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RESEARCH ARTICLE

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Lactuca sativa L. Growth in DFT Hydroponic System

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Abstract

The cultivation of lettuce (*Lactuca sativa* L.) in hydroponic farming aims to replace the conventional nutrient source, AB mix, with an organic fertilizer known as Jakaba. Hydroponic cultivation is a soilless farming method in which plants receive nutrients through a solution. The objective is to reduce reliance on chemical fertilizers in AB mix, which are often inconsistent and costly. This study utilized a Deep Flow Technique (DFT) hydroponic system with a completely randomized design. The results indicate that applying Jakaba at 20 ml/L and 30 ml/L did not fully replicate the effects of AB mix on lettuce leaf size. However, the Jakaba treatment resulted in a greater number of leaves compared to the AB mix. Therefore, while Jakaba can enhance leaf number development, it does not achieve the same leaf length and width as AB mix. Further research is needed to comprehensively understand Jakaba's impact on lettuce growth and development in hydroponic systems. Additionally, the nutrient quality of Jakaba and its optimal dosage require careful evaluation.

Keywords: Growth, Leaves, Lettuce, Nutrients, Organic Farming

1. Introduction

Significant market demand for lettuce is a key factor driving its economic value. Land constraints are one of the factors affecting lettuce production. Land conversion to residential, industrial, or infrastructure areas significantly reduces growing space. Lettuce consumption is increasing in urban areas as people become more aware of adopting a healthy lifestyle by consuming vegetables. Lettuce is an excellent source of vitamins, minerals, and dietary fiber, while remaining low in calories (Muttaqin *et al.*, 2025).

Consuming lettuce fresh, without prior processing, requires cultivation methods that avoid harmful chemicals to human health. Harmful practices in lettuce cultivation include the use of chemical pesticides, unhygienic conditions, and the use of nutrients derived from manufactured chemicals.

Hydroponic farming offers a potential solution to these challenges. Its ability to be grown vertically or in terraced patterns means it has the potential to be used in limited areas to improve land utilization while maintaining high population density.

The effectiveness of hydroponic farming depends on nutrient availability. Nutrient availability affects plant growth and production. Hydroponic systems typically use AB mix as a nutrient source, consisting of A and B stocks. Each stock contains macro and micronutrients. AB mix production still relies on inorganic fertilizers produced in factories. The use of chemical fertilizers makes hydroponic cultivation difficult because they are not always available locally, and their prices continue to soar. As a result, hydroponic cultivation requires a larger capital investment (Ribeiro *et al*, 2020).

The use of organic fertilizers in hydroponic cultivation can overcome the problem of AB mix availability. Research using Jakaba has never been conducted in hydroponic systems. Jakaba is one of the organic fertilizers that can be used for hydroponic nutrition. Jakaba is a homemade liquid organic fertilizer. It symbolizes eternal luck-bringing mushrooms and is shaped like brown coral, with a crunchy texture that makes it easy to break. Jakaba consists of a shell and liquid. This liquid is used as a liquid organic fertilizer. Many organic materials make up Jakaba. Jakaba has several functions in the agricultural sector, including as a source of nutrition, providing growth regulators, and preventing plants from fusarium attacks (Verma *et al*, 2022), (Ramadita *et al.*, 2024),.

Jakaba will act as a substitute for AB-mix nutrients in providing nutrients to plants. The use of Jakaba in

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hydroponics aims to promote sustainable organic plant cultivation and is free of chemical inputs (Meliza et al., 2025). The impact of the Jakaba application on lettuce in a hydroponic system must be closely monitored. This study aims to evaluate the efficacy of Jakaba and its effect on lettuce plant growth.

2. Material and Methods

This research was conducted in the Hydroponic Area of the Payakumbuh State Agricultural Polytechnic with coordinates $0^{0}10'9.394''$ S $100^{0}39'52.855''$ E, with an altitude of 540 meters above sea level. This research used a completely randomized design with six replications. This study aimed to analyze the effects of various nutrients on lettuce plant growth in a hydroponic system. The treatments given included:

1. Apply 5 ml AB-Mix per liter.
2. Apply Jakaba with a concentration of 20 ml per liter.
3. Administration of Jakaba with a concentration of 30 ml per liter.

