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[CarakaTani] Submission Acknowledgement

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Dr. Ir. Mujiyo, S.P., M.P. <jurnal@mail.uns.ac.id>
to me

Wed, Feb 23, 8:44 PM

The following message is being delivered on behalf of Caraka Tani: Journal of Sustainable Agriculture.

Dear Dr. Darwin Habinsaran Pangaribuan,

Thank you for submitting the manuscript, "The effect of combination of plant extract and seaweed (Sargassum sp.) on the growth of mustard plant (Brassica juncea L.) grown by hydroponic wick system" to Caraka Tani: Journal of Sustainable Agriculture. With the online journal management system that we are using, you will be able to track its progress through the editorial process by logging in to the journal web site:

Manuscript URL: https://jurnal.uns.ac.id/carakatani/author/submission/59668
Username: dhpangaribuan

If you have any questions, please contact me. Thank you for considering this journal as a venue for your work.

31°C Berawan | 11:54 29/11/2022

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[CarakaTani] Editor Decision

External | 0 2020 Hidro Rossi CARAKA TANI ×

Dr. Ir. Mujiyo, S.P., M.P. <jurnal@mail.uns.ac.id>
to me, yohannesginting, rugayah.1961

Thu, Mar 10, 11:55 AM

The following message is being delivered on behalf of Caraka Tani: Journal of Sustainable Agriculture.

Dear Dr. Darwin Habinsaran Pangaribuan,

We have reached a first decision regarding your submission to Caraka Tani: Journal of Sustainable Agriculture, "The effect of combination of plant extract and seaweed (Sargassum sp.) on the growth of mustard plant (Brassica juncea L.) grown by hydroponic wick system".

Our decision is: Resubmit for Review

Your article should be corrected according to editors' comments. Please find the file attached in your journal account dated today for the reviewers' comments.

Please revise the article within 21 days from the date of sending off. We

31°C Berawan | 11:59 29/11/2022

The effect of organic nutrition combination of plant extract and seaweed (*Sargassum* sp.) on the growth of mustard plant (*Brassica juncea* L.) hydroponic wick system

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Based on metadata OJS:
The effect of combination of plant extract and seaweed (Sargassum sp.) on the growth of mustard plant (Brassica juncea L.) grown by hydroponic wick system

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General Comments of Initial Review

Decision: Resubmit for Review

This manuscript has interesting topics for Caraka Tani. This paper can be continued to peer review process after revising by addressing the following comments.

- Please read the Caraka Tani: Journal of Sustainable Agriculture guidelines and follow these instructions carefully. URL: https://jurnal.uns.ac.id/carakatani/about/submissions#authorGuidelines

- Please improve the introduction, background to the study, especially a summary of the existing literature, reason why the study was necessary, and the novelty must be explained,

- There are still many words in Indonesian, please check carefully.

- Please improve the Result and Discussion

The Effect of Nutrition Combination of Plant Extract and Seaweed (*Sargassum* sp.) on The Growth of Mustard Plant (*Brassica juncea* L.) Hydroponic Wick System

Abstract

Nutrient solution is an important factor for the growth and quality of hydroponic plants. The study aims to (1) determine organic nutrition of brown seaweed extract (*Sargassum* sp.) with a combination of lamtoro leaf and coconut fiber to equal the quality of AB-mix nutrition as a hydroponic nutrient for mustard plants; (2) knowing the best organic nutrition among brown seaweed extracts (*Sargassum* sp.), brown seaweed extract extracts (Sargassum sp.) with coconut fiber, and brown seaweed extract extracts (Sargassum sp.) with lamtoro leaf as hydroponic nutrient solution for growth mustard plants. This research was conducted in the greenhouse of the Faculty of Agriculture, University of Lampung in ~~November 2019 – February 2020~~. The design used was a Randomized Block Design (RBD) with six replications. The treatments consisted of six types of treatment, namely AB-mix nutrition, brown seaweed, seaweed and lamtoro leaf, seaweed and coconut fiber, seaweed and moringa leaf, seaweed and african leaf. The results showed that the organic nutrition of the mixture of brown seaweed and lamtoro leaf is better than other organic nutrients by producing 57.88 g total fresh weight of mustard plants, but only 51.08 % of the total fresh weight of mustard plants in the AB-mix treatment was 113.31 g. Research implied that the organic nutrient solution extracting the mixture of brown seaweed with lamtoro leaf, or coconut fiber or or moringa leaves or african leaves has not been able to match the quality of AB-mix nutrition for mustard plants in the hydroponic system.

Keywords: African leaf, coconut fibre, lamtoro leaf, moringa leaf, plant extract

INTRODUCTION

~~Agriculture is a very important sector for Indonesian society. The agricultural sector is a source of income for some people, because most of Indonesia's territory is agricultural land.~~ Farmers usually use the land for media in developing their agricultural products. ~~This has become commonplace among the agricultural world.~~ Utilization of non-agricultural land can be supported by agricultural intensification, one of which is hydroponic technology. Hydroponics is an agricultural cultivation land without using soil media, so that it uses water as a nutrient medium that will be directly absorbed by plants to support plant growth. According to (Vidianto, Fatimah, & Wasonowati, 2013), hydroponic technology does not have to require a large area of land so that hydroponic cultivation is suitable to be developed on narrow land.

One of the hydroponic techniques used is the wicks system hydroponics technology. ~~According to (Embarsari, Taofik, & Qurrohman, 2015), wick hydroponics is a simple hydroponic method that uses an axis as a link between nutrients to the root parts of the planting medium~~. The advantages of this hydroponic system do not require electrical resources, the amount of fertilizer, plants grow optimally and are easy to control. The weakness of the hydroponic axis system is that the nutrient solution is not circulating so that plant growth slowly (Kamalia, Dewanti, & Soedradjad, 2017). The essential part that needs to be considered in hydroponic cultivation is nutrient solutions.

Nutrient solution is an important factor for the growth and quality of hydroponic plants, so it must be precise in terms of the amount of nutrient ion composition and temperature. The source of nutrition used in hydroponic cultivation generally uses inorganic nutrients, one of which is AB-mix

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Keywords are the labels of your manuscript and critical to correct indexing and searching. Keywords should not more than 5 words or phrases in alphabetical order which has not been used in the title. Therefore, the keywords should represent the content and highlight of your article.

Recommendation: seedling growth; mineralization or plant nutrition

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e. Please provide a statement to demonstrate this paper in support of sustainable agricultural systems (with references).
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nutrient solution. AB-mix nutrient solution contains macro and micro elements. Treatment using AB-mix nutrition gave higher yields and plant quality. According to research by (Nugraha & Susila, 2015b), AB-mix nutrition increases growth and production in pakcoy, lettuce and spinach. According to the research results of (Ramadiani & Susila, 2014) and (Abdillah, Aini, & Hariyono, 2017), AB-mix inorganic nutrients affect the growth and production of kailan, caisin, and kale plants. In terms of cost, AB-mix nutrition has a relatively more expensive price (Nugraha & Susila, 2015a) because the use and purchase of AB-mix nutrients must be in one package. Therefore, a solution is needed to overcome this problem, namely obtaining nutrients whose composition ends in inorganic nutrients by utilizing organic material sources.

Based on the description above, it is necessary to conduct research on organic hydroponic nutrition whose composition could approach the quality of inorganic nutrients. The organic materials that will be used need to be extracted and fermented so that their nutritional content can be utilized as a source of organic nutrition for hydroponic nutrient solution. So that agricultural products that will be produced are free from chemicals that are harmful to human health and are safe for consumption.

Organic materials that can be used as a source of organic nutrition for hydroponic nutrient solutions are brown seaweed, coconut husk, lamtoro leaves, moringa leaves, or ~~african~~African leaves. According to the results of (Basmal, 2009) study, seaweed can be used as organic fertilizer because it contains growth regulators including auxins, cytokines, ~~gibberillin~~gibberellin, abscisic acid and ethylene and is rich in trace minerals (Fe, B, Ca, Cu, Cl, K, Mg, and Mn). This is reinforced by the results of research by (Basmal, Kusumawati, & Utomo, 2015), which found that the liquid extract of seaweed contained auxin of 127.48 ppm, gibberellin 131.11 ppm, 68.77 ppm of ~~cytokinins~~cytokinin and cytokinzeatin 82.41 ppm; macro nutrient potassium (K) of 345.29 mg~~/~~ 100 g^{-1}, nitrogen (N) of 0.78%, phosphorus (P) 55.39 mg / 100 ml, viscosity value of 11.5 cPs, and EC value of 3, 3 mS / cm. Coconut coir can be used as an ingredient in organic nutrition by fermenting and extracting it. According to (Ramadhani, 2011), coconut husk has a very rich element of potassium and also contains 30% fiber. According to (Eniolorunda, 2011) proximate composition of lamtoro are crude protein, crude fibre, ash, and nitrogen free extract. Moringa leaves contain protein, calcium, phosphorus, iron and zinc (Salim, Hasyim, & Adam, 2018). African leaves have several substances that are good for plants such as protein, amino acids, ascorbic acid, carotenoids, fats, carbohydrates, and fiber (Ijeh & Ejike, 2011). African leaves are medicinal plants that can be used as inflammation (Setiani & Rusli, 2020).

There have been limited studies concerned on nutrient organic alternative for hydroponic plant nutrition. Therefore, this study was conducted to determine organic nutrition extract mixture of brown seaweed (*Sargassum* sp.) combined with coconut husk or lamtoro leaves or moringa leaves or african leaves that match to the nutritional quality of AB-mix as hydroponic nutrition for mustard plants.

MATERIALS AND METHOD

This research was conducted in the greenhouse of the Faculty of Agriculture, University of

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Lampung in November 2019 - March 2020. The materials used are mustard seeds, seaweed chocolate ~~(Sargassum sp.),~~ coconut husk, lamtoro leaves, AB-mix nutrient solution, water, beef rumen, EM4, and sugar.

The design used was a randomized complete design (RCD) with six replications. The treatments consisted of six types of treatment, namely AB-mix nutrition, brown seaweed, brown seaweed and lamtoro leaves, brown seaweed and coconut husk, brown seaweed and moringa leaves, and brown seaweed and African leaves. Analysis of variance (F test) is carried out then continued with the separation of the middle value with the Honestly Significantly Difference at the 5% level.

This research was carried out in several stages, namely the preparation stage of hydroponic wick system installation, preparation of liquid organic nutrition using each 5 kg of brown seaweed, lamtoro leaves, coconut husk, moringa leaves, ~~african~~African leaves which had been chopped into small pieces. Then, the ingredients are blended until smooth for 3 minutes with a ratio of 300 g: 1 l of water. All materials were extracted and fermented and added with beef rumen, EM4 as a bioactivator, 80 l of refined sugar and water. ~~-~~Fermentation was carried out for 20 days. Sowing of the seeds is carried out in rice husk and compost for 14 days or until 2 to 3 leaves appear. Then, analysis of nutrients was carried out in the fermented organic nutrient solution to determine the N, P, and K content of each organic nutrient solution. Preparation of AB-mix nutrient solution (Hydro J.) consists of nutrients A and B. Nutrients A as much as 500 ml combined with and B as much as 250 ml and add 100 l of water, then stir until blended. Organic nutrition is made by mixing organic matter and water, namely in a ratio of 1: 9.

Planting of mustard plants that are 14 days old or after the mustard plants appear 2-3 leaves to the hydroponic wick system. After that, maintenance is carried out by controlling the nutrients in the tube including the volume of the solution, measuring the pH, and measuring the viscosity of the solution (EC) at each installation. Harvesting of mustard greens is carried out at the age of 30 days after planting (DAP) when the plants have reached their maximum growth with the characteristics of the plant height of approximately 26-33 cm, fresh green leaves, light green stems. The observed variables were number of leaves, shoot dry weight, root fresh weight, total plant fresh weight, and leaf greenness (SPAD).

