per plot with golden apple snail LOF application showed a positive linear relationship, with the regression equation ŷ = 7,7907 + 0.1287x and a correlation of 98.81%, meaning that the mean fruit weight per plot at tbaihe first to fourth harvest was 7,7907 g and increased by 0.1287 times for each increase in golden apple snail LOF dose, with a correlation between golden apple snail LOF and fruit weight per plot of 98.81%.

From this equation, it can be seen that cucumber fruit weight increases more rapidly with the application of a balanced fertilizer that meets the plant's nutrient needs. The more complete the available nutrients, the more optimally the plant's physiological and morphological processes proceed. Fruit growth is highly dependent on nitrogen, phosphorus, and potassium, each of which plays an important role in protein and cell formation as well as flower and fruit development, and also emphasizes the role of macro- and micronutrients in influencing overall plant weight (Bai et al., 2021; Zewide & Melash, 2021).

CONCLUSION

Golden apple snail liquid organic fertilizer (LOF) significantly affected yield components, including the number of fruits per plant, fruit weight per plant, and fruit weight per plot. The best results were obtained at the highest concentration, M_3 (112.5 ml/l), producing 13.50 fruits per plant, 3,290 g fruit weight per plant, and 23,163 g per plot. Biosaka significantly affected leaf chlorophyll content and fruit weight per plant, but not the number of fruits, fruit weight per plot, runner length, leaf area, or flowering age. Chlorophyll content peaked at 30 ml/l (optimum approximately 27 ml/l), while fruit weight per plant was highest at 45 ml/l (2,594 g). No significant interaction occurred between the two factors, indicating independent effects. However, combining M_3 with B_2 or B_3 tended to yield the highest values for several parameters, suggesting a synergy that was not statistically significant.

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