Proceeding SYMBION
(Symposium on Biology Education)
http://seminar.uad.ac.id/index.php/symbion
2540-752X (print) | 2528-5726 (online)

Substitution of eco enzyme in AB mix on growth and weight of red spinach

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ARTICLE INFO

Article history
Submission Dec 10th, 2022
Revision May 11th, 2023
Accepted May 18th, 2023

Keyword
AB Mix
Red Spinach
Eco Enzymes
Hydroponic Wick System

ABSTRACT

Red Spinach *(Amaranthus tricolor* L.*)* is a vegetable that has quite high nutritional value and is liked by many Indonesian people. The content contained in red spinach is protein, vitamin A, vitamin C and mineral salts and contains anthocyanins which can cure anemia. Awareness of the importance of consuming vegetables for health has led to increased consumption of red spinach. Along with the existence of agricultural land which is increasingly limited and food needs must be met, it is necessary to do alternative hydroponic planting with a wick system. This study aims to determine the effect of Eco Enzyme substitution at AB Mix concentrations on the growth and weight of red spinach *(Amaranthus tricolor* L.*)* in hydroponic wick systems. This study used a completely randomized design (CRD) with 4 treatments and 3 replications which were carried out for 28 days. Parameters measured were the growth of red spinach including plant height, number of leaves and leaf width and wet weight of red spinach plants. The data obtained were analyzed by 5% ANOVA and followed by 5% Duncan's test. The results showed that substitution of *Eco Enzyme* at concentrations of AB Mix significantly affected plant height, number of leaves, leaf width and wet weight of red spinach *(Amaranthus tricolor* L.) plants in hydroponic wick systems.

Introduction

Red Spinach (*Amaranthus tricolor* L.) is a vegetable that has high nutritional value and is liked by many Indonesian people. Known as one of the highly nutritious vegetables because they contain lots of protein, vitamin A, vitamin C and mineral salts which are needed by the body and contain anthocyanins which are useful in curing anemia [1]. At the consumer market level, red spinach (*Amaranthus tricolor* L.) is a type of spinach that is in great demand after green spinach. In addition, the selling value is higher than other types of spinach. The projection

results from the Central Statistics Agency (BPS) for 2020 show that the population in Indonesia will reach 269,603.4 million people and will continue to increase for the next 15 years. According to the Central Bureau of Statistics in 2018, spinach production in Indonesia has decreased from year to year, namely in 2018 production reached 162,277 tons and in 2019 it decreased to 160,306 tons, in 2020 it decreased again to 157,024 tons. Along with the increasing population, the market demand for the food sector, especially vegetables, is increasing. However, related to the level of production, it is now increasingly difficult to obtain fertile, productive and large areas for agricultural land, this is due to the rapid development of industry from year to year. Now, agricultural land is getting narrower while the need for agricultural products is increasing along with the increasing population. Therefore, it is necessary to think about other alternatives to overcome this problem, one of which is by using a hydroponic cultivation system [2].

One of the cultivation of plants to improve the quality of red spinach is a hydroponic system. The use of water as a substitute for soil media and also not requiring too much land is one of the advantages of planting a hydroponic system [3]. There are various types of hydroponics, one of which is the wick system. The wick system technique is a hydroponic method that uses a wick to distribute nutrients by utilizing the capillarity of water [4]. The level of nutrient solution is an important factor in the growth and quality of hydroponic plants. Excessive use of nutrients will inhibit plant growth and vice versa, lack of nutrient levels used can also cause plants to wither and die [5]. Providing proper nutrition in a hydroponic system will provide optimal results in the growth and productivity of red spinach plants. According to Hidayanti & Kartika's research the nutrients commonly used in hydroponic techniques are AB Mix. The current problem is that AB Mix nutrition has a relatively high price [6]. To meet the nutritional adequacy of AB Mix definitely requires a lot of money. Therefore, efforts need to be made to reduce the high costs incurred, one of which is by reducing the dosage of AB Mix nutrients and looking for additional nutritional alternatives that are easier to obtain, so as to reduce costs incurred and obtain optimal crop yields.

One alternative source of nutrition that can be used is Eco Enzyme. There is a need for an alternative Eco Enzyme substitution at AB Mix concentration which is expected to provide optimal results for the growth of red spinach (*Amaranthus tricolor* L.) in the wick hydroponic system. The existing Eco Enzyme is sourced from the use of various organic raw materials such as fruit and vegetable skin waste. With the reprocessing of organic waste that is used in the manufacture of Eco Enzyme, it will reduce environmental pollution and gain benefits from the processing. This study aims to determine the effect of Eco Enzyme substitution at AB Mix concentrations on the growth and weight of red spinach with a hydroponic system.