RESULTS AND DISCUSSION

The results showed that the treatment of organic nutrient solutions could not match the quality of AB-mix hydroponic nutrient solutions as hydroponic nutrients for mustard plant cultivation. Mustard plants treated with organic nutrition produced leaf numbers and greenish levels that were significantly different from those treated with AB-mix hydroponic nutrition.

This can be seen from the number of mustard leaves in the organic nutrient solution treatment only reached 85.61% of the number of leaves in the AB-mix hydroponic nutrient solution treatment. The number of leaves in the AB-mix hydroponic nutrition treatment was 8.56 leaves, while the average number of leaves in the three types of organic nutrition treatment was only 6.27 leaves (Table 1). The

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level of leaf greenness in the organic nutrition treatment of the mixture of brown seaweed and lamtoro leaf extract and the organic nutrition of the mixture of brown seaweed and coconut husk only reached 88.73% of the greenness level of the leaves in the AB-mix nutrient solution treatment. The highest leaf greenness level variable was obtained in the AB-mix treatment, it was 34.37 unit compared to the organic nutrient treatment of the mixture of brown seaweed and lamtoro leaf extract which was only 28.52 unit and followed by the organic nutrition treatment of the mixture of brown seaweed and coconut husk extract which was 25.66 unit (Table 1).

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Table 1. Effect of organic nutrients from extracts of several organic materials on the variable number of leaves and SPAD of mustard plants

Treatment	Number of leaves		SPAD	
	Original	Trans $\sqrt{(X + 0.5)}$	Original	Trans $\sqrt{(X + 0.5)}$
	blade		unit	
AB-mix	8.56 a	2.92	34.37 a	5.86
Seaweed	1.64 e	1.28	12.85 c	3.57
Seaweed + lamtoro leaf	6.50 b	2.54	28.52 b	5.34
Seaweed + coconut fiber	6.61 c	2.57	25.66 b	5.06
Seaweed + moringa leaf	3.29 c	1.80	33.77 ab	5.80
Seaweed + ~~african~~African leaf	2.58 d	1.58	27.01 b	5.18
HSD 5%	0.33		0.46	

Notes: The mean value followed by the same letter does not differ at the 5% level

The results showed that AB-mix nutrition resulted in shoot dry weight, root fresh weight and total plant fresh weight, which were significantly different from the mustard plants treated with organic nutrition. Shoot dry weight in the treatment of organic nutrition mixture of brown seaweed and lamtoro leaves and organic nutrition treatment of a mixture of brown seaweed and coconut husk only reached 62.18% of the shoot dry weight in AB-mix nutrient solution treatment. Mustard plants given AB-mix treatment has dry medicine the shoot greater, namely 10.54 g compared to the treatment of organic nutrition mixture of brown seaweed and leaves of lamtoro, namely 4.50 g, followed by treatment of organic nutrition mixture of brown seaweed and coconut husk, namely 3.96 g (Table 2).

The AB-mix nutritional treatment resulted in a 41.11% higher root fresh weight than the root fresh weight of the organic nutrient solution of the mixture of brown seaweed and lamtoro leaf extract. The AB-mix nutritional treatment produced the highest root fresh weight, namely 5.01 g compared to 2.95 g (Table 2). The total fresh weight of mustard plants in the organic nutrient treatment of the mixture of brown seaweed and lamtoro leaves only reached 51.08% of the total fresh weight of the plants in the AB-mix nutrient solution treatment (Figure 1). The AB-mix nutritional treatment resulted in the total fresh weight of mustard plants in the mustard plant, namely 113.31 g, higher than the treatment of organic nutrient solution mixture of brown seaweed and lamtoro leaves which was 57.88 g (Table 2).

Figure 1. Growth of mustard plants treated with AB-Mix (left) and treated seaweed and lamtoro leaf (right).

Table 2. Effect of organic nutrients from extracts of some organic matter on shoot dry weight, root fresh weight, and total fresh weight variables of mustard plants

Treatment	Shoot dry weight of 3 plants		Root fresh weight of 3 plants		Total fresh weight of mustard plants of 6 plants	
	Original	Trans √ (X + 0.5)	Original	Trans √ (X + 0.5)	Original	Trans √ (X + 0.5)
	g		g		g	
AB-mix	10.54 a	3.20	5.01 a	2.22	113.31 a	10.51
Seaweed	0.24 d	0.47	0.95 e	0.96	2.59 e	1.60
Seaweed + lamtoro leaf	4.50 b	2.05	2.95 b	1.71	57.88 b	7.51
Seaweed + coconut fiber	3.96 b	1.93	1.89 c	1.36	27.87 b	5.17
Seaweed + moringa leaf	5.16 b	2.25	1.66 d	1.28	23.79 c	4.85
Seaweed + ~~african~~African leaf	1.20 c	1.07	1.31 de	1.14	6.99 d	2.64
HSD 5%	0.40		0.19		1.39	

Notes: The mean value followed by the same letter does not differ at the 5% level.

The pH value of all treatments are the AB-mix solution ranges from 6.8 -7, brown seaweed extract is 4-4.5, in a mixture of brown seaweed extract and lamtoro leaf is 5.2 - 5,5, a mixture of brown seaweed and coconut husk is 4.8 - 5, in a mixture seaweed and moringa leaf is 4.8 – 5.0, and in a mixture seaweed and african leaf is 4.0 – 4.5. In this study, the highest EC value was in the AB-mix nutrient solution, which ranged from 1,082 to 1,111 ppm, while the EC value in organic nutrient solutions of all treatments ranged from 550-701 ppm.

Table 3. Concentration parameters of the nutrient solution of mustard plants

Treatment	EC (ppm)			
	7 DAP	14 DAP	21 DAP	28 DAP
AB-mix	1082,00	1101,00	1103,00	1092,00
Seaweed	508,00	500,00	502,00	500,00
Seaweed + lamtoro leaf	562,00	619,00	620,00	701,00
Seaweed + coconut fiber	520,00	500,00	610,00	625,00
Seaweed + moringa leaf	501,00	571,00	600,00	602,00
Seaweed + ~~african~~ African leaf	510,00	520,00	511,00	507,00

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Table 4. pH parameter of mustard plants

Treatment	pH			
	7 DAP	14 DAP	21 DAP	28 DAP
AB-mix	6,9	6,8	7,0	6,9
Seaweed	4,1	4,0	4,3	4,5
Seaweed + lamtoro leaf	5,2	5,2	5,5	5,4
Seaweed + coconut fiber	4,9	5,0	4,8	5,0
Seaweed + moringa leaf	5,0	4,9	4,9	4,8
Seaweed + ~~african~~ African leaf	4,3	4,0	4,5	4,4

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The results of the correlation test for vegetative and generative variables through the Pearson correlation test (Table 5) showed that the vegetative variable i.e. number of leaves resulted in a significantly different positive correlation with the generative variables i.e. shoot dry weight, root fresh weight, and shoot fresh weight. Likewise, there is a significant correlation between root fresh weight and shoot fresh weight.

Table 5. Correlation coefficient between vegetative and generative traits

Peubah	Number of leaves	SPAD	Shoot dry weight	Root fresh weight	Shoot fresh weight
Number of leaves	1				
SPAD	0,58	1			
Shoot dry weight	0,84*	0,78	1		
Root fresh weight	0.88*	0.62	0.93**	1	
Shoot fresh weight	0,88*	0,62	0,94**	0.99**	1

Note: * = Significant at P<0.05; ** = highly significant at P<0.01

~~DISCUSSION~~

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The organic nutrition treatment of the mixture of brown seaweed and lamtoro leaf extract resulted in higher root fresh weight among other organic nutrient treatments (Table 2). It is suspected that the availability of nutrients in the organic nutrition of the mixture of brown seaweed and lamtoro leaves during the growth process is able to provide the essential macro needs of plants. In addition, the combination of these organic nutrients is thought to be able to support the supply of nutrients in the root area, so that the roots can easily absorb these nutrients. According to (Atari, Murdiono, & Koesriharti,

2017), good plant roots can affect the photosynthesis process and nutrients can be easily absorbed so that it can increase plant growth which will affect the components of mustard plant production. The greater the weight of the plant roots, the greater the plant will absorb nutrients. The fact that lamtoro is the best plant for the source of extraction is supported by its nutrient content. Results of the analysis of nutrients N, P, and K showed that the nutrient content of N, P, and K in the organic nutrition of the mixture of brown seaweed and lamtoro leaf extract is the highest among other organic nutrients, which is equal to N (216.98 mg / L), P (16.52 mg / L), and K (6 mg / L). The organic nutrient content of the mixture of brown seaweed and coconut husk extract shows that the nutrient content of N, P, and K is N (39.98 mg / L), P (11.90 mg / L), and K (4 mg / L). The organic nutrient content of the mixture of brown seaweed and moringa leaves shows that the nutrient content of N, P, and K is N (268,01 mg / L), P (17,52 mg / L), and K (4 mg / L). The organic nutrient content of the mixture of brown seaweed and african leaves extract shows that the nutrient content of N, P, and K is N (42,03 mg / L), P (13,62 mg / L), and K (5 mg / L).

The organic nutrition of a mixture of brown seaweed and lamtoro leaf extract produced a higher canopy dry weight compared to other organic nutrient treatments, this is presumably the treatment has a higher P nutrient content, because phosphorus itself plays an important role in the process of photosynthesis. According to (Liferdi, 2010) and (Malhotra, Vandana, Sharma, & Pandey, 2018) P plays an important role in the processes of photosynthesis, assimilation, respiration, nucleic acid biosynthesis, and is used as a constituent component of several plant structures such as phospholipids. When photosynthesis is higher, the assimilation rate is high. The rate of assimilation has an effect on the shoot growth rate of the plant which will affect the dry weight of the plant crown. The higher the dry weight of the plant canopy, it shows that the vegetative growth is going well. When photosynthesis is higher, the assimilation rate is high. The rate of assimilation has an effect on the shoot growth rate of the plant which will affect the dry weight of the plant shoot. There is also a positive correlation between root growth and shoot growth in plants (Table 5). Similar trend was also reported by (Tolley & Mohammadi, 2020).

The total fresh weight of the plant is influenced by the large number of leaves, because the leaves where the photosynthesis occurs, if photosynthesis goes well, more photosynthate will be formed so that the plant's fresh weight is greater. According to (Efendi, Mawarni, & Junaidi, 2017), short-lived leaf vegetable crops require large amounts of N as the main nutrient. The availability of sufficient amounts of N nutrient will be responded to maximally by mustard plants, so that the plants are able to form protoplasm in greater numbers and produce a greater plant fresh weight.

In the organic nutrition extract mixture of brown seaweed and lamtoro leaves, the total plant fresh weight was the highest among other organic nutrients. This is presumably because the content of N, P, and K in the organic nutrients combined with lamtoro leaves is quite high. According to (Hidayat & Suharyana, 2019) and (Rop, Karuku, Mbui, Njomo, & Michira, 2019), N contained in liquid organic fertilizer made from lamtoro leaves functions as a protein constituent, while the P and K in lamtoro leaves can stimulate meristem tissue division, stimulate root growth, leaf development so that N, P, and K can increase plant fresh weight and increasing crop production, according to (Rambe, 2014), states

that plants will thrive if the nutrients needed by plants are available in a balanced proportion, especially macro nutrients such as N, P and K both in soil and in organic matter. The use of different substrates or organic solutions and inorganic solutions can affect the absorption of nutrients in plants, water absorption, oxygen availability, and maximum plant growth (Ebrahimi, Ebrahimi, & Ahmadizadeh, 2012) so that AB-mix nutritional treatment has more total plant fresh weight. compared to organic nutrient treatment.