Observations of lettuce plant growth, including length, width, and number of leaves, were recorded when the plants were 4 weeks old after transplanting. Statistical analysis was performed using one-way analysis of variance (ANOVA), and data were processed using a significant difference test based on the F test. If the calculated F value for the treatment is greater than the F Table value at the 5% level, a further Duncan's New Multiple Range Test (DNMRT) test will be carried out at a significance level of 5%. Statistical analysis used the SPSS 16.0 application.

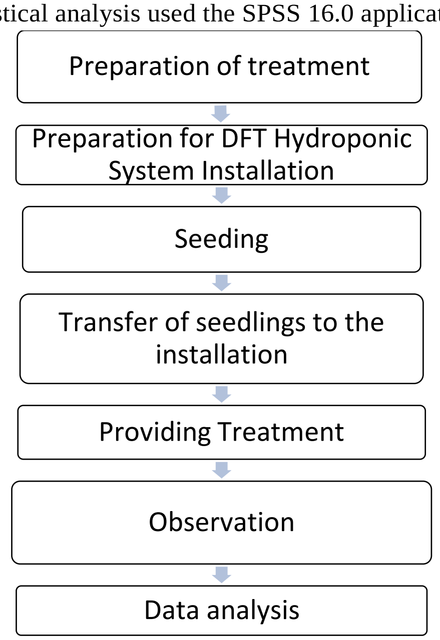

Figure 1. Research Implementation Flowchart

3. Results and Discussion

3.1. Leaf Length

The results of the Duncan Multiple Range Test (DMRT) analysis for leaf length parameters at the observation age of 4 MSPT are presented in Table 1.

Table 1. Average Leaf Length of Lettuce Plants Aged 4 MSPT.

No	Treatment	Average
1	5 ml AB-Mix/L	**13.29 ± 0.13 b**
2	Jakaba with a concentration of 20 ml/l	**11.45 ± 1.01 a**
3	Jakaba with a concentration of 30 ml/l	**11.41 ± 0.99 a**

Note: numbers accompanied by the same letter indicate no significant difference based on the 5% DMRT test.

The leaf length observation parameters presented in Table 1 show significantly different results in the planting treatments at the age of 4 MSPT. At the age of 4 MSPT, the observation results showed that lettuce plants in the 5 ml AB-mix treatment had the highest average leaf length of 13.29 cm, which was significantly greater than the average leaf length in the 20 ml/l Jakaba POC treatment, which was only 11.45 cm. The average leaf length in the 20 ml/l Jakaba POC treatment was not significantly different from that in the 30 ml/l Jakaba treatment, which had an average leaf length of 11.41 cm. Leaf length indicates cell division and enlargement in plants that receive nutrients through root absorption.

Leaf length observations are influenced by the nutrients provided. Lettuce plants require a lot of nitrogen for optimal growth. Nitrogen deficiency causes stunted stem and leaf growth by inhibiting cell division and enlargement, resulting in yellowing leaves and reduced chlorophyll content. Symptoms of nutrient deficiency in plants can be observed through changes in leaf color, size, and morphology.

Nutrient deficiencies in the plant cause this symptom. Differences in lettuce leaf length are caused by the nutrient content provided; higher or lower nutrient levels will affect plant growth. Proper nutrient levels that meet plant needs will aid plant growth and development. Liquid organic fertilizer has a lower effect on lettuce leaf length than AB mix (Khodijah & Kusmiadi, 2021). AB Mix, which contains complete macro- and micro-nutrients, including nitrogen (N) and phosphorus (P), plays an important role in leaf length growth. The nutrient content in jakaba is insufficient to meet plant needs, resulting in shorter leaf length in the jakaba treatment compared to the AB mix treatment. The results of this study corroborate previous similar studies (Marta *et al.*, 2023) and (Meliza *et al.*, 2025).