Method

Materials and tools

The research begins with the preparation of materials and research tools. The research materials included ±20 grams of red spinach seeds, 6 packs of rock woll, 1 liter of AB mix, 500 ml of Eco Enzyme and ±100 liters of water, while the research tools included wick system hydroponic media (Plastic Buckets, Plastic Trays, Netpots, flannel cloth, Styrofoam covers), hydroponic treatment tools (pH meters, TDS meters) and others include measuring cups, rulers, books, pens, treatment labels, pipettes, stirrers, digital scales, cutters and cameras. What is done is seeding, preparation and manufacture of nutrients, planting in hydroponic growing media, maintenance and addition of nutrients.

Research sites

The location of this research was carried out in the yard of the house which is located in Sugihan Pulo Village, RT 06 RW 03, Rembang District, Rembang Regency, Central Java, Indonesia. When the research will be carried out in April-May 2022.

Data collection

The data collection technique used in this study was to measure plant height, count the number of leaves, measure leaf width and wet weight of red spinach plants. Plant height can be measured starting from the red spinach plants starting to germinate until harvest time with the help of a measuring ruler from the surface of the planting medium to the tip of the highest leaf of the plant. The number of leaves is counted from the youngest leaves that have opened completely to the oldest leaves. Leaf width calculations were carried out on leaves that opened perfectly by measuring the width of the leaf using a ruler. Measurements were made at the 1st, 2nd, 3rd and 4th week after planting. While the calculation of wet weight is done after the harvest using a scale. Wet weight is the fresh weight of a plant that still contains moisture content in it.

Data analysis

Data analysis is the process of searching and systematically compiling data obtained from experimental results and documentation. The research data on plant height, number of leaf blades, leaf width, and plant wet weight are presented in tabular form which describes the average value of each treatment. Then the research data were analyzed using Analysis of Variance (ANOVA).

Results and Discussion

Research result

In observing the effect of Eco Enzyme substitution at AB Mix concentration on the growth and weight of red spinach (*Amaranthus tricolor* L.) observations have been obtained including plant height, number of leaves, leaf width and wet weight as an observation indicator of red spinach plant growth parameters. From these observations it can be seen that the results of a significant increase in both the control treatment, treatment 1 (AB Mix 75% + Eco Enzyme 25%), treatment 2 (AB Mix 50% + Eco Enzyme 50%) and treatment 3 (AB Mix 25% + Eco Enzymes 75%).

Table 1. Data on increasing the height of red spinach plants *(Amaranthus tricolor L.*)

Treatment	Plant height (cm)				Increase in plant height (cm)	Standard*
	1 MST	2 MST	3 MST	4 MST		
P0	2,33	5,33	12,33	29,67	27,34[c]	21,2-22,4 cm
P1	2,67	5,17	9	22	19,33[c]	
P2	3,40	5,17	9,33	15,33	11,93[b]	
P3	3,47	5	7	10,67	7,2[a]	

* Standards from the Decree of the Minister of Agriculture of the Republic of Indonesia (035/Kpts/SR.120/D.2.7/3/2019)

Table 2. Data on the increase in the number of red spinach leaves *(Amaranthus tricolor* L.)

Treatment	Number of leaves (strands)				increase in the number of leaves (strands)	Standard*
	1 MST	2 MST	3 MST	4 MST		
P0	3	6	10	14	11[d]	10- 18 (strands)
P1	3	6	9	12	9[c]	
P2	3	6	8	10	7[b]	
P3	3	6	7	8	5[a]	

* Standard Standards from the attachment to the decree of the minister of agriculture (85/Kpts/SR.120/3/2005)

Table 3. Data on increasing the width of red spinach leaves *(Amaranthus tricolor* L.)