According to (Sunarpi, Prasedya, & Nikmatullah, 2019) *Sargassum* sp. is one of the largest genera of brown seaweed from the family Sargassaceae with the main component in the talus *Sargassum* sp. are holocellulose (cellulose and hemicellulose), lignin, and alginate. Talus Sargassum sp. also contains nutrients (macro and micro nutrients), growth promoting hormones, protein and vitamins. This seaweed is also very potential as a food source of minerals, especially a source of calcium, phosphorus, and iron. Seaweed is also in almost all parts of Indonesia, so it has the potential to be used as organic nutrition for plant growth. According to (Basmal et al., 2015), the liquid extract of *Sargassum* sp. can be used as liquid organic fertilizer.

Based on the results of observations of the number of leaves and the level of greenness of the leaves, it was shown that the application of organic nutrition resulted in the number of leaves and leaf greenness that were significantly different from the mustard plants given AB-mix nutrition. Meanwhile, application of organic nutrition to extract a mixture of brown seaweed with lamtoro leaves and mustard greens which were given organic nutrition from a mixture of brown seaweed with coconut husk resulted in the number of leaves and leaf greenness levels that were not significantly different.

Mustard plants that were treated with AB-mix nutrition produced a higher number of leaves compared to the organic nutrition treatment because the nutrients in AB-mix nutrition were readily available in a form that was readily absorbed by plants and their content was in accordance with the plant's needs. One of the highest nutrient elements in the AB-mix nutrient solution is Nitrogen (N). (Xing et al., 2019) stated that nitrogen can be used for the synthesis of nucleic acids and proteins, phospholipids, and many secondary metabolites needed by plants. Leaves that are supplied with nitrogen will form wider leaf blades with a higher chlorophyll content, so that plants are able to produce carbohydrates in high amounts to support the vegetative growth of a plant. (Fitriani, Pangaribuan, Niswati, & Yusnaini, 2020) found that in hydroponic wick system, Nitrogen efficiency could be improved with application of urea and extract of nutrient from organic material derived from vermicompost.

In plants, nitrogen is a macro nutrient needed by plants in large quantities, because nitrogen functions as a form of chlorophyll, which plays an important role in the process of photosynthesis. Chlorophyll functions as a light-capturing pigment for photosynthesis which produces carbohydrates as a source of energy in the respiration process, so that plants can continue their life (Ai & Banyo, 2011). The higher the nitrogen application within the optimum limit, the amount of chlorophyll produced will increase. Nitrogen plays an important role in the photosynthesis process and leaves are green in the presence of chlorophyll. Nitrogen is also the main component in making organic compounds in plants such as nucleic

acids, chlorophyll, amino acids, ADP, and ATP (Syofia, Munar, & Sofyan, 2014).

The quality of water indicated by pH and EC in this experiment is favorable for mustard growth (Table 3 and 4). According to (Mengel & Kirkby, 2011), a nutrient solution that has a pH value of 6 or an optimum pH makes all nutrients dissolve easily and is sufficiently available for plants so that plant growth will be better. At high EC values, organic nutrients cause the plant to have insufficient nutrient needs or decrease the concentration of fertilizers in plants (Argo, 2004)) so that plant growth is inhibited.

The organic nutrient solution not being able to match the quality of AB-mix hydroponic nutrition is thought to be caused by several factors, namely the extraction process, fermentation results, and the hydroponic system used. In the observation that the organic nutrient solution in the anaerobic fermentation method which was carried out for 20 days was not yet perfect (smells like alcohol), so that microorganisms were still active in the organic nutrient solution. In addition to that, this were supported by a nutrient solution that did not move using in the hydroponic axis system. Active microorganisms would cause low pH during fermentation process, so that root development in mustard plants to be

Microorganisms that are still active in the fermentation of organic nutrients make microbes and plant roots compete with each other for oxygen. Root growth that lacks oxygen will result in stunted plants and black/brown roots. According to (Surtinah, 2016), respiration produces the energy needed by plants so that it can be used for assimilation in water absorption, ion absorption and nutrient absorption so that oxygen is very important for the growth and function of plant cells, without oxygen that is sufficient for respiration, water and ion absorption stops, and dead plant roots. Lack of oxygen caused by disturbances in the roots can cause imperfect plant growth and reduce crop yields in plants (Pratiwi, Subandi, & Mustari, 2015).

Fermentation is a way to change the organic substrate with the help of microorganisms, one of the microorganisms that can be used to help composting organic material, namely using EM4 (Effective Microorganism-4) as liquid organic fertilizer because it contains microorganisms that are useful for the composting process and using cattle rumen as an activator for helps speed up composting (Bunga & Lewar, 2009).

This experiment used the hydroponic wix system. The drawback of this system is the absence of movement of the nutrient solution. According to (Akasiska, Samekto, & Siswadi, 2014), roots that are immersed in immobile nutrient solutions cause stunted plant growth due to lack of oxygen which causes root activity in the absorption process of water and mineral nutrients to be disturbed. This results in the organic nutrient solution to be difficult to dissolve, making it difficult for the mustard plant to absorb.

Further research is still needed by testing various extract methods, namely the first stage of the aerobic fermentation method and the second stage of the anaerobic fermentation method in order to obtain a more effective method for dissolving nutrients from organic matter. We suggest also using another method of hydroponic system and not using the wick system. This is because, in the fermentation method and the hydroponic wick system used in this study, the nutrient absorption process is still not effective for the growth of mustard plants.

CONCLUSION

The organic nutrient solution extract of the mixture of brown seaweed, lamtoro leaf, or coconut fiber or moringa or African leaves has not been able to match the nutritional quality of AB-mix for mustard plants in the hydroponic system. The organic nutrition of the mixed extract of brown seaweed and lamtoro leaf was better than other organic nutrients by producing 57.88 g of fresh weight of mustard plants, but only 51.08% of the fresh weight of mustard plants in AB-mix treatment which was 113.31 g.

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ACKNOWLEDGMENT

Thank you for supporting from the staff of the greenhouse and laboratory at Faculty of Agriculture, Universitas Lampung.

REFERENCES

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Influence of Ecklonia maxima Extracts on Growth, Yield, and Postharvest Quality of Hydroponic Leaf Lettuce;

The Effects of Different Seaweed Doses on Yield and Nutritional Values of Hydroponic Wheatgrass Juice

The utilization of vegetable waste as a nutrient addition in hydroponic media for the growth of green mustard (Brassica juncea L.)

Aquaponics using Asian leafy vegetables - Potential and challenge

Effects of aqueous Moringa oleifera leaf extract on growth performance and accumulation of cadmium in a Thai jasmine rice—Khao Dawk Mali 105 variety

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RESPONSES to EDITOR

Edtor Notes	Author Responses
1. This paper is not prepared correctly. Do not prepare the manuscript in layout format, please read the instruction in the template CAREFULLY on how to prepare your paper	The format has been revised
2 Abstract should be initiated with a brief (1 sentence) introduction why this study is urgent.	1 sentence in Abstract has been added
3. Please focus on one objective	The objective has only one
4. Please add the implication of this study to close the abstract	Implication has been added
5. The introduction has not justified the gap of why this study is important. Fail to justify the gap will lead to rejection.	The sentences refer to gap has been added (There have been limited studies concerned on nutrient organic alternative for hydroponic plant nutrition)
6. Please present figures of study objects in the methods and results.	Figure 1 is added
7. Discussion is prepared incorrectly, read the instruction carefully. NEVER divide your discussion into some sub-sections. The results should be discussed COMPREHENSIVELY in the Discussion, starting with the main finding (answering the objective), supported with other data. Fail to prepare the Discussion correctly will lead to rejection.	Discussion start with the main findings
8. Add the discussion with the correlation and regression analysis to help explaining the mechanism of your main finding.	Coefficient Pearson has been added
9. Prepare the citations and references using Mendeley or Endnote.	References is corrected
10. References older than 10 years old should be removed and replaced with references published after 2010.	Many old references < 2010 has been deleted

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Dr. Ir. Mujiyo, S.P., M.P. <jurnal@mail.uns.ac.id>
to me, yohannesginting, rugayah.1961

Tue, Apr 12, 11:40 AM

The following message is being delivered on behalf of Caraka Tani: Journal of Sustainable Agriculture.

Dear Dr. Darwin Habinsaran Pangaribuan,

We have reached a second decision regarding your submission to Caraka Tani: Journal of Sustainable Agriculture, "The effect of combination of plant extract and seaweed (Sargassum sp.) on the growth of mustard plant (Brassica juncea L.) grown by hydroponic wick system".

Our decision is: Revisions Required

This article has the potential to be published (and cited).
Your article should be corrected according to editors' comments. Please find the file attached in your journal account dated today for the reviewers' comments.

31°C Berawan | 12:02 29/11/2022

THE EFFECT OF COMBINATION OF SEAWEED (*SARGASSUM* SP.) AND PLANT EXTRACT ON THE GROWTH OF MUSTARD PLANT (*BRASSICA JUNCEA* L.) GROWN BY HYDROPONIC WICK SYSTEM

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4. Orcid ID :

General comments:

Overall, this research very interesting. However, there are some improvements and corrections needed to get the manuscript to an accepted condition.

Decision: Revisions Required

THE EFFECT OF ~~COMBINATIO~~SEAWEED (~~S~~*sargassum* sp.) COMBINATION ~~*SARGASSUM* SP.)~~ AND PLANT EXTRACT ~~COMBINATION~~ ON THE GROWTH OF MUSTARD PLANT (*BRASSICA JUNCEA* L.) GROWN BY HYDROPONIC WICK SYSTEM

Abstract

Nutrient solution is an important factor for the growth and quality of hydroponic plants; however, the price is getting more expensive. ~~.~~The study was conducted to determine the best combination of extract of brown seaweed~~Seaweed~~ (*Sargassum* sp.) combined with coconut~~Coconut~~ husk~~,~~ leucaena~~Leucaena~~ leaves~~,~~ moringa~~Moringa~~ leaves or African leaves that match to the nutritional quality of AB-mix as hydroponic nutrition for mustard~~Mustard~~ plants. This research was conducted in the greenhouse of the Faculty of Agriculture, University of Lampung. The design used was a Randomized Block Design (RBD) with six replications. The treatments consisted of six types of treatment, namely AB-mix nutrition, brown seaweed, seaweed~~Seaweed, Seaweed~~ and leucaena~~Leucaena~~ leaf, seaweed~~Seaweed~~ and coconut~~Coconut~~ fiber, seaweed~~Seaweed~~ and moringa~~Moringa~~ leaf, seaweed~~Seaweed~~ and African leaf. ~~–~~Research showed that the organic nutrient solution extracting from the mixture of brown seaweed~~Seaweed~~ with leucaena~~Leucaena~~ leaf, or coconut~~Coconut~~ fiber or moringa~~Moringa~~ leaves or African leaves has not been able to match the quality of AB-mix nutrition for mustard~~Mustard~~ plants in the hydroponic system. However, among those treatments, the best fresh weight of mustard~~Mustard~~ was found on the treatment of brown Seaweed and Leucaena leaf combination namely 51.08% from the total fresh weight from of the control AB Mix.

Keywords: fresh weight of plants, organic nutrition, plant extract, plant nutrition, seedling growth

INTRODUCTION

Farmers usually use the land for media in developing their agricultural products. ~~Utilization~~ The utilization of non-agricultural land can be supported by agricultural intensification, one of which is hydroponic technology. Hydroponics is an agricultural cultivation ~~of~~ land without using soil media, so that it uses water as a nutrient medium that will be directly absorbed by plants to support plant growth Resh (2013). According to Vidianto et al. (2013), hydroponic technology does not have to require a large area of land so that hydroponic cultivation is suitable to be developed on a narrow land.