Nitrogen is an essential element in plant metabolism because it is involved in the synthesis of amino acids, proteins, and chlorophyll. Amino acids and proteins are key components in the growth and development of plant cells, while chlorophyll is an important pigment involved in photosynthesis. Adequate nitrogen availability supports efficient protein synthesis, which, in turn, can accelerate cell division, elongation, and new cell formation. These processes are crucial for plant growth, including the formation of leaves, stems, and roots. Plants require large amounts of nitrogen, and adequate nitrogen availability can promote good plant growth.

Phosphorus also plays a vital role in several plant biochemical processes, including energy transfer, photosynthesis, and nutrient transfer. Phosphorus is a key component of the ATP (adenosine triphosphate) molecule, which is the primary source of chemical energy in plant cells. Phosphorus is also essential for photosynthesis, as it plays a role in energy transfer and the formation of DNA and RNA. Adequate phosphorus availability allows plants to maximize their photosynthetic and growth potential. (Coleto *et al.*, 2023) .

Without sufficient phosphorus, plants can experience slow growth and stunted development. Therefore, AB Mix, rich in nitrogen and phosphorus, along with other macro and micronutrients, is effective in maximizing leaf length growth in lettuce plants.

3.2. Leaf Width

The results of the Duncan Multiple Range Test (DMRT) for leaf width parameters at 4 MSPT can be seen in Table 2.

Table 2. Average leaf width of lettuce plants at 4 MSPT.

No	Treatment	Average
1	5 ml AB-Mix/L	**11.08 ± 0.73 b**
2	Jakaba with a concentration of 20 ml/l	**7 ± 1.16 a**
3	Jakaba with a concentration of 30 ml/l	**6.4 ± 0.56 a**

Note: numbers accompanied by the same letter indicate no significant difference based on the 5% DMRT test.

The leaf width observation parameters are shown in Table 2, which shows significant differences among the treatment groups at 4 MSPT. At the age of 4 MSPT, the results of lettuce leaf width measurements showed the highest average value in the 5 ml AB-mix treatment, namely 11.08 cm. This is significantly different from the 20 ml/L Jakaba POC treatment, which recorded a value of 7 cm. However, the 20 ml/L Jakaba POC treatment was not significantly different from the 30 ml/L Jakaba treatment, which recorded a value of 6.4 cm.

The observations in Table 2 show that lettuce leaf width depends on the nutrient treatment. The 5 ml AB Mix treatment produced the widest average leaf width, possibly due to AB Mix's more complete nutrient composition, particularly its high nitrogen (N) content, which is crucial for rapid leaf growth.

Nitrogen (N) is an essential nutrient required by plants, particularly for photosynthesis. This process produces energy and organic matter necessary for plant growth, including leaf growth. Increasing the availability of this nutrient can enhance plant growth and development. Nutrient-rich solutions, such as AB Mix 5ml, can significantly increase plant nutrient uptake. This allows plants to absorb more nutrients needed for optimal leaf growth, including leaf width. Meeting plant nutrient needs is a key aspect of good plant growth. Therefore, selecting appropriate nutrients and closely monitoring plant conditions can help improve lettuce yields and quality (Li et al., 2019).

Nutrient availability, especially nitrogen, is crucial for efficient photosynthesis. Plants require nitrogen to build essential components such as chlorophyll, proteins, and amino acids, which are essential for photosynthesis. Nutrient solutions, such as AB Mix, can be a good source of nutrients for plants. Applying a nutrient-rich solution at the correct concentration can increase nutrient uptake by plants, thereby supporting leaf and overall plant growth. Nutrient availability to plants is crucial for optimal growth. This can impact leaf size and quality, as well as overall crop yield.

3.3. Number of Leaves

The observation parameter, the number of leaves, showed significantly different results at the age of 4 MSPT. At the same age, the study also showed that the highest average number of leaves was observed in the treatment with 20 ml/L Jakaba POC, with a value of 6.13. This value was significantly higher than the treatment using 30 ml/L Jakaba POC (5.37) and the treatment using 5 ml/L AB mix nutrients (5.37). The results of the Duncan Multiple Range Test (DMRT) for the number of leaves parameter at the age of 4 MSPT are shown in Table 3.

Table 3. Average number of lettuce leaves at 4 MSPT.