Treatment	leaf width (cm)				increase in leaf width (cm)	Standard*
	1 MST	2 MST	3 MST	4 MST		
P0	1,13	2,3	4,83	7,63	6,5[c]	6,2-7,6 cm
P1	1,03	2,3	4,67	6,33	5,3[b]	
P2	1,27	2,17	4,33	5,33	4,06[a]	
P3	1,27	2,3	3,83	4	2,73[a]	

* Standards from the Decree of the Minister of Agriculture of the Republic of Indonesia (035/Kpts/SR.120/D.2.7/3/2019)

Table 4. Data on wet weight of red spinach plants *(Amaranthus tricolor* L.) with hydroponic system (grams)

Treatment	**Test**			**Number of Treatments**	**Treatment Average**
	1	**2**	**3**		
P0	27	25	23	75	25[d]
P1	13	12	13	38	12,68[c]
P2	7	6	5	18	6[b]
P3	3	3	2	8	2,68[a]
Amount	50	46	43	139	
General Average					11,58

* treatment followed by a different letter in the column indicates a significant difference at the 95% confidence interval ($\alpha = 0.05$)

Information:

P0 = AB Mix 100% (Kontrol)

P1 = AB Mix 75% + *Eco Enzyme* 25%

P2 = AB Mix 50% + *Eco Enzyme* 50%

P3 = AB Mix 25% + *Eco Enzyme* 75%

Based on Table 1, it can be seen that the effect of Eco Enzyme substitution on the AB Mix concentration on increasing the height of red spinach plants (*Amaranthus tricolor* L.) with a hydroponic system. The data obtained is in the form of an increase in plant height every week. Based on the calculation of one-way analysis of variance (ANOVA) it is known that the significance value is 0.000 <0.05 so it can be concluded that the average of the four treatments on red spinach plant height differed significantly. Fcount (74,535) > Ftable 5% (4.07) then H0 which stated that there was no effect of Eco Enzyme substitution at AB Mix concentration on the height growth of red spinach plants with a hydroponic system was rejected and H1 which stated that there was an effect of Eco Enzyme substitution on AB concentration Mix on high

growth of red spinach plants with a hydroponic system is accepted. In addition to the increase in plant height, it can also be seen from the increase in the number of leaves on the red spinach plant. Data can be seen in Table 2, Observations were made by counting the number of red spinach leaves from the day after planting (HST) until the harvest. The results of the substitution of Eco Enzyme at the concentration of AB Mix on the number of leaves on red spinach (*Amaranthus tricolor* L.) Based on the calculation of one-way analysis of variance (ANOVA) it is known that the significance value is 0.000 <0.05 so it can be concluded that the average of the four treatments on the number of red spinach plant leaves differed significantly. Fcount (60,000) > F table 5% (4.07) then H0 which stated that there was no effect of Eco Enzyme substitution on AB Mix concentration on the growth of the number of leaves of red spinach plants with the hydroponic system was rejected and H1 which stated that there was an effect of Eco Enzyme substitution on the concentration AB Mix on the growth of the number of leaves of red spinach plants with a hydroponic system was accepted.

Next is an indicator of an increase in leaf width of the red spinach plant. Observation results can be seen in Table 3, The results of the existence of Eco Enzyme substitution at the concentration of AB Mix on the leaf width of red spinach (*Amaranthus tricolor* L.) homogeneity with a significance value of 0.229 > 0.05 (Table 4.10). Based on the calculation of one-lane analysis of variance (ANOVA) it is known that the significance value is 0.003 <0.05 so it can be concluded that the average of the four treatments on leaf width of red spinach plants differs significantly. Fcount (11.556) > Ftable 5% (4.07) then H0 which stated that there was no effect of Eco Enzyme substitution on AB Mix concentration on the growth of red spinach leaf width with the hydroponic system was rejected and H1 which stated that there was an effect of Eco Enzyme substitution on the concentration AB Mix on the growth of red spinach leaf width with a hydroponic system was accepted. Effect of Eco Enzyme substitution at AB Mix concentration on red spinach plant weight (*Amaranthus tricolor* L.) seen from red spinach plant wet weight after 4 WAP (week after planting). Wet weight is the total weight that still contains water that has not been dried or dried in the sun. Wet weight is influenced by the ability of plants to absorb water from the planting medium. Observation of wet weight was carried out by weighing the plants using a digital scale.

Based on Table 4, the results of the Eco Enzyme substitution at AB Mix concentration on the wet weight of red spinach (*Amaranthus tricolor* L.) Based on one way analysis of variance (ANOVA) it is known that the significance value is 0.000 <0.05 so it can be concluded that the fourth mean treatment of the wet weight of red spinach plants differed significantly. Fcount (206.020) > Ftable 5% (4.07) then H0 which stated that there was no effect of Eco Enzyme substitution on AB Mix concentration on the wet weight of red spinach plants with the hydroponic system was rejected and H1 which stated that there was an effect of Eco Enzyme substitution on AB concentration Mix on the wet weight of red spinach plants with a hydroponic system was accepted. Of the four indicators that have been observed, they have the same pattern, namely the best treatment is in treatment P0 and the lowest is in treatment P3.