One of the hydroponic techniques used is the wicks system hydroponics technology. The advantages of this hydroponic system do not require electrical resources, the amount of fertilizer, plants grow optimally~~,~~ and are easy to control. The weakness of the hydroponic axis system is that the nutrient solution is not circulating so that~~the~~ plant growth~~grows~~ slowly ~~(~~Kamalia et al. (~~,~~2017). The essential part that needs to be considered in hydroponic cultivation is nutrient solutions.

Nutrient~~The nutrient~~ solution is an important factor for the growth and quality of hydroponic plants, so it must be precise in terms of the amount of nutrient ion composition and temperature (Trejo-Téllez & Gómez-Merino, 2012). The source of nutrition used in hydroponic cultivation generally uses inorganic nutrients, one of which is AB-mix nutrient solution. AB-mix nutrient solution contains macro and micro elements.~~microelements.~~ Treatment using AB-mix nutrition gave higher yields and plant quality. AB-mix nutrition increased~~increases~~ growth and production in spinach, pakcoy~~Spinach, Pak choy~~, and lettuce~~Lettuce~~ (Nugraha & Susila, 2015) and spinach, caisin~~Spinach, Caisin~~, and kalian~~Kailan~~,

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THE EFFECT OF SEAWEED (*SARGASSUM* SP.) AND PLANT EXTRACT COMBINATIONS ON THE GROWTH OF MUSTARD PLANT (*BRASSICA JUNCEA* L.) GROWN BY HYDROPONIC WICK SYSTEM

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(Ramadiani & Susila, 2014). In terms of cost, AB-mix nutrition has a relatively more expensive price (Nugraha & Susila, 2015) because the use and purchase of AB Mix nutrients must be in one package. Therefore, a solution is needed to overcome this problem, namely obtaining organic nutrients by utilizing plant-based organic material sources.

Ideally, the composition of organic hydroponic nutrition should approach the quality of inorganic nutrients from AB Mix. Those organic materials that will be used need to be extracted and fermented as shown by several researchers (Kamla et al., 2008; Ndubuaku et al., 2014) so that their nutritional content can be released as a source of organic nutrition for hydroponic nutrient solution. The advantage of agricultural organic products harvested here will be free from chemicals that are harmful to human health and are safe for consumption.

Organic materials that can be used as a source of organic nutrition for hydroponic nutrient solutions are brown seaweed, coconut husk, leucaena leaves, moringa leaves, or African leaves. According to the study of Basmal (2009), seaweed can be used as an organic fertilizer because it contains growth regulators including auxins, cytokines, gibberellin, abscisic acid, and ethylene and is rich in trace minerals (Fe, B, Ca, Cu, Cl, K, Mg, and Mn). This is reinforced by the results of research by Basmal et al. (2015), which found that the liquid extract of seaweed contained auxin of 127.48 ppm, gibberellin at 131.11 ppm, cytokinin-kinetin at 68.77 ppm, cytokinin-zeatin at 82.41 ppm; macro nutrient potassium (K) of 345.29 mg 100 g^{-1}, nitrogen (N) of 0.78%, phosphorous (P) 55.39 mg 100 ml^{-1}, and pH value 7. Another ploant-based organic material are coconut coir, leucaena, moringa leaves, and African leaves. According to Ramadhani (2011), coconut husk has a very rich element of potassium and also contains 30% fiber. According to Eniolorunda (2011), proximate composition of leucaena are crude protein, crude fibre, ash, and nitrogen free extract. Moringa leaves contain protein, calcium, phosphorus, iron, and zinc (Salim et al., 2018). African leaves have several substances that are good for plants such as protein, amino acids, ascorbic acid, carotenoids, fats, carbohydrates, and fiber (Ijeh & Ejika, 2011). African leaves are medicinal plants that can be used as for inflammation (Setiani & Rusli, 2020). Researcher Nurjannah et al. (2021), used fermented brown algae extract and showed that the growth of corn was improved.

There have been limited studies concerned on with nutrient organic alternative for hydroponic plant nutrition. Therefore, this study was conducted to determine organic nutrition extract mixture of brown seaweed (*Sargassum* sp.) combined with coconut husk, or leucaena leaves, or moringa leaves, and African leaves that match to the nutritional quality of AB-mix as hydroponic nutrition for mustard plants.

MATERIALS AND METHOD

This research was conducted in the greenhouse of the Faculty of Agriculture, University of

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Lampung located at 220 5°21'55"~~-~~S and 105°14'32"~~-~~E with an elevation of 150 meters above mean sea level in~~from~~ November 2019 - March 2020. The materials used are mustard~~Mustard~~ seeds, seaweed~~Seaweed~~ (*Sargassum* sp.) coconut~~Coconut~~ husk, leucaena~~Leucaena~~ leaves, AB Mix nutrient solution, water, beef rumen, EM4, and sugar.

The design used was a randomized complete design (RCD) with six replications. The treatments consisted of six types of treatment, namely AB-mix nutrition, brown seaweed~~Seaweed~~, brown seaweed~~Seaweed~~ and leucaena~~Leucaena~~ leaves, brown seaweed~~Seaweed~~ and coconut~~Coconut~~ husk, brown seaweed~~Seaweed~~ and moringa~~Moringa~~ leaves, and brown seaweed~~Seaweed~~ and African leaves.

This research was carried out starting from the preparation stage of hydroponic wick system installation. After that the preparation of liquid organic nutrition by preparing 5 kg respectively of brown seaweed, leucaena~~Seaweed, Leucaena~~ leaves, coconut~~Coconut~~ husk, moringa~~Moringa~~ leaves, African leaves. All materials, then, had been chopped into small pieces. Then, the ingredients are blended until smooth for 3 minutes with a ~~ratio of 300 g: 1 l of water~~300 g : 1 l~~L~~ of water ratio. All materials were extracted and fermented and added with beef rumen and EM4 as a bio activator, 80 l~~L~~ of refined sugar, and water. Fermentation was carried out for 20 days. Sowing of the seeds is carried out in rice husk and compost for 14 days or until 2 to 3 leaves appear. Then, ~~an~~ analysis of nutrients was carried out in the fermented organic nutrient solution to determine the N, P, and K content of each organic nutrient solution. Preparation of AB-mix nutrient solution (Hydro J.) consists of nutrients A and B. Nutrients A as much as 500 ml~~mL~~ combined with and B as much as 250 ml~~mL~~ and add 100 l~~L~~ of water, then stir until blended. Organic nutrition is made by mixing organic matter and water, namely in a ratio of 1: 9.

Planting of mustard~~Mustard~~ plants that are 14 days old or after the mustard~~Mustard~~ plants appear 2-3 leaves to the hydroponic wick system. After that, maintenance is carried out by controlling the nutrients in the tube ~~including the volume of the solution~~, including the solution's volume, measuring the pH, and measuring the viscosity of the solution (EC) at each installation. Harvesting of mustard~~Mustard~~ greens is carried out at the age of 30 days after planting (DAP) when the plants have reached their maximum growth with the characteristics of the plant height of approximately 26-33 cm, fresh green leaves, light green stems.

The observed variables were ~~the~~ number of leaves (14 DAP), leaf greenness (SPAD at 21 DAP), shoot dry weight (30 DAP), root fresh weight (30 DAP), total plant fresh weight (30 DAP). Data were analysis~~analyzed~~ using ~~the~~ F test then continued with the mean separation with the Honestly Significantly Difference at the 5% level.

RESULTS AND DISCUSSION

The organic nutrition treatment of the mixture of brown seaweed~~Seaweed~~ and leucaena~~Leucaena~~ leaf extract resulted in higher root fresh weight among other organic nutrient treatments (Table 1). It is suspected that the availability of nutrients in the organic nutrition of the mixture of brown

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seaweedSeaweed and leucaenaLeucaena leaves during the growth process is able to provide the essential macro needs of plants. In addition, the combination of these organic nutrients is thought to be able to support the supply of nutrients in the root area, so that the roots can easily absorb these nutrients. According to Atari et al. (2017), good plant roots can affect the photosynthesis process and nutrients can be easily absorbed so that it can increase plant growth which will affect the components of mustardMustard plant production. The greater the weight of the plant roots, the greater the plant will absorb nutrients. The fact that leucaenaLeucaena is the best plant for the source of extraction is supported by its nutrient content. Results of the analysis of nutrients N, P, and K showed that the nutrient content of N, P, and K in the organic nutrition of the mixture of brown seaweedSeaweed and leucaenaLeucaena leaf extract is the highest among other organic nutrients, which is equal to N (216.98 mg L^{-1}), P (16.52 mg L^{-1}), and K (6 mg L^{-1}). The organic nutrient content of the mixture of brown seaweedSeaweed and coconutCoconut husk extract shows that the nutrient content of N, P, and K is N (39.98 mg L^{-1}), P (11.90 mg L^{-1}), and K (4 mg L^{-1}). The organic nutrient content of the mixture of brown seaweedSeaweed and moringaMoringa leaves shows that the nutrient content of N, P, and K is N (268,01 mg L^{-1}), P (17,52 mg L^{-1}), and K (4 mg L^{-1}). The organic nutrient content of the mixture of brown seaweedSeaweed and African leaves extract shows that the nutrient content of N, P, and K is N (42,03 mg L^{-1}), P (13,62 mg L^{-1}), and K (5 mg L^{-1}).

The results showed that AB-mix nutrition resulted in shoot dry weight, root fresh weight, and total plant fresh weight, which werewas significantly different from the mustardMustard plants treated with organic nutrition. Shoot dry weight in the treatment of organic nutrition mixture of brown seaweedSeaweed and leucaenaLeucaena leaves and organic nutrition treatment of a mixture of brown seaweedSeaweed and coconutCoconut husk only reached 62.18% of the shoot dry weight in AB-mix nutrient solution treatment. Mustard plants given AB-mix treatment has dry medicine the shoot greater, namely 10.54 g compared to the treatment of organic nutrition mixture of brown seaweedSeaweed and leaves of leucaenaLeucaena, namely 4.50 g, followed by treatment of organic nutrition mixture of brown seaweedSeaweed and coconutCoconut husk, namely 3.96 g (Table 1).

The AB-mix nutritional treatment resulted in a 41.11% higher root fresh weight than the root fresh weight of the organic nutrient solution of the mixture of brown seaweedSeaweed and leucaenaLeucaena leaf extract. The AB-mix nutritional treatment produced the highest root fresh weight, namely 5.01 g compared to 2.95 g (Table 2). The total fresh weight of mustardMustard plants in the organic nutrient treatment of the mixture of brown seaweedSeaweed and leucaenaLeucaena leaves only reached 51.08% of the total fresh weight of the plants in the AB-mix nutrient solution treatment (Figure 1). The AB-mix nutritional treatment resulted in the total fresh weight of mustardMustard plants in the mustardMustard plant, namely 113.31 g, higher than the treatment of organic nutrient solution mixture of brown seaweedSeaweed and leucaenaLeucaena leaves which was 57.88 g (Table 2).

Table 1. Effect of organic nutrients from extracts of some organic matter on shoot dry weight, root

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fresh weight, and total fresh weight variables of mustardMustard plants

Treatment	Shoot dry weight of 3 plants		Root fresh weight of 3 plants		Total fresh weight of mustardMustard plants of 6 plants	
	Original	Trans √ (X + 0.5)	Original	Trans √ (X + 0.5)	Original	Trans √ (X + 0.5)
	g		g		g	
AB-mix	10.54 a	3.20	5.01 a	2.22	113.31 a	10.51
Seaweed	0.24 d	0.47	0.95 e	0.96	2.59 e	1.60
Seaweed + leucaenaLeucaena leaf	4.50 b	2.05	2.95 b	1.71	57.88 b	7.51
Seaweed + coconutCoconut fiber	3.96 b	1.93	1.89 c	1.36	27.87 b	5.17
Seaweed + moringaMoringa leaf	5.16 b	2.25	1.66 d	1.28	23.79 c	4.85
Seaweed + African leaf	1.20 c	1.07	1.31 de	1.14	6.99 d	2.64
HSD 5%	0.40		0.19		1.39	

Notes: The mean value followed by the same letter does not differ at the 5% level.

