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Effect of Fish Amino Acid (FAA) Organic Fertilizer on Growth Performance of *Brassica rapa* L. cv. Pak Choi in a Hydroponic NFT System

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Abstract: This study aimed to evaluate the effect of organic fertilizer Fish Amino Acid (FAA) on the growth of *Brassica rapa* L. cv. Pak Choi cultivated under a hydroponic Nutrient Film Technique (NFT) system. FAA was produced through the fermentation of mackerel fish waste with molasses and applied to one experimental plot, while the control group received no FAA. The growth parameters measured included plant height and leaf width over six weeks. The results revealed that FAA-treated plants showed significantly higher growth rates, with average final plant height and leaf width reaching 11.0 cm and 14.2 cm, respectively, compared to 5.7 cm and 6.4 cm in the control group. This suggests that FAA can enhance vegetative growth performance in hydroponic systems and serve as a sustainable organic alternative to synthetic fertilizers. The adoption of FAA may contribute to improved crop yields and environmentally friendly agricultural practices.

Keywords: Fish Amino Acid (FAA), hydroponics, Brassica rapa, NFT system, organic fertilizer, sustainable agriculture

1. Introduction

Urban agriculture has gained significant momentum in Malaysia due to increasing concerns over food security, rising urban populations, and the need for self-sufficiency in food production (Ali et al., 2021). As arable land becomes increasingly scarce in urban areas, innovative approaches such as hydroponics are being adopted to maximize yield per unit area and reduce environmental footprints. At the same time, the escalating global demand for sustainable agricultural practices has catalyzed a shift toward organic and environmentally friendly inputs that can reduce dependence on chemical fertilizers and mitigate soil and water pollution (Rahman et al., 2020; FAO, 2021).

Among various organic inputs, Fish Amino Acid (FAA), a liquid organic fertilizer derived from the fermentation of fish waste with molasses, has emerged as a promising biofertilizer. It is rich in amino acids, peptides, and essential micronutrients, which are crucial for plant development. Several studies have shown that FAA can enhance chlorophyll synthesis, promote vegetative growth, and improve plants' resilience to abiotic stresses such as salinity and drought (Lee et al., 2020; Wahyuni et al., 2021). The utilization of FAA not only supports crop productivity but also contributes to waste valorization in fisheries, aligning with circular economy principles and sustainable agricultural goals (Nguyen et al., 2019).

Hydroponic cultivation systems, particularly the Nutrient Film Technique (NFT), are gaining popularity due to their efficient use of water and nutrients and suitability for vertical and urban farming setups (Resh, 2022). Integrating organic fertilizers such as FAA into hydroponic systems represents a convergence of sustainable waste management and innovative food production. Although chemical nutrient solutions dominate current hydroponic practices, emerging evidence suggests that liquid organic fertilizers can serve as viable alternatives, supporting plant growth and yield comparable to that achieved with inorganic nutrient sources (Zhao et al., 2021; Mahmud et al., 2023).

Brassica rapa L. cv. Pak Choi, commonly referred to as Pak Choi or bok choy, is a fast-growing leafy vegetable prized for its nutritional value, especially in Asian diets. It is frequently grown in hydroponic systems due to its adaptability and short harvest cycle. However, despite the growing interest in organic hydroponics, the application of organic nutrient sources like FAA in Pak Choi cultivation remains underexplored. Notably, a recent comparative study found that bok choy grown with organic nutrient solutions exhibited comparable growth performance and biomass

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accumulation to those cultivated with synthetic fertilizers, suggesting the feasibility of organic alternatives in controlled environment agriculture (Tan et al., 2022).

This study aims to evaluate the effects of FAA on the growth performance of Pak Choi cultivated in a hydroponic NFT system. By assessing parameters such as plant height and leaf width, the research seeks to determine the viability of FAA as an organic nutrient solution in soilless cultivation, contributing to sustainable agricultural practices.

2. Materials and Methods

2.1 Experimental Site and Design

The study was conducted at the Horticulture Unit, Kolej Vokasional Pertanian Teluk Intan, Perak, Malaysia, using a simple randomized design with two treatments: (1) hydroponic NFT system with FAA supplementation and (2) control without FAA. Each treatment included 10 Pak Choi plants.

2.2 Preparation of Fish Amino Acid (FAA)

FAA was prepared using mackerel fish waste and molasses (red sugar) in a 1:1 ratio (w/w). The fish was chopped and mixed with molasses, placed into a sealed container with a paper lid, and fermented in a shaded area for two weeks. After fermentation, the liquid was filtered and stored for application.