Discussion

Based on the results of the research that has been done, it can be seen that the effect of Eco Enzyme substitution of 25%, 50% and 75% on AB Mix nutrient concentrations can reduce the growth of red spinach plants (*Amaranthus tricolor* L.) when compared to the control treatment (100% AB Mix) both from the indicators of plant height, number of leaves and leaf width of red spinach (*Amaranthus tricolor* L.). The higher the concentration of Eco Enzyme substituted for AB Mix nutrients, the slower the growth. The most optimal growth of red spinach plants occurred in the control treatment (AB Mix 100%), while the Eco Enzyme substitution treatment on AB Mix nutrition was the best where the growth results still met the standard standards for red spinach plant growth both from indicators of plant height, number of leaves and width. leaves occurred in P1 treatment with Eco Enzyme substitution of 25%. This

is because AB Mix nutrition already contains sufficient macro and micro nutrients for physiological and metabolic processes in plants which will trigger plant growth. AB mix is a nutrient solution consisting of nutrient solution stock A containing macronutrients and stock B containing micronutrients. The nutritional content of AB mix is N : 18.1%, Ca : 14.2%, K : 25.3%, Mg : 5.3%, S : 13.6%, P : 5.1%, Fe : 0.10%, Mn : 0.05%, Cu : 0.05%, B : 0.03%, Zn : 0.07% and Mo : 0.001% (Ariananda et al., 2020). Because in this study using a hydroponic system where AB Mix is the main nutrient for the plant, if the main nutrient is reduced and replaced (in this study it was replaced with Eco Enzyme) then the plant will experience less than optimal growth due to genetic factors and nutrient availability in the plant. Adequate and balanced amounts greatly affect plant growth. Whereas in the P2 and P3 treatments where the Eco Enzyme substitution was 50% and 75% the plant growth yields decreased, this was due to the too high dose of the Eco Enzyme substituted so that the plant growth process was hampered. This is because Eco Enzyme is not a plant fertilizer but Eco Enzyme contains macro nutrients N, P and K which are needed by plants whose content is still small so that Eco Enzyme can only be used as a biocatalyst by adding a few ml of Eco Enzyme solution to the main nutrients especially planting with a hydroponic system. The content of the Eco Enzyme sample used in this study which was analyzed at the Agricultural Consultant and Training Laboratory of the Faculty of Agriculture and Business, Satya Wacana Christian University Salatiga states that Eco Enzyme contains N = 1.08%, P = 2.26%, K = 1, 57% and organic matter of 60.83%. In Manurung's study the recommended dose for adding an Eco Enzyme solution is 1 ml/liter of water in which this dose can affect the growth and development of lettuce plants [7].

Plants need more N, P and K nutrients when compared to other elements [14]. Nutrients containing sufficient elements of N, P and K to meet the needs of plant nutrients is one of the important factors needed by plants for their growth. According to Arianandaʼs research, the nutrient requirements for N = 10.5%, P 5.2% and K 10.3% are considered sufficient in plant tissue for growth [8]. In treatment P1 (AB Mix 75% + Eco Enzyme 25%) the growth in plant height, number of leaves and leaf width of red spinach (*Amaranthus tricolor* L.) was still optimal, this indicated that there was a 25% Eco Enzyme substitution at AB concentration Mix can still increase plant height, although not as optimal as the control treatment which only uses AB Mix. This is consistent with research Wiryonoʼs research which states that using substitution of the lowest concentration of Eco Enzyme produces the most optimal results for plant height compared to high concentrations because it is influenced by the supply of nitrogen and molybdate nutrients contained in Eco Enzyme which are less needed. Giving the right dose is another factor that can affect plant growth [9]. The need for macro and micro nutrients is very much needed in the process of plant growth, the composition and content of macro and micro nutrients greatly affect plant growth, so the provision of nutrients must be balanced according to plant needs. Based on the results of research on P2 treatment (AB Mix 50% + Eco Enzyme 50%) and P3 treatment (AB Mix 25% + Eco Enzyme 75%) the increase in plant height, leaf number and leaf width of red spinach (*Amaranthus tricolor* L.) experienced decline. The lowest decrease occurred in the P3 treatment, this was due to the non-optimal absorption of nutrients by plants at P3. The concentration of the nutrient solution that is too high can affect the absorption of nutrients by the roots. Concentrated solutions cannot be absorbed by the roots to the fullest because the osmotic pressure of the cells becomes lower than the osmotic pressure outside the cells, so there is a possibility of backflow of plant cell fluids (plasmolysis) [10].