The organic nutrition of a mixture of brown seaweedSeaweed and leucaenaLeucaena leaf extract produced a higher canopy dry weight compared to other organic nutrient treatments, this is presumably the treatment has a higher P nutrient content, because phosphorus itself plays an important role in the process of photosynthesis. According to Liferdi (2010) and Malhotra et al. (2018)), P plays an important role in the processes of photosynthesis, assimilation, respiration, nucleic acid biosynthesis, and is used as a constituent component of several plant structures such as phospholipids. When photosynthesis is higher, the assimilation rate is high. The rate of assimilation has an effect on the shoot growth rate of the plant which will affect the dry weight of the plant crown. The higher the dry weight of the plant canopy, it shows that the vegetative growth is going well. When photosynthesis is higher, the assimilation rate is high. The rate of assimilation has an effect on the shoot growth rate of the plant which will affect the dry weight of the plant shoot. There is also a positive correlation between root growth and shoot growth in plants (Table 5). SimilarA similar trend was also reported by Tolley and Mohammadi (2020).

The total fresh weight of the plant is influenced by thea large number of leaves, because the leaves are where the photosynthesis occurs, if photosynthesis goes well, more photosynthate will be formed so that the plant's fresh weight is greater. According to Efendi et al. (2017), short-lived leaf vegetable crops require large amounts of N as the main nutrient. The availability of sufficient amounts of N nutrient will be responded to maximally by mustardMustard plants, so that the plants are able tocan form protoplasm in greater numbers and produce a greater plant fresh weight.

In the organic nutrition extract mixture of brown seaweedSeaweed and leucaenaLeucaena leaves, the total plant fresh weight was the highest among other organic nutrients. This is presumably because the content of N, P, and K in the organic nutrients combined with leucaenaLeucaena leaves is quite high. According to Hidayat and Suharyana (2019) and Rop et al. (2019), N contained in liquid organic

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fertilizer made from leucaenaLeucaena, leaves functions as a protein constituent, while the P and K in leucaenaLeucaena, leaves can stimulate meristem tissue division, stimulate root growth, leaf development so that N, P, and K increase plant fresh weight and increasing crop production. Rambe (2014), stated that plants will survive if the nutrients needed by plants are available in a balanced proportion, especially macro nutrientsmacronutrients, such as N, P, and K both in soil and in organic matter. The use of different substrates or organic solutions and inorganic solutions can affect the absorption of nutrients in plants, water absorption, oxygen availability, and maximum plant growth Ebrahimi et al. (2012)), so that AB-mix nutritional treatment has more total plant fresh weight, compared to organic nutrient treatment.

According to Sunarpi et al. (2019)), *Sargassum* sp. is one of the largest genera of brown seaweedSeaweed, from the family Sargassaceae with the main component in the talus *Sargassum* sp. are holocellulose (cellulose and hemicellulose), lignin, and alginate. Talus *Sargassum* sp. also contains nutrients (macro and micro nutrientsmicronutrients), growth-, promoting hormones, protein-, and vitamins. This seaweedSeaweed, is also very potential as a food source of minerals, especially a source of calcium, phosphorus, and iron. Seaweed is also in almost all parts of Indonesia, so it has the potential to be used as organic nutrition for plant growth. According to Basmal et al. (2015), the liquid extract of *Sargassum* sp. can be used as liquid organic fertilizer. Research by Miceli et al. (2021) showed that Ecklonia maxima is a brown algae seaweedSeaweed, between 2 and 4 mL L_{-1}, enhanced plant growth and improved the yield and many morphological and physiological traits of lettuceLettuce.

The results showed that the treatment of organic nutrient solutions could not match the quality of AB-mix hydroponic nutrient solutions as hydroponic nutrients for mustardMustard, plant cultivation. Mustard plants treated with organic nutrition produced leaf numbers and the, greenish levels that were significantly different from those treated with AB-mix hydroponic nutrition. This can be seen from the number of mustardMustard, leaves in the organic nutrient solution treatment only reachedreaching, 85.61% of the number of leaves in the AB-mix hydroponic nutrient solution treatment. The number of leaves in the AB-mix hydroponic nutrition treatment was 8.56 leaves, while the average number of leaves in the three types of organic nutrition treatment was only 6.27 leaves (Table 2). The level of leaf greenness in the organic nutrition treatment of the mixture of brown seaweedSeaweed, and leucaenaLeucaena, leaf extract and the organic nutrition of the mixture of brown seaweedSeaweed, and coconutCoconut, husk only reached 88.73% of the greenness level of the leaves in the AB-mix nutrient solution treatment. The highest leaf greenness level variable was obtained in the AB-mix treatment, it was 34.37 unitunits, compared to the organic nutrient treatment of the mixture of brown seaweedSeaweed, and leucaenaLeucaena, leaf extract which was only 28.52 unitunits, and followed by the organic nutrition treatment of the mixture of brown seaweedSeaweed, and coconutCoconut, husk extract which was 25.66 unitunits, (Table 2).

Table 2. Effect of organic nutrients from extracts of several organic materials on the variable number

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of leaves and SPAD of mustard plants

Treatment	Number of leaves		SPAD	
	Original	Trans √ (X + 0.5)	Original	Trans √ (X + 0.5)
	blade		unit	
AB-mix	8.56 a	2.92	34.37 a	5.86
Seaweed	1.64 e	1.28	12.85 c	3.57
Seaweed + leucaena leaf	6.50 b	2.54	28.52 b	5.34
Seaweed + coconut fiber	6.61 c	2.57	25.66 b	5.06
Seaweed + moringa leaf	3.29 c	1.80	33.77 ab	5.80
Seaweed + African leaf	2.58 d	1.58	27.01 b	5.18
HSD 5%	0.33		0.46	

Notes: The mean value followed by the same letter does not differ at the 5% level

Based on the results of observations of the number of leaves and the level of greenness of the leaves, it was shown that the application of organic nutrition resulted in the number of leaves and leaf greenness that were significantly different from the mustard plants given AB-mix nutrition. Meanwhile, the application of organic nutrition to extract a mixture of brown seaweed with leucaena leaves and mustard greens which were given organic nutrition from a mixture of brown seaweed with coconut husk resulted in the number of leaves and leaf greenness levels that were not significantly different.

Mustard plants that were treated with AB-mix nutrition produced a higher number of leaves compared to the organic nutrition treatment because the nutrients in AB-mix nutrition were readily available in a form that was readily absorbed by plants and their content was in accordance with the plant's needs. One of the highest nutrient elements in the AB-mix nutrient solution is Nitrogen (N). Xing et al. (2019) stated that nitrogen can be used for the synthesis of nucleic acids and proteins, phospholipids, and many secondary metabolites needed by plants. Leaves that are supplied with nitrogen will form wider leaf blades with a higher chlorophyll content, so that plants are able to produce carbohydrates in high amounts to support the vegetative growth of a plant. Fitriani et al. (2020) found that in a hydroponic wick system, Nitrogen efficiency could be improved with the application of urea and extract of nutrient from organic material derived from vermicompost.

In plants, nitrogen is a macro nutrient needed by plants in large quantities, because nitrogen functions as a form of chlorophyll, which plays an important role in the process of photosynthesis. Chlorophyll functions as a light-capturing pigment for photosynthesis which produces carbohydrates as a source of energy in the respiration process, so that plants can continue their life (Ai & Banyo, 2011). The higher the nitrogen application within the optimum limit, the amount of chlorophyll produced will increase. Nitrogen plays an important role in the photosynthesis process and leaves are green in the presence of chlorophyll. Nitrogen is also the main component in making organic compounds in plants such as nucleic acids, chlorophyll, amino acids, ADP, and ATP (Syofia et al., 2014).

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Figure 1. Growth of mustard~~Mustard~~ plants treated with AB-Mix (left) and treated seaweed~~Seaweed~~ and leucaena~~Leucaena~~ leaf (right).

The pH value of all treatments are the AB-mix solution ranges from 6.8-7, brown seaweed~~Seaweed~~ extract is 4-4.5, in a mixture of brown seaweed~~Seaweed~~ extract and leucaena~~Leucaena~~ leaf is 5.2-5,5, a mixture of brown seaweed~~Seaweed~~ and coconut~~Coconut~~ husk is 4.8-5, in a mixture seaweed~~Seaweed~~ and moringa~~Moringa~~ leaf is 4.8-5.0, and in a mixture seaweed~~Seaweed~~ and African leaf is 4.0-4.5. In this study, the highest EC value was in the AB-mix nutrient solution, which ranged from 1,082 to 1,111 ppm, while the EC value in organic nutrient solutions of all treatments ranged from 550-701 ppm.

The quality of water indicated by pH and EC in this experiment is favorable for mustard~~Mustard~~ growth (Table~~Tables~~ 3 and 4). According to Mengel et al. (2001), a nutrient solution that has a pH value of 6 or an optimum pH makes all nutrients dissolve easily and is sufficiently available for plants so that plant growth will be better. At high EC values, organic nutrients cause the plant to have insufficient nutrient needs or decrease the concentration of fertilizers in plants (Argo, 2004) so that plant growth is inhibited.

Table 3. Concentration parameters of the nutrient solution of mustard~~Mustard~~ plants

Treatment	EC (ppm)			
	7 DAP	14 DAP	21 DAP	28 DAP
AB-mix	1,082.00	1,101.00	1,103.00	1,092.00
Seaweed	508.00	500.00	502.00	500.00
Seaweed + leucaena~~Leucaena~~ leaf	562.00	619.00	620.00	701.00
Seaweed + coconut~~Coconut~~ fiber	520.00	500.00	610.00	625.00
Seaweed + moringa~~Moringa~~ leaf	501.00	571.00	600.00	602.00
Seaweed + African leaf	510.00	520.00	511.00	507.00

Table 4. pH parameter of mustard~~Mustard~~ plants

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Treatment	pH			
	7 DAP	14 DAP	21 DAP	28 DAP
AB-mix	6.9	6.8	7.0	6.9
Seaweed	4.1	4.0	4.3	4.5
Seaweed + leucaena~~Leucaena~~ leaf	5.2	5.2	5.5	5.4
Seaweed + coconut~~Coconut~~ fiber	4.9	5.0	4.8	5.0
Seaweed + moringa~~Moringa~~ leaf	5.0	4.9	4.9	4.8
Seaweed + African leaf	4.3	4.0	4.5	4.4

The results of the correlation test for vegetative and generative variables through the Pearson correlation test (Table 5) showed that the vegetative variable i.e. ~~the~~ number of leaves resulted in a significantly different positive correlation with the generative variables i.e. shoot dry weight, root fresh weight, and shoot fresh weight. Likewise, there is a significant correlation between root fresh weight and shoot fresh weight.

Table 5. Correlation coefficient between vegetative and generative traits

Variables	Number of leaves	SPAD	Shoot dry weight	Root fresh weight	Shoot fresh weight
Number of leaves	1				
SPAD	0.58	1			
Shoot dry weight	0.84*	0.78	1		
Root fresh weight	0.88*	0.62	0.93**	1	
Shoot fresh weight	0.88*	0.62	0.94**	0.99**	1

Note: * = Significant at P<0.05; ** = highly significant at P<0.01

In plants, nitrogen is a macro nutrient~~macronutrient~~ needed by plants in large quantities, because nitrogen functions as a form of chlorophyll, which plays an important role in the process of photosynthesis. Chlorophyll functions as a light-capturing pigment for photosynthesis which produces carbohydrates as a source of energy in the respiration process, so that plants can continue their life (Ai & Banyo, 2011). The higher the nitrogen application within the optimum limit, the amount of chlorophyll produced will increase. Nitrogen plays an important role in the photosynthesis process and leaves are green in the presence of chlorophyll. Nitrogen is also the main component in making organic compounds in plants such as nucleic acids, chlorophyll, amino acids, ADP, and ATP (Syofia et al., 2014).