2.3 Planting and Hydroponic Setup

Seeds of Pak Choi were germinated in a peatmoss medium for 7 days until seedlings developed 3–4 leaves. Seedlings were then transferred into net pots filled with coconut coir and placed into hydroponic NFT channels. The FAA-treated group received 30 mL of FAA per 75 L of water, with gradual increases to 60 mL in later weeks. The pH and EC levels were monitored and maintained at 6.0 and 1.5 mS/cm, respectively.

2.4 Growth Measurements

Plant height and leaf width were recorded weekly from Week 5 to Week 10 post-transplant. Measurements were made using a ruler from the base to the apex (height) and the widest part of the leaf (width). Data were tabulated and analyzed descriptively.

3. Results

3.1 Plant Height

Figure 1 illustrates the average plant height of Pak Choi over six weeks for both FAA-treated and control groups. Initially, both groups exhibited similar heights, but significant differences began emerging from Week 7 onward. By Week 10, FAA-treated plants reached an average height of 11.0 cm, nearly double that of the control group at 5.7 cm. The most pronounced growth occurred between Weeks 9 and 10, indicating a cumulative effect of FAA application. These results suggest that FAA significantly enhances vegetative elongation compared to non-treated plants.

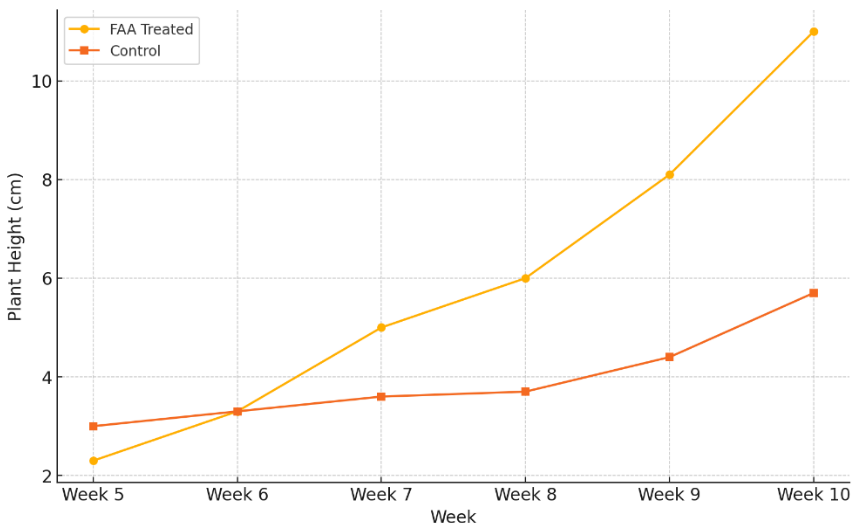

Fig. 1: Comparison of plant height (cm) over six weeks between FAA-treated and control groups.

3.2 Leaf Width

Figure 2 presents the weekly average leaf width of Pak Choi. As with height, FAA-treated plants outperformed the control group throughout the trial period. Leaf width in the FAA group rose from 2.8 cm in Week 5 to 14.2 cm in Week 10, whereas the control group reached only 6.4 cm. The sharp increase in the FAA group between Weeks 9 and 10 highlights FAA's impact during peak vegetative development, further supporting its role in promoting vigorous leaf expansion.

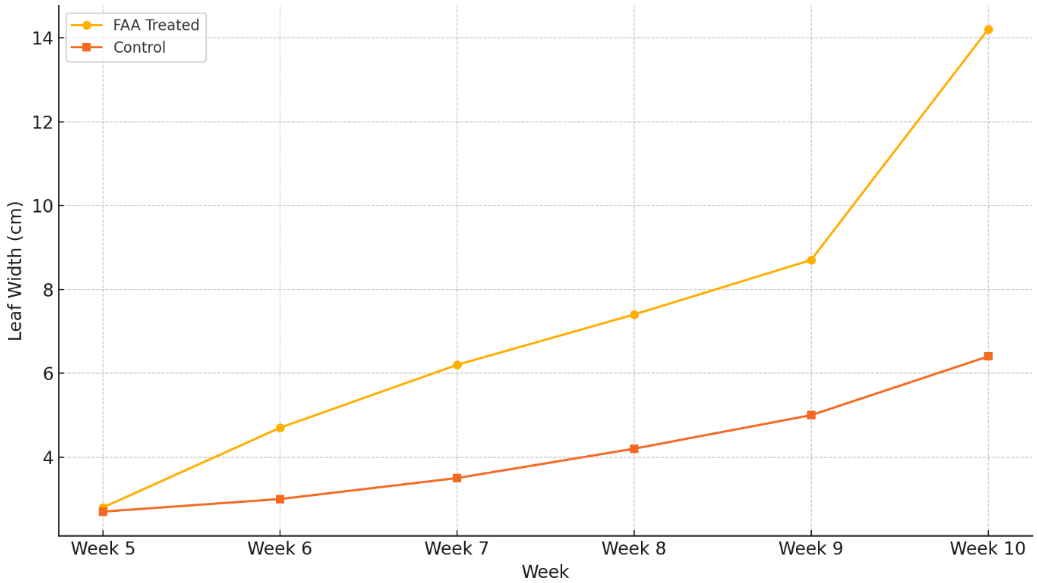

Fig. 2: Comparison of leaf width (cm) over six weeks between FAA-treated and control groups.