In another study, Eco Enzyme made from organic waste from pineapple, banana and papaya peels was applied to pea flower plants with soil as a planting medium.). In this study, an analysis of the content of Eco Enzyme was carried out at the Laboratory of Soil Science, University of North Sumatra, which contained C-Organic nutrition = 0.38%, N = 0.05%, P = 6.13 ppm, K = 0.91 ppm, and pH = 4.26. Concentration of Eco Enzyme significantly affected plant height, number of leaves, number of branches, stem diameter and fresh material production of butterfly pea flower (Clitoriaternatea ternatea L.) but had no significant effect on

parameters of leaf width and dry matter production. The concentration of Eco Enzyme in the K1 treatment was 1% Eco Enzyme which showed more effective results than other concentrations (0.5% K2 and 0.33% K3). Eco Enzyme in K1 contains more nutrients than other treatments [11].

There are 2 factors that influence plant growth and development, namely internal factors including genetics and hormones, besides that there are also external factors including pH, climate, weather, nutrients and CO2. One of the external factors affecting the growth of red spinach (*Amaranthus tricolor* L.) is pH. In this study, the pH value of water at P0 was 6.3 while P1 was 6.5 then the pH increased to 6.7 while P2 was 6.7 which increased to 6.9 and P3 increased to 6.9 to 7.2. Provision of an optimal nutrient solution is very important in hydroponic cultivation, the ideal nutritional pH value for red spinach plants is 6.0-7.0. The increase in the pH value of the nutrients was followed by the presence of nutrient precipitates, especially in the P2 and P3 treatments which gradually turned alkaline. If the pH exceeds the ideal pH, the Fe element in the solution will not function and cause the condition of the solution to become alkaline which eventually precipitates the solution so that it cannot be absorbed by plants [12]. The concentration of the nutrient solution in each treatment was 1,115 ppm. The ideal solution concentration for red spinach plants is 1050-1400 ppm. The optimal air temperature for red spinach plants is around 20-32 ^{0}C. The air temperature observed in this study averaged 29.56 ^{0}C. This temperature affects the growth of the number of leaves on red spinach (*Amaranthus tricolor* L.). Nutrient concentrations thaFt are unable to meet plant needs in carrying out physiological processes cause slow growth and development processes.

Furthermore, from the results of the four treatments it was known that the average wet weight of red spinach plants after 4 MST was the most optimal, namely the AB Mix control treatment, which was 25 grams, while the lowest average red spinach plant wet weight was in treatment 3 (AB Mix 25 % + Eco Enzyme 75%) of 2.68 grams. This is because the increase in plant weight is caused by an increase in plant size, if plant growth is low then the wet weight obtained will also be low and vice versa. Optimization of plant growth will be in line with the wet weight produced. The wet weight consisted of all parts of the red spinach plant except the roots. The increase in fresh weight is influenced by plant height, leaf width and the number of leaves where the vegetative growth process takes place. The increase in plant wet weight is also influenced by the sufficient amount of water, the environment, the nutrients that are fulfilled and the quality of the water. According to Febriani's research, the composition and levels of macro and micro nutrients affect growth. Plant wet weight is influenced by the availability of sufficient N nutrients to increase plant growth, such as plant height growth and leaf formation [13]. The nutrient requirement factor can affect plant growth and development, thus affecting plant wet weight. Haryadi also stated that the availability of nutrients plays an important role in influencing the biomass of a plant. Therefore, regulation of the nutrients needed by plants is very important so that plants can grow properly and optimally.

Conclusion

The results of this study indicate that the presence of Eco Enzyme substitution at AB Mix concentrations of 25%, 50% and 75% can reduce the growth and weight of red spinach (*Amaranthus tricolor* L.) plants with a hydroponic system including plant height, number of leaf blades, leaf width and wet weight of red spinach (*Amaranthus tricolor* L.) when compared to the control treatment.

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