The organic nutrient solution not being able to match the quality of AB-mix hydroponic nutrition is thought to be caused by several factors, namely the extraction process, fermentation results, and the hydroponic system used. In the observation that the organic nutrient solution in the anaerobic fermentation method which was carried out for 20 days was not yet perfect (smells like alcohol), so that microorganisms were still active in the organic nutrient solution. In addition to that, this were~~was~~ supported by a nutrient solution that did not move using in the hydroponic axis system. Active

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microorganisms would cause low pH during ~~the~~ fermentation process, so that root development in mustard~~Mustard~~ plants to be ?~~????????~~

Microorganisms that are still active in the fermentation of organic nutrients make microbes and plant roots compete with each other for oxygen. Root growth that lacks oxygen will result in stunted plants and black/brown roots. According to Surtinah (2016), respiration produces the energy needed by plants so that it can be used for assimilation in water absorption, ion absorption~~,~~ and nutrient absorption so that oxygen is very important for the growth and function of plant cells, without oxygen that is sufficient for respiration, water~~,~~ and ion absorption stops, and dead plant roots. Lack of oxygen caused by disturbances in the roots can cause imperfect plant growth and reduce crop yields in plants (Pratiwi et al., 2015).

Fermentation is a way to change the organic substrate with the help of microorganisms (Sharma et al., 2020), one of the microorganisms that can be used to help composting~~compost~~ organic material, namely using EM4 (Effective Microorganism-4) as liquid organic fertilizer because it contains microorganisms that are useful for the composting process and using cattle rumen as an activator for helps speed up composting (Bunga & Lewar, 2009).

This experiment used the hydroponic wix~~wick~~ system. The drawback of this system is the absence of movement of the nutrient solution. According to Akasiska et al. (2014), roots that are immersed in immobile nutrient solutions cause stunted plant growth due to ~~a~~ lack of oxygen which causes root activity in the absorption process of water and mineral nutrients to be disturbed. This results in the organic nutrient solution to be~~being~~ difficult to dissolve, making it difficult for the mustard~~Mustard~~ plant to absorb.

Many resources could be utilized as the substitutes of~~for~~ AB Mix nutrition, such as vegetable waste (Faruq et al., 2021) and seaweed~~Seaweed~~ extract as shown from~~by~~ this research. Further research is still needed by testing various extract methods, namely the first stage of the aerobic fermentation method and the second stage of the anaerobic fermentation method in order to obtain a more effective method for dissolving nutrients from organic matter. We suggest also using another method of hydroponic system and not using the wick system. This is because, in the fermentation method and the hydroponic wick system used in this study, the nutrient absorption process is still not effective for the growth of mustard~~Mustard~~ plants.

CONCLUSION

The organic nutrient solution extract of the mixture of brown seaweed, leucaena~~Seaweed, Leucaena~~ leaf, coconut~~Coconut~~ fiber, moringa~~Moringa~~, or African leaves has not been able to match the nutritional quality of AB-mix for mustard~~Mustard~~ plants in the hydroponic system. The organic nutrition of the mixed extract of brown seaweed~~Seaweed~~ and leucaena~~Leucaena~~ leaf was better than other organic nutrients by producing 57.88 g of fresh weight of mustard~~Mustard~~ plants, but only 51.08% of the fresh weight of mustard~~Mustard~~ plants in AB-mix treatment which was 113.31 g. Further research

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to find the best organic nutrition which has the same quality as AB Mix is needed.

ACKNOWLEDGMENT

Thank you for supporting from the staff of the greenhouse and laboratory at Faculty of Agriculture, Universitas Lampung.

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THE EFFECT OF COMBINATION OF SEAWEED (*SARGASSUM* SP.) AND PLANT EXTRACT ON THE GROWTH OF MUSTARD PLANT (*BRASSICA JUNCEA* L.) GROWN BY HYDROPONIC WICK SYSTEM

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THE EFFECT OF SEAWEED (*SARGASSUM* SP.) AND PLANT EXTRACT COMBINATION ON THE GROWTH OF MUSTARD PLANT (*BRASSICA JUNCEA* L.) GROWN BY HYDROPONIC WICK SYSTEM

Abstract

Nutrient solution is an important factor for the growth and quality of hydroponic plants; however, the price is getting more expensive. Seaweed is abundantly available along tropical coast. The study was conducted to determine the best combination of extract of brown seaweed (*Sargassum* sp.) combined with coconut husk or leucaena leaves or moringa leaves or African leaves that match to the nutritional quality of AB-mix as hydroponic nutrition for mustard plants. This research was conducted in the greenhouse of the Faculty of Agriculture, Universitas Lampung. The design used was a Randomized Block Design (RBD) with six replications. The treatments consisted of six types of treatment, namely AB-mix nutrition, brown seaweed, seaweed and leucaena leaf, seaweed and coconut fiber, seaweed and moringa leaf, seaweed and African leaf. Research showed that the organic nutrient solution extracting from the mixture of brown seaweed with leucaena leaf, or coconut fiber or moringa leaves or African leaves has not been able to match the quality of AB-mix nutrition for mustard plants in the hydroponic system. However, among those treatments, the best fresh weight of mustard was found on the treatment of the combination of brown seaweed and leucaena leaf namely 51.08% from total fresh weight from control AB Mix.

Keywords: fresh weight of plants, organic nutrition, plant extract, plant nutrition, seedling growth

INTRODUCTION

Farmers usually use the land for media in developing their agricultural products. The utilization of non-agricultural land can be supported by agricultural intensification, one of which is hydroponic technology. Hydroponics is an agricultural cultivation land without using soil media, so that it uses water as a nutrient medium that will be directly absorbed by plants to support plant growth (Resh 2013). According to Vidianto et al. (2013), hydroponic technology does not have to require a large area of land so that hydroponic cultivation is suitable to be developed on a narrow land.

One of the hydroponic techniques used is the wicks system hydroponics technology. The advantages of this hydroponic system do not require electrical resources, the amount of fertilizer, plants grow optimally, and are easy to control. The weakness of the hydroponic axis system is that the nutrient solution is not circulating so that plant growth slowly Kamalia et al., (2017). The essential part that needs to be considered in hydroponic cultivation is nutrient solutions.

Nutrient solution is an important factor for the growth and quality of hydroponic plants, so it must be precise in terms of the amount of nutrient ion composition and temperature (Trejo-Téllez & Gómez-Merino, 2012). The source of nutrition used in hydroponic cultivation generally uses inorganic nutrients, one of which is AB-mix nutrient solution. AB-mix nutrient solution contains macro and micro elements. Treatment using AB-mix nutrition gave higher yields and plant quality. AB-mix nutrition increased growth and production in spinach, pakcoy, and lettuce (Nugraha & Susila, 2015) and spinach, caisin, and kalian (Ramadiani & Susila, 2014). In terms of cost, AB-mix nutrition has a relatively more expensive price (Nugraha & Susila, 2015) because the use and purchase of AB Mix nutrients must be in one package. Therefore, a solution is needed to overcome this problem, namely obtaining organic

nutrients by utilizing plant-based organic material sources. Utilization of plant-based organic materials will support sustainable tropical agriculture to provide cheap and easily available nutrients.

Ideally, the composition of organic hydroponic nutrition should approach the quality of inorganic nutrients from AB Mix. Those organic materials that will be used need to be extracted and fermented as shown by several researchers (Kamla et al., 2008; Ndubuaku et al., 2014) so that their nutritional content can be released as a source of organic nutrition for hydroponic nutrient solution. The advantage of agricultural organic products harvested here will be free from chemicals that are harmful to human health and are safe for consumption.

Organic materials that can be used as a source of organic nutrition for hydroponic nutrient solutions are brown seaweed, coconut husk, leucaena leaves, moringa leaves, or African leaves. According to the study of Basmal (2009), seaweed can be used as organic fertilizer because it contains growth regulators including auxins, cytokines, gibberellin, abscisic acid and ethylene and is rich in trace minerals (Fe, B, Ca, Cu, Cl, K, Mg, and Mn). This is reinforced by the results of research by Basmal et al. (2015), which found that the liquid extract of seaweed contained auxin of 127.48 ppm, gibberellin 131.11 ppm, cytokinin-kinetin 68.77 ppm, cytokinin-zeatin 82.41 ppm; macro nutrient potassium (K) of 345.29 mg 100 g^{-1}, nitrogen (N) of 0.78%, phosphorous (P) 55.39 mg 100 ml^{-1}, and pH value 7. The positive benefits of seaweed originating from tropical coastal waters when combined with other land plant extracts will provide richer content. Another plant-based organic material is coconut coir, leucaena, moringa leaves, and African leaves. According to Ramadhani (2011), coconut husk has a very rich element of potassium and also contains 30% fiber. According to Eniolorunda (2011) proximate composition of leucaena are crude protein, crude fibre, ash, and nitrogen free extract. Moringa leaves contain protein, calcium, phosphorus, iron and zinc (Salim et al., 2018). African leaves have several substances that are good for plants such as protein, amino acids, ascorbic acid, carotenoids, fats, carbohydrates, and fiber (Ijeh & Ejika, 2011). African leaves are medicinal plants that can be used as inflammation (Setiani & Rusli, 2020). Researcher Nurjannah et al., (2021) used fermented brown algae extract and showed that the growth of corn was improved.

There have been limited studies concerned on nutrient organic alternative for hydroponic plant nutrition. Therefore, this study was conducted to determine organic nutrition extract mixture of brown seaweed (*Sargassum* sp.) combined with coconut husk, or leucaena leaves, or moringa leaves, and African leaves that match to the nutritional quality of AB-mix as hydroponic nutrition for mustard plants.

MATERIALS AND METHOD

This research was conducted in the greenhouse of the Faculty of Agriculture, University of Lampung located at 220 5°21'55" S and 105°14'32" E with an elevation of 150 meters above mean sea level in November 2019 - March 2020. The microclimate of inside greenhouse was temperature 30.5°C, RH 69%, and light intensity 10000 lux. The materials used are mustard seeds, seaweed (*Sargassum* sp.)

coconut husk, leucaena leaves, AB Mix nutrient solution, water, beef rumen, EM4, and sugar.

The design used was a randomized complete design (RCD) with six replications. The treatments consisted of six types of treatment, namely AB-mix nutrition, brown seaweed, brown seaweed and leucaena leaves, brown seaweed and coconut husk, brown seaweed and moringa leaves, and brown seaweed and African leaves.

This research was carried out starting from the preparation stage of hydroponic wick system installation. After that the preparation of liquid organic nutrition by preparing 5 kg respectively of brown seaweed, leucaena leaves, coconut husk, moringa leaves, African leaves. All materials, then, had been chopped into small pieces. Then, the ingredients are blended until smooth for 3 minutes with a 300 g: 1 l of water. All materials were extracted and fermented and added with beef rumen and EM4 as a bioactivator, 80 l of refined sugar and water. Fermentation was carried out for 20 days. Sowing of the seeds is carried out in rice husk and compost for 14 days or until 2 to 3 leaves appear. Then, analysis of nutrients was carried out in the fermented organic nutrient solution to determine the N, P, and K content of each organic nutrient solution. Preparation of AB-mix nutrient solution (*Hydro J.)* consists of nutrients A and B. Nutrients A as much as 500 ml combined with and B as much as 250 ml and add 100 l of water, then stir until blended. Organic nutrition is made by mixing organic matter and water, namely in a ratio of 1: 9.

Planting of mustard plants that are 14 days old or after the mustard plants appear 2-3 leaves to the container with dimensions of 38 cm x 28 cm x 12 cm in hydroponic wick system. Planting distance was 12 cm x 15 cm. After that, maintenance is carried out by controlling the nutrients in the tube including the volume of the solution, measuring the pH, and measuring the viscosity of the solution (EC) at each installation. Harvesting of mustard greens is carried out at the age of 30 days after planting (DAP) when the plants have reached their maximum growth with the characteristics of the plant height of approximately 26-33 cm, fresh green leaves, light green stems.

The observed variables were number of leaves (14 DAP), leaf greenness (soil plant analysis development, SPAD, at 21 DAP), shoot dry weight (30 DAP), root fresh weight (30 DAP), total plant fresh weight (30 DAP). Data were analysis using F test then continued with the mean separation with the Honestly Significantly Difference at the 5% level.

RESULTS AND DISCUSSION

The organic nutrition treatment of the mixture of brown seaweed and leucaena leaf extract resulted in higher root fresh weight among other organic nutrient treatments (Table 1). It is suspected that the availability of nutrients in the organic nutrition of the mixture of brown seaweed and leucaena leaves during the growth process is able to provide the essential macro needs of plants. In addition, the combination of these organic nutrients is thought to be able to support the supply of nutrients in the root area, so that the roots can easily absorb these nutrients. According to Atari *et al*., (2017), good plant

roots can affect the photosynthesis process and nutrients can be easily absorbed so that it can increase plant growth which will affect the components of mustard plant production. The greater the weight of the plant roots, the greater the plant will absorb nutrients. The fact that leucaena is the best plant for the source of extraction is supported by its nutrient content. Results of the analysis of nutrients N, P, and K showed that the nutrient content of N, P, and K in the organic nutrition of the mixture of brown seaweed and leucaena leaf extract is the highest among other organic nutrients, which is equal to N (216.98 mg L^{-1}), P (16.52 mg L^{-1}), and K (6 mg L^{-1}). The organic nutrient content of the mixture of brown seaweed and coconut husk extract shows that the nutrient content of N, P, and K is N (39.98 mg L^{-1}), P (11.90 mg L^{-1}), and K (4 mg L^{-1}). The organic nutrient content of the mixture of brown seaweed and moringa leaves shows that the nutrient content of N, P, and K is N (268,01 mg L^{-1}), P (17,52 mg L^{-1}), and K (4 mg L^{-1}). The organic nutrient content of the mixture of brown seaweed and african leaves extract shows that the nutrient content of N, P, and K is N (42,03 mg L^{-1}), P (13,62 mg L^{-1}), and K (5 mg L^{-1}).

The results showed that AB-mix nutrition resulted in shoot dry weight, root fresh weight and total plant fresh weight, which were significantly different from the mustard plants treated with organic nutrition. Shoot dry weight in the treatment of organic nutrition mixture of brown seaweed and leucaena leaves and organic nutrition treatment of a mixture of brown seaweed and coconut husk only reached 62.18% of the shoot dry weight in AB-mix nutrient solution treatment. Mustard plants given AB-mix treatment has dry medicine the shoot greater, namely 10.54 g compared to the treatment of organic nutrition mixture of brown seaweed and leaves of leucaena, namely 4.50 g, followed by treatment of organic nutrition mixture of brown seaweed and coconut husk, namely 3.96 g (Table 1).

The AB-mix nutritional treatment resulted in a 41.11% higher root fresh weight than the root fresh weight of the organic nutrient solution of the mixture of brown seaweed and leucaena leaf extract. The AB-mix nutritional treatment produced the highest root fresh weight, namely 5.01 g compared to 2.95 g (Table 2). The total fresh weight of mustard plants in the organic nutrient treatment of the mixture of brown seaweed and leucaena leaves only reached 51.08% of the total fresh weight of the plants in the AB-mix nutrient solution treatment (Figure 1). The AB-mix nutritional treatment resulted in the total fresh weight of mustard plants in the mustard plant, namely 113.31 g, higher than the treatment of organic nutrient solution mixture of brown seaweed and leucaena leaves which was 57.88 g (Table 2).

Table 1. Effect of organic nutrients from extracts of some organic matter on shoot dry weight, root fresh weight, and total fresh weight variables of mustard plants

Treatment	Shoot dry weight of 3 plants		Root fresh weight of 3 plants		Total fresh weight of mustard plants of 6 plants	
	Original	Trans √ (X + 0.5)	Original	Trans √ (X + 0.5)	Original	Trans √ (X + 0.5)
	g		g		g	
AB-mix	10.54 a	3.20	5.01 a	2.22	113.31 a	10.51
Seaweed	0.24 d	0.47	0.95 e	0.96	2.59 e	1.60
Seaweed + leucaena leaf	4.50 b	2.05	2.95 b	1.71	57.88 b	7.51
Seaweed + coconut fiber	3.96 b	1.93	1.89 c	1.36	27.87 b	5.17
Seaweed + moringa leaf	5.16 b	2.25	1.66 d	1.28	23.79 c	4.85
Seaweed + African leaf	1.20 c	1.07	1.31 de	1.14	6.99 d	2.64
HSD 5%	0.40		0.19		1.39	

Notes: The mean value followed by the same letter does not differ at the 5% level.

The organic nutrition of a mixture of brown seaweed and leucaena leaf extract produced a higher canopy dry weight compared to other organic nutrient treatments, this is presumably the treatment has a higher P nutrient content, because phosphorus itself plays an important role in the process of photosynthesis. According to Liferdi (2010) and Malhotra et al., (2018) P plays an important role in the processes of photosynthesis, assimilation, respiration, nucleic acid biosynthesis, and is used as a constituent component of several plant structures such as phospholipids. When photosynthesis is higher, the assimilation rate is high. The rate of assimilation has an effect on the shoot growth rate of the plant which will affect the dry weight of the plant crown. The higher the dry weight of the plant canopy, it shows that the vegetative growth is going well. When photosynthesis is higher, the assimilation rate is high. The rate of assimilation has an effect on the shoot growth rate of the plant which will affect the dry weight of the plant shoot. There is also a positive correlation between root growth and shoot growth in plants (Table 5). Similar trend was also reported by Tolley and Mohammadi (2020).

The total fresh weight of the plant is influenced by the large number of leaves, because the leaves where the photosynthesis occurs, if photosynthesis goes well, more photosynthate will be formed so that the plant's fresh weight is greater. According to Efendi et al., (2017), short-lived leaf vegetable crops require large amounts of N as the main nutrient. The availability of sufficient amounts of N

nutrient will be responded to maximally by mustard plants, so that the plants are able to form protoplasm in greater numbers and produce a greater plant fresh weight.

In the organic nutrition extract mixture of brown seaweed and leucaena leaves, the total plant fresh weight was the highest among other organic nutrients. This is presumably because the content of N, P, and K in the organic nutrients combined with leucaena leaves is quite high. According to Hidayat and Suharyana (2019) and Rop et al., (2019), N contained in liquid organic fertilizer made from leucaena leaves functions as a protein constituent, while the P and K in leucaena leaves can stimulate meristem tissue division, stimulate root growth, leaf development so that N, P, and K increase plant fresh weight and increasing crop production. Rambe (2014) stated that plants will survive if the nutrients needed by plants are available in a balanced proportion, especially macro nutrients such as N, P and K both in soil and in organic matter. The use of different substrates or organic solutions and inorganic solutions can affect the absorption of nutrients in plants, water absorption, oxygen availability, and maximum plant growth Ebrahimi et al. (2012) so that AB-mix nutritional treatment has more total plant fresh weight. compared to organic nutrient treatment.

According to Sunarpi et al., (2019) *Sargassum* sp. is one of the largest genera of brown seaweed from the family Sargassaceae with the main component in the talus *Sargassum* sp. are holocellulose (cellulose and hemicellulose), lignin, and alginate. Talus *Sargassum* sp. also contains nutrients (macro and micro nutrients), growth promoting hormones, protein and vitamins. This seaweed is also very potential as a food source of minerals, especially a source of calcium, phosphorus, and iron. Seaweed is also in almost all parts of Indonesia, so it has the potential to be used as organic nutrition for plant growth. According to Basmal et al. (2015), the liquid extract of *Sargassum* sp. can be used as liquid organic fertilizer. Research by Miceli et al. (2021) showed that Ecklonia maxima is a brown algae seaweed between 2 and 4 mL L−1, enhanced plant growth and improved the yield and many morphological and physiological traits of lettuce.

The results showed that the treatment of organic nutrient solutions could not match the quality of AB-mix hydroponic nutrient solutions as hydroponic nutrients for mustard plant cultivation. Mustard plants treated with organic nutrition produced leaf numbers and greenish levels that were significantly different from those treated with AB-mix hydroponic nutrition. This can be seen from the number of mustard leaves in the organic nutrient solution treatment only reached 85.61% of the number of leaves in the AB-mix hydroponic nutrient solution treatment. The number of leaves in the AB-mix hydroponic nutrition treatment was 8.56 leaves, while the average number of leaves in the three types of organic nutrition treatment was only 6.27 leaves (Table 2). The level of leaf greenness in the organic nutrition treatment of the mixture of brown seaweed and leucaena leaf extract and the organic nutrition of the mixture of brown seaweed and coconut husk only reached 88.73% of the greenness level of the leaves in the AB-mix nutrient solution treatment. The highest leaf greenness level variable was obtained in the AB-mix treatment, it was 34.37 unit compared to the organic nutrient treatment of the mixture of brown seaweed and leucaena leaf extract which was only 28.52 unit and followed by the organic nutrition treatment of the mixture of brown seaweed and coconut husk extract which was 25.66 unit (Table 2).

Table 2. Effect of organic nutrients from extracts of several organic materials on the variable number of leaves and SPAD of mustard plants

Treatment	Number of leaves		SPAD	
	Original	Trans $\sqrt{(X + 0.5)}$	Original	Trans $\sqrt{(X + 0.5)}$
	blade		unit	
AB-mix	8.56 a	2.92	34.37 a	5.86
Seaweed	1.64 e	1.28	12.85 c	3.57
Seaweed + leucaena leaf	6.50 b	2.54	28.52 b	5.34
Seaweed + coconut fiber	6.61 c	2.57	25.66 b	5.06
Seaweed + moringa leaf	3.29 c	1.80	33.77 ab	5.80
Seaweed + African leaf	2.58 d	1.58	27.01 b	5.18
HSD 5%	0.33		0.46	

Notes: The mean value followed by the same letter does not differ at the 5% level

Based on the results of observations of the number of leaves and the level of greenness of the leaves, it was shown that the application of organic nutrition resulted in the number of leaves and leaf greenness that were significantly different from the mustard plants given AB-mix nutrition. Meanwhile, application of organic nutrition to extract a mixture of brown seaweed with leucaena leaves and mustard greens which were given organic nutrition from a mixture of brown seaweed with coconut husk resulted in the number of leaves and leaf greenness levels that were not significantly different.

Mustard plants that were treated with AB-mix nutrition produced a higher number of leaves compared to the organic nutrition treatment because the nutrients in AB-mix nutrition were readily available in a form that was readily absorbed by plants and their content was in accordance with the

plant's needs. One of the highest nutrient elements in the AB-mix nutrient solution is Nitrogen (N). Xing et al., (2019) stated that nitrogen can be used for the synthesis of nucleic acids and proteins, phospholipids, and many secondary metabolites needed by plants. Leaves that are supplied with nitrogen will form wider leaf blades with a higher chlorophyll content, so that plants are able to produce carbohydrates in high amounts to support the vegetative growth of a plant. Fitriani et al., (2020) found that in hydroponic wick system, Nitrogen efficiency could be improved with application of urea and extract of nutrient from organic material derived from vermicompost.

In plants, nitrogen is a macro nutrient needed by plants in large quantities, because nitrogen functions as a form of chlorophyll, which plays an important role in the process of photosynthesis. Chlorophyll functions as a light-capturing pigment for photosynthesis which produces carbohydrates as a source of energy in the respiration process, so that plants can continue their life (Ai & Banyo, 2011). The higher the nitrogen application within the optimum limit, the amount of chlorophyll produced will increase. Nitrogen plays an important role in the photosynthesis process and leaves are green in the presence of chlorophyll. Nitrogen is also the main component in making organic compounds in plants such as nucleic acids, chlorophyll, amino acids, ADP, and ATP (Syofia et al., 2014).

Figure 1. Growth of mustard plants treated with AB-Mix (left) and treated with seaweed and leucaena leaf (right).

The pH value of all treatments are the AB-mix solution ranges from 6.8 -7, brown seaweed extract is 4-4.5, in a mixture of brown seaweed extract and leucaena leaf is 5.2 - 5,5, a mixture of brown seaweed and coconut husk is 4.8 - 5, in a mixture seaweed and moringa leaf is 4.8 – 5.0, and in a mixture seaweed and African leaf is 4.0 – 4.5. In this study, the highest EC value was in the AB-mix nutrient solution, which ranged from 1,082 to 1,111 ppm, while the EC value in organic nutrient solutions of all treatments ranged from 550-701 ppm.

The quality of water indicated by pH and EC in this experiment is favorable for mustard growth (Table 3 and 4). According to Mengel *et al*., (2001), a nutrient solution that has a pH value of 6 or an optimum pH makes all nutrients dissolve easily and is sufficiently available for plants so that plant growth will be better. At high EC values, organic nutrients cause the plant to have insufficient nutrient needs or decrease the concentration of fertilizers in plants (Argo, 2004) so that plant growth is inhibited.

Table 3. Concentration parameters of the nutrient solution of mustard plants

Treatment	EC (ppm)			
	7 DAP	14 DAP	21 DAP	28 DAP
AB-mix	1082.00	1101.00	1103.00	1092.00
Seaweed	508.00	500.00	502.00	500.00
Seaweed + leucaena leaf	562.00	619.00	620.00	701.00
Seaweed + coconut fiber	520.00	500.00	610.00	625.00
Seaweed + moringa leaf	501.00	571.00	600.00	602.00
Seaweed + African leaf	510.00	520.00	511.00	507.00

Table 4. pH parameter of mustard plants

Treatment	pH			
	7 DAP	14 DAP	21 DAP	28 DAP
AB-mix	6.9	6.8	7.0	6.9
Seaweed	4.1	4.0	4.3	4.5
Seaweed + leucaena leaf	5.2	5.2	5.5	5.4
Seaweed + coconut fiber	4.9	5.0	4.8	5.0
Seaweed + moringa leaf	5.0	4.9	4.9	4.8
Seaweed + African leaf	4.3	4.0	4.5	4.4

The results of the correlation test for vegetative and generative variables through the Pearson correlation test (Table 5) showed that the vegetative variable i.e. the number of leaves resulted in a significantly different positive correlation with the generative variables i.e., shoot dry weight, root fresh weight, and shoot fresh weight. Likewise, there is a significant correlation between root fresh weight and shoot fresh weight.

Table 5. Correlation coefficient between vegetative and generative traits

Variabels	Number of leaves	SPAD	Shoot dry weight	Root fresh weight	Shoot fresh weight
Number of leaves	1				
SPAD	0.58	1			
Shoot dry weight	0.84*	0.78	1		
Root fresh weight	0.88*	0.62	0.93**	1	
Shoot fresh weight	0.88*	0.62	0.94**	0.99**	1

Note: * = Significant at P<0.05; ** = highly significant at P<0.01

The organic nutrient solution not being able to match the quality of AB-mix hydroponic nutrition is thought to be caused by several factors, namely the extraction process, fermentation results, and the hydroponic system used. In the observation that the organic nutrient solution in the anaerobic

fermentation method which was carried out for 20 days was not yet perfect (smells like alcohol), so that microorganisms were still active in the organic nutrient solution. In addition to that, this were supported by a nutrient solution that did not move using in the hydroponic axis system. Active microorganisms would cause low pH during fermentation process, so that root development in mustard plants to be stunted.

Microorganisms that are still active in the fermentation of organic nutrients make microbes and plant roots compete with each other for oxygen. Root growth that lacks oxygen will result in stunted plants and black/brown roots. According to Surtinah (2016), respiration produces the energy needed by plants so that it can be used for assimilation in water absorption, ion absorption and nutrient absorption so that oxygen is very important for the growth and function of plant cells, without oxygen that is sufficient for respiration, water and ion absorption stops, and dead plant roots. Lack of oxygen caused by disturbances in the roots can cause imperfect plant growth and reduce crop yields in plants (Pratiwi *et al.*, 2015).

Fermentation is a way to change the organic substrate with the help of microorganisms (Sharma et al., 2020), one of the microorganisms that can be used to help composting organic material, namely using EM4 (Effective Microorganism-4) as liquid organic fertilizer because it contains microorganisms that are useful for the composting process and using cattle rumen as an activator for helps speed up composting (Bunga & Lewar, 2009).

This experiment used the hydroponic wix system. The drawback of this system is the absence of movement of the nutrient solution. According to Akasiska *et al*., (2014), roots that are immersed in immobile nutrient solutions cause stunted plant growth due to lack of oxygen which causes root activity in the absorption process of water and mineral nutrients to be disturbed. This results in the organic nutrient solution to be difficult to dissolve, making it difficult for the mustard plant to absorb.

Many resources could be utilized as the substitutes of AB Mix nutrition, such as vegetable waste (Faruq *et al*., 2021) and seaweed extract as shown from this research. Further research is still needed by testing various extract methods, namely the first stage of the aerobic fermentation method and the second stage of the anaerobic fermentation method in order to obtain a more effective method for dissolving nutrients from organic matter. We suggest also using another method of hydroponic system and not using the wick system. This is because, in the fermentation method and the hydroponic wick system used in this study, the nutrient absorption process is still not effective for the growth of mustard plants.

CONCLUSION

The organic nutrient solution extract of the mixture of brown seaweed, leucaena leaf, or coconut fiber, or moringa, or African leaves has not been able to match the nutritional quality of AB-mix for mustard plants in the hydroponic system. The organic nutrition of the mixed extract of brown seaweed and leucaena leaf was better than other organic nutrients by producing 57.88 g of fresh weight of

mustard plants, but only 51.08% of the fresh weight of mustard plants in AB-mix treatment which was 113.31 g. Further research to find the best organic nutrition which has the same quality as AB Mix is needed.

ACKNOWLEDGMENT

Thank you for supporting from the staff of the greenhouse and laboratory at Faculty of Agriculture, Universitas Lampung.

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THE EFFECT OF COMBINATION OF SEAWEED (*SARGASSUM* SP.) AND PLANT EXTRACT ON THE GROWTH OF MUSTARD PLANT (*BRASSICA JUNCEA* L.) GROWN BY HYDROPONIC WICK SYSTEM

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The Effect of Seaweed (*Sargassum* sp.) and Plant Extract Combination on the Growth of Mustard Plant (*Brassica juncea* L.) Grown by Hydroponic Wick System

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This manuscript has excellent revision progress. However, there are some improvements and corrections needed to get the manuscript to an accepted condition. Here are some specific comments [on the manuscript].

Editor Decision: Revision Required

Abstract

Nutrient solution is an important factor for the growth and quality of hydroponic plants; however, the price is getting more expensive. Seaweed is abundantly available along tropical coast. The study was conducted to determine the best combination of extract of brown seaweed (*Sargassum* sp.) combined with coconut husk or leucaena leaves or moringa leaves or African leaves that match to the nutritional quality of AB-mix as hydroponic nutrition for mustard plants. This research was conducted in the greenhouse of the Faculty of Agriculture, Universitas Lampung. The design used was a Randomized Block Design (RBD) with six replications. The treatments consisted of six types of treatment, namely AB-mix nutrition, brown seaweed, seaweed and leucaena leaf, seaweed and coconut fiber, seaweed and moringa leaf, seaweed and African leaf. Research showed that the organic nutrient solution extracting from the mixture of brown seaweed with leucaena leaf, or coconut fiber or moringa leaves or African leaves has not been able to match the quality of AB-mix nutrition for mustard plants in the hydroponic system. However, among those treatments, the best fresh weight of mustard was found on the treatment of the combination of brown seaweed and leucaena leaf namely 51.08% from total fresh weight from control AB Mix.

Keywords: fresh weight of plants; organic nutrition; plant extract; plant nutrition; seedling growth

INTRODUCTION

Farmers usually use the land for media in developing their agricultural products. The utilization of non-agricultural land can be supported by agricultural intensification, one of which is hydroponic technology. Hydroponics is an agricultural cultivation land without using soil media, so that it uses water as a nutrient medium that will be directly absorbed by plants to support plant growth (Resh, 2013). According to Vidianto et al. (2013), hydroponic technology does not have to require a large area of land so that hydroponic cultivation is suitable to be developed on a narrow land.

One of the hydroponic techniques used is the wicks system hydroponics technology. The advantages of this hydroponic system do not require electrical resources, the amount of fertilizer, plants grow optimally, and are easy to control. The weakness of the hydroponic axis system is that the nutrient solution is not circulating so that plant growth slowly Kamalia et al., (2017). The essential part that needs to be considered in hydroponic cultivation is nutrient solutions.

Nutrient solution is an important factor for the growth and quality of hydroponic plants, so it must be precise in terms of the amount of nutrient ion composition and temperature (Trejo-Téllez & Gómez-Merino, 2012). The source of nutrition used in hydroponic cultivation generally uses inorganic nutrients, one of which is AB-mix nutrient solution. AB-mix nutrient solution contains macro and micro elements. Treatment using AB-mix nutrition gave higher yields and plant quality. AB-mix nutrition increased growth and production in spinach, pakcoy, and lettuce (Nugraha & Susila, 2015) and spinach, caisin, and kalian (Ramadiani & Susila, 2014). In terms of cost, AB-mix nutrition has a relatively more expensive price (Nugraha & Susila, 2015) because the use and purchase of AB Mix nutrients must be in one package. Therefore, a solution is needed to overcome this problem, namely obtaining organic

nutrients by utilizing plant-based organic material sources. Utilization of plant-based organic materials will support sustainable tropical agriculture to provide cheap and easily available nutrients.

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Ideally, the composition of organic hydroponic nutrition should approach the quality of inorganic nutrients from AB Mix. Those organic materials that will be used need to be extracted and fermented as shown by several researchers (Kamla et al., 2008; Ndubuaku et al., 2014) so that their nutritional content can be released as a source of organic nutrition for hydroponic nutrient solution. The advantage of agricultural organic products harvested here will be free from chemicals that are harmful to human health and are safe for consumption.

Organic materials that can be used as a source of organic nutrition for hydroponic nutrient solutions are brown seaweed, coconut husk, leucaena leaves, moringa leaves, or African leaves. According to the study of Basmal (2009), seaweed can be used as organic fertilizer because it contains growth regulators including auxins, cytokines, gibberellin, abscisic acid and ethylene and is rich in trace minerals (Fe, B, Ca, Cu, Cl, K, Mg, and Mn). This is reinforced by the results of research by Basmal et al. (2015), which found that the liquid extract of seaweed contained auxin of 127.48 ppm, gibberellin 131.11 ppm, cytokinin-kinetin 68.77 ppm, cytokinin-zeatin 82.