4. Discussion

The findings of this study clearly underscore the positive influence of Fish Amino Acid (FAA) on the vegetative growth performance of *Brassica rapa* L. cv. Pak Choi cultivated within a hydroponic Nutrient Film Technique (NFT) system. Plants treated with FAA exhibited significantly greater plant height and leaf width compared to untreated controls, highlighting FAA's efficacy as an organic input suitable for soilless leafy vegetable production. These enhancements can be directly associated with the rich composition of amino acids and micronutrients in FAA, which are known to stimulate plant growth through various physiological mechanisms. Amino acids serve not only as building blocks for protein synthesis but also act as signaling molecules, promoting nitrogen metabolism, enzymatic activity, and photosynthetic efficiency (Souri & Hatamian, 2019).

In addition to direct nutritional contributions, FAA has been reported to support microbial proliferation in the rhizosphere, especially in organic systems. Enhanced microbial activity aids in nutrient solubilization and uptake, contributing to improved plant vigor and health (Zhang et al., 2022). In the present study, growth improvements in FAA-treated Pak Choi became particularly pronounced starting from Week 7, indicating a cumulative or slow-release effect of FAA components that may sustain prolonged vegetative development. This delayed but consistent enhancement is especially beneficial in longer growth cycles, where sustained nutrient availability is critical.

The integration of FAA into the hydroponic NFT system aligns with emerging evidence that organic liquid fertilizers can be effectively utilized in controlled environment agriculture (CEA). Hosseinzadeh et al. (2021) demonstrated that when applied at optimal concentrations, organic extracts such as FAA do not destabilize the nutrient solution and are capable of supporting comparable growth to inorganic fertilizers in hydroponic setups. This compatibility is particularly relevant for urban agriculture, where nutrient management must be precise, efficient, and sustainable.

Conventional hydroponic systems often rely on synthetic nutrient solutions due to their rapid solubility and predictable uptake. However, their long-term use contributes to environmental degradation, including nutrient runoff, soil degradation, and chemical accumulation in water bodies (Pathak et al., 2020). In contrast, FAA represents a low-impact alternative, aligning with the principles of the circular economy by repurposing fishery waste into valuable agricultural input. Its biodegradability and reduced carbon footprint make it a promising candidate for sustainable urban farming, particularly as it also reduces production costs and promotes local resource utilization (Yuan et al., 2023).

The significant improvements in vegetative traits observed in this study namely plant height and leaf width are agronomically relevant, as they often correlate with increased marketable yield, especially for leafy vegetables like Pak Choi. Furthermore, the local production potential of FAA using fishery by-products makes it economically viable for small-scale and commercial growers alike. Its adoption may also cater to the growing consumer demand for organic, chemical-free produce, which is increasingly preferred for health and environmental reasons (Yuan et al., 2023).

Despite the promising outcomes, several limitations warrant further investigation. This study focused solely on vegetative parameters and did not assess the nutritional or phytochemical quality of harvested leaves. Future research should evaluate biochemical markers such as chlorophyll content, vitamin levels, antioxidant capacity, and nitrate accumulation to determine whether FAA also enhances produce quality. Additionally, investigations into the microbial dynamics of the nutrient solution could elucidate how FAA modulates the hydroponic microbiome, potentially contributing to plant–microbe symbioses. Lastly, optimizing FAA dosage, application frequency, and compatibility with other organic nutrient sources will be crucial to scaling up this approach for commercial hydroponic production systems.

5. Conclusion

Based on the findings of this study, the application of Fish Amino Acid (FAA) as an organic fertilizer significantly enhanced the vegetative growth of *Brassica rapa* L. cv. Pak Choi cultivated in a hydroponic Nutrient Film Technique (NFT) system. FAA-treated plants demonstrated greater plant height and broader leaf width compared to untreated controls, indicating its effectiveness in promoting robust and healthy growth. The results support the potential of FAA as a sustainable and low-cost alternative to synthetic fertilizers in hydroponic farming, contributing to environmentally friendly agricultural practices and improved crop productivity.

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Conflict of Interest
The authors declare no conflicts of interest.

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