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The Effect of Combination of Nutrition on Growth and Yield of Water Spinach Plants in NFT Hydroponic System

Kirana Ceri Fortuna, Darwin Pangaribuan*, Sri Ramadiana, and R.A. Diana Widyastuti
Program Studi Agronomi, Fakultas Pertanian Universitas Lampung, Indonesia

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*Corresponding author:
E-mail:
darwin.pangaribuan@fp.unila.ac.id

ABSTRACT

A hydroponic system is a technique for growing plants without soil, utilizing water combined with nutrients as a replacement for soil. The purpose of this research was to determine the most effective combination of treatments between AB – Mix with liquid organic fertilizer (LOF) shrimp waste extract, LOF chicken manure extract, and eco-enzyme solution in supporting the growth of water spinach plants in the NFT hydroponic system. This research applied a Randomized Block Design with four types of treatments: AB – Mix 100% as a control, AB – Mix 75% + 15% shrimp waste extract + 10% chicken manure extract + 0 ml/l eco enzyme solution, AB – Mix 75% + 15% shrimp waste extract + 10% chicken manure extract + 1 ml/l eco enzyme solution, AB – Mix 75% + 15% shrimp waste extract + 10% chicken manure extract + 2 ml/l eco enzyme solution.. The results showed that the combination of AB-Mix with shrimp waste extract, chicken manure extract, and eco-enzyme produced the best results for hydroponic water spinach plants. This study showed the potential of using organic waste as an alternative nutrient from the treatment of AB-Mix 75% + 15% shrimp waste extract + 10% chicken manure extract + 0 ml/l eco-enzyme solution, AB-Mix 75% + 15% shrimp waste extract + 10% chicken manure extract + 1 ml/l eco-enzyme solution, and AB-Mix 75% + 15% shrimp waste extract + 10% chicken manure extract + 2 ml/l eco-enzyme solution gave the best results for hydroponic water spinach plants. This study shows the potential for using organic waste as an alternative source of nutrients.

INTRODUCTION

The current population increase has resulted in more settlements taking over agricultural land. Meanwhile, demand for agricultural products is increasing (Natalia et al., 2017). This conversion of agricultural land necessitates the development of agricultural technologies or systems that can increase crop yields in limited areas. Roidah (2014) explains that hydroponics is a technology that can be used to cultivate plants in limited areas.

One type of hydroponic system often used for growing vegetables is the NFT system. The NFT system is a hydroponic method that pumps nutrients to plants through a very fine water flow, allowing plant roots to develop by coming into direct contact with a thin layer of flowing nutrients. The NFT system is designed to reduce agricultural land use, systematize

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water use through continuous circulation, and ensure that plant nutrients are well maintained for optimal plant growth and development. Place plant seedlings in a nutrient solution supplied regularly by a pump, allowing roots to grow and develop in the existing nutrient solution (Singgih et al., 2019).

A hydroponic system is a method of cultivating plants without using soil, but instead using water and the addition of nutrients as a substitute for soil (Pangaribuan et al., 2022). Nutrients in hydroponics play a crucial role in meeting the plant's needs for optimal growth and development. AB-Mix is a fertilizer that can be used as a nutrient solution in hydroponic methods. This fertilizer consists of two components: Stock A containing macronutrients and Stock B containing micronutrients (Nugraha and Susila, 2015).

AB-Mix is a type of fertilizer often used in hydroponic farming. This is because AB-Mix contains complete nutrients. However, AB-Mix nutrients also have the disadvantage of being made from synthetic chemicals and are not very cost-effective. Therefore, it is necessary to find alternative nutrient sources that can boost plant growth and development. One option that can be considered is the use of liquid organic fertilizer (LOF) (Hambali et al., 2018). Pradita and Koesriharti (2019) explain that the efficient use of inorganic fertilizers can be achieved by using LOF. The addition of LOF is useful as an alternative supplier of nutrients, especially macronutrients, as well as other nutrients such as micronutrients, amino acids, growth hormones, and microbes. This can stimulate plant growth.