No	Treatment	Average
1	5 ml AB-Mix/L	**4.25 ± 0.41 c**
2	Jakaba with a concentration of 20 ml/l	**6.13 ± 0.84 a**
3	Jakaba with a concentration of 30 ml/l	**5.37 ± 0.37 b**

Note: numbers accompanied by the same letter indicate no significant difference based on the 5% DMRT test.

Table 3 shows that nutrient treatments significantly affected leaf number across all lettuce plant ages. Providing plants with adequate nutrients, such as nitrogen (N), is crucial, as demonstrated by the AB Mix nutrient treatment.

The number of leaves on the jakaba is not accompanied by leaf length and width. The length and width of leaves given jakaba are smaller than those given AB-mix. The relationship between leaf number, leaf length, and leaf width in lettuce plants is an indicator of plant health and growth. Adequate nutrient availability, especially nitrogen, can increase the number and size of lettuce leaves, ultimately affecting crop yields and plant productivity.

Plant growth is influenced by genetics and environmental factors. One such environmental factor is nutrient availability. If nutrients are available in sufficient and balanced quantities, plants will thrive. Meanwhile, in lettuce plants, leaf number is influenced by pest attacks, nutrient content, aeration treatment, and root drainage. The number of leaves in lettuce plants is an indicator of nutrient availability. Leaf growth can be influenced by the high nutrient requirements of inorganic fertilizers, which can affect photosynthesis. Photosynthesis in plants requires the nutrient N.

Photosynthetic results evidence this, as these elements are used to produce food and energy reserves, as well as to facilitate cell division and differentiation. The availability of adequate and balanced nutrients is crucial for proper growth (Meliza et al., 2025). These processes are closely related to the growth of plant organs, such as the increase in leaf number (Li *et al.*, 2019).

Leaf growth and development are influenced by internal factors that can be influenced by humans, namely, nutritional engineering, such as plant nutrition. Providing nitrogen at the right concentration will increase plant growth, metabolism, and the formation of proteins and carbohydrates, resulting in increased plant growth and production (Koo et al., 2016).

Nitrogen deficiency will prevent plants from growing optimally. In contrast, excess nitrogen produces soft/weak and vegetative young shoots, acidifies soil pH, and is detrimental to plants because it binds other nutrients, making them difficult for plants to absorb and reducing the effectiveness and efficiency of fertilization. Nutrients, especially nitrogen, play an important role in photosynthesis (Peiro et al., 2020).

Photosynthesis is a vital process by which plants produce the food and energy necessary for growth and development. Nitrogen is used in the production of food reserves and energy, as well as cell division and differentiation, all of which contribute to the growth of leaves and other plant organs.

Nutrients are essential for plants, especially during the vegetative phase. Jakaba contains a high level of carbohydrates, which in large quantities also aid in the formation of growth hormones such as auxin, gibberellin, and alanine. Jakaba contains carbohydrates in the form of starch, vitamins, minerals, and various proteins, which aid in the formation of growth hormones such as auxin, gibberellin, and alanine, which can stimulate leaf bud growth and transport nutrients to the most important cells in the leaves and stems. (Mutalib *et al.*, 2021; Meliza *et al.*, 2025) Jakaba contains 0.40% Nitrogen, 0.10% Phosphorus, and 0.06% Potassium, so that by giving jakaba, it can stimulate plant growth because the nutrient content is complete and directly absorbed by plants compared to the use of control fertilizers tested (Apriyanto, Fedri Ibnusina, 2023), (Ramadita *et al.*, 2024).

4. Conclusion

This study shows a significant relationship among leaf length, leaf width, and the number of leaves at the age of 4 MSPT. The provision of 5 ml/L AB mix in the results of the analysis of lettuce leaf width and length was significantly different from the treatment of adding jakaba at concentrations of 20 ml/L and 30 ml/L. In the number of leaves observation, it was found that the application of jakaba at concentrations of 20 ml/L and 30 ml/L produced a greater number of leaves than the AB mix. To support the growth of leaf size, both length and width of the leaf, with the provision of AB mix, are the best treatments in this study. In comparison, the best treatment for the number of leaves was the provision of jakaba at concentrations of 20 ml/L and 30 ml/L, which can replace the role of 5 ml/L AB Mix on this parameter.

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