The plant cultivated using the hydroponic system in this study was land spinach. Water spinach is a plant belonging to the Convolvulaceae family. Water spinach can be categorized as a vegetable. This vegetable can grow well in the yard. Water spinach consists of three types: water spinach (*Ipomea aquatica*), land spinach (*Ipomea reptans*), and forest spinach (*Ipomea crassiculatus*) (Putri et al., 2019). Based on the information above, the objective of this study was to determine the best treatment combination between AB-Mix with shrimp waste extract LOF chicken manure extract LOF and eco-enzyme solution in supporting the growth of water spinach in the NFT hydroponic system.

MATERIALS AND METHODS

This research was conducted from February 2025 – March 2025 in the Field Garden, Kota Sepang Jaya Village, Labuhan Ratu District, Bandar Lampung City. The tools used consisted of plastic tubs, net pots, rockwool, flannel, PVC pipes, water hoses, drums, 1.5 L plastic bottles, buckets, plastic trays, styrofoam, spoons, knives, scales, calipers, measuring cups, TDS (Total Dissolved Solid), SPAD (Soil Plant Analysis Development), pH meters, rulers, and labels. The materials used in this study were water spinach seeds, water, AB – Mix, shrimp waste extract, chicken manure extract, and eco enzyme solution.

The treatments were arranged in a Randomized Block Design involving 4 treatments and 6 replications resulting in a total of 24 experimental units. Each experimental unit had 6 holes, creating 144 plant populations. From the data, a homogeneity test was performed using the Bartlett test and an additivity test was performed using the Tukey test. After both requirements were met, an F test (analysis of variance) was then carried out and continued with the separation of the mean values using the Least Significant Difference (LSD) test at the 5% level.

The variables observed in this study included (1) plant height, measured from the bottom of the stem to the tip of the leaf using a ruler, (2) number of leaves, counted manually on each plant sampled, (3) length of leaf stalk, measured from the bottom to the tip of the stalk using a ruler, (4) wet weight of the plant, weighed entirely using a digital scale, (5) dry weight of the plant, dried in an oven at 80°C for 3 days until the weight was stable, (6) maximum root length, measured from the root neck or the point where the root emerges to the tip of the longest root using a ruler, (7) level of leaf greenness, by placing the SPAD tool at three points on the leaf, namely the bottom, middle, and top, (8) number of stomata,

observed using a microscope, taking 1 sample from each treatment, (9) stomatal density, calculated using the formula number of stomata/area of field of view

RESULTS AND DISCUSSION

Analysis of variance on the variables of plant height, number of leaves, and length of leaf stalks of water spinach in treatment P0 showed no significant difference from treatment P1, but showed a significant difference from treatments P2 and P3 (Table 1). This occurs because the nutrient levels in treatments P2 and P3 are higher compared to treatments P0 and P1. Plant growth is greatly influenced by the presence of nutrients, especially nitrogen. Sumiati et al (2023) explained that nitrogen nutrients play a role in chlorophyll synthesis. Therefore, the more chlorophyll in plants, the more photosynthesis process can be increased and produce plant growth, such as plant height, number of leaves, and length of leaf stalks. In addition to the nitrogen nutrient content, the difference between the two treatments is the addition of eco-enzyme. Providing eco-enzyme to plants can increase plant growth because it functions as a bio-stimulant that can help plant growth.

Providing eco-enzyme to plants can increase plant growth because it functions as a biostimulant that can help plant growth. Eco-enzyme enhances plant growth by functioning as a biostimulant that improves nutrient availability, stimulates microbial activity, and promotes physiological processes such as chlorophyll synthesis and photosynthesis, ultimately leading to increased biomass production (Yuliandewi et al. 2018).

In terms of leaf greenness data, the best treatments were P3, P2, P0, and P1, respectively, with 43.14 units, 42.34 units, 42.33 units, and 41.27 units (Table 2). Leaf greenness indicates the amount of chlorophyll present in the plant. Nitrogen is a vital nutrient for chlorophyll formation, which is the pigment responsible for the green color in leaves and functions in photosynthesis (Aziez et al., 2014). Therefore, the more chlorophyll produced by plants with AB-Mix fertilizer treatment, shrimp waste extract, chicken manure extract, and the addition of eco-enzyme, the more chlorophyll production will increase and the leaves will appear greener. Therefore, the greener leaves observed under AB-mix fertilization combined with shrimp waste extract, chicken manure extract, and eco-enzyme application are primarily associated with enhanced chlorophyll synthesis (Table 1). While shrimp and chicken manure extracts mainly serve as nutrient sources, whose availability depends on mineralization processes, eco-enzyme acts as a biostimulant by promoting nutrient transformation and

Table 1. Effect of shrimp waste extract, chicken manure extract, and eco-enzyme solution with AB-Mix on plant height, number of leaves, and leaf stalk length 28 days after planting

Treatment	Plant height (cm)	Number of leaves	Leaf stalk length (cm)
P0	68.66 b	32.44 b	9.96 b
P1	68.24 b	32.17 b	9.80 b
P2	69.53 a	32.89 a	10.19 a
P3	69.99 a	33.44 a	10.56 a

Note: Treatments: P0 = AB – Mix 100% as a control, P1 = AB – Mix 75% + 15% shrimp waste extract + 10% chicken manure extract + 0 ml/l eco enzyme solution, P2 = AB – Mix 75% + 15% shrimp waste extract + 10% chicken manure extract + 1 ml/l eco enzyme solution, P3 = AB – Mix 75% + 15% shrimp waste extract + 10% chicken manure extract + 2 ml/l eco enzyme solution. Means in the same column followed by the same letters are not significantly different according to DNMRT at α=5%

Table 2. Effect of shrimp waste extract, chicken manure extract, and eco-enzyme solution with AB-Mix on the variables of leaf greenness, number of stomata, and stomatal density

Treatment	Leaf greenness (unit)	Number of stomata	Stomata density/mm^2
P0	42.33 a	20.83 b	4.59 b
P1	41.27 b	19.67 b	4.33 b
P2	42.34 a	21.33 a	4.70 a
P3	43.14 a	22.50 a	4.96 a

Note: Treatments: P0 = AB – Mix 100% as a control, P1 = AB – Mix 75% + 15% shrimp waste extract + 10% chicken manure extract + 0 ml/l eco enzyme solution, P2 = AB – Mix 75% + 15% shrimp waste extract + 10% chicken manure extract + 1 ml/l eco enzyme solution, P3 = AB – Mix 75% + 15% shrimp waste extract + 10% chicken manure extract + 2 ml/l eco enzyme solution. Means in the same column followed by the same letters are not significantly different according to DNMRT at α=5%

improving nitrogen uptake efficiency. This enhanced nitrogen assimilation directly supports chlorophyll formation, photosynthetic activity, and subsequent plant growth (Rouphael and Colla, 2020; Yuliandewi et al., 2018).

In terms of leaf greenness data, the best treatments were P3, P2, P0, and P1, respectively, with 43.14 units, 42.34 units, 42.33 units, and 41.27 units (Table 2). Leaf greenness indicates the amount of chlorophyll present in the plant. Nitrogen is a vital nutrient for chlorophyll formation, which is the pigment responsible for the green color in leaves and functions in photosynthesis (Aziez et al., 2014). Therefore, the more chlorophyll produced by plants with AB-Mix fertilizer treatment, shrimp waste extract, chicken manure extract, and the addition of eco-enzyme, the more chlorophyll production will increase and the leaves will appear greener. In the number and density of stomata, the best treatment was P3, followed by P2, P0, and P1 (Table 2);(Figure 1). The number of stomata affects the level of stomata density, where the more there are, the higher the stomata density. The level of stomata density is influenced by various environmental factors, including water availability, light levels, temperature, and CO_2 levels. Stomata density tends to increase with increasing light intensity. On the other hand, if the light received is minimal, then there will also be few stomata (Toriq and Puspitawati, 2023).

In the fresh weight data of the plants, the best treatment was in treatment P3 which was not significantly different from P2 with values of 119.45 g and 118.94 g (Table 3). This is in line with plant growth such as plant height, number of leaves, and length of leaf stalks. Tiljuir et al (2023) explained that fresh weight indicates the quality of plant growth. In line with the fresh weight of the plant, dry weight also showed the best results in treatment P3 which was not significantly different from P2 with values of 23.81 g and 22.82 g. Dry weight is the result of the shrinkage of water content stored in the plant which describes the weight of the plant itself without water. Water content plays a crucial role as it influences the physical, chemical, and biological characteristics of the material, such as freshness, texture, shelf life, and metabolic activity. Since oven drying only removes free water, the moisture content determined by this method essentially reflects the amount of free water in the material, not the total water content (free water + bound water).

Plant growth responses, such as plant height, leaf number, and leaf stalk length, are directly proportional to the results of wet and dry weight. However, there are differences in root length, where the best root length was in treatment P0, which was not significantly different from P3. This is because the nutrient solution concentration in treatment P0 from weeks 1 to 4 was higher than in the other treatments. However, root length in each treatment did not affect plant growth. Yama and Kartiko (2020) explain that roots in

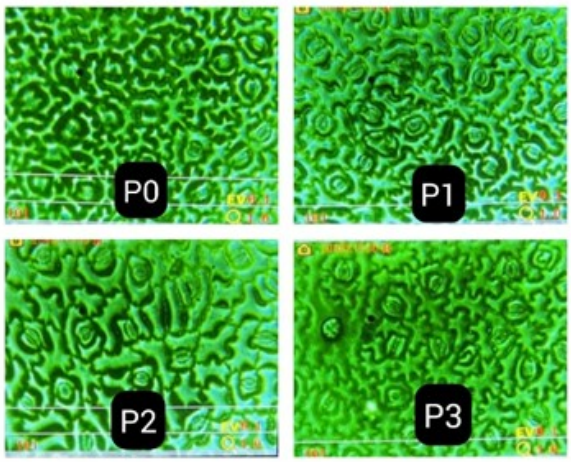

Figure 1. The number and density of stomata in P0, P1, P2, and P3

Table 3. Effect of shrimp waste extract, chicken manure extract, and eco-enzyme solution with AB-Mix on plant fresh weight, plant dry weight, and maximum root length

Treatment	Plant fresh weight (g)	Plant dry weight (g)	Root length (cm)
P0	118.73 b	22.50 b	30.67 a
P1	118.39 b	21.87 b	29.67 b
P2	118.94 a	22.82 a	29.83 b
P3	119.45 a	23.81 a	30.33 a

Note: Treatments: P0 = AB – Mix 100% as a control, P1 = AB – Mix 75% + 15% shrimp waste extract + 10% chicken manure extract + 0 ml/l eco enzyme solution, P2 = AB – Mix 75% + 15% shrimp waste extract + 10% chicken manure extract + 1 ml/l eco enzyme solution, P3 = AB – Mix 75% + 15% shrimp waste extract + 10% chicken manure extract + 2 ml/l eco enzyme solution. Means in the same column followed by the same letters are not significantly different according to DNMRT at α=5%

hydroponic cultivation are seen from their ability to absorb water and nutrients contained in the nutrient solution, within the range for plant survival.

CONCLUSION

Treatment AB – Mix 75% + 15% shrimp waste extract + 10% chicken manure extract + 2 ml/l eco enzyme solution was able to increase the best growth of water spinach plants in terms of plant height, number of leaves, length of leaf stalks, increased chlorophyll levels, more and denser stomata, increased wet weight, and less weight loss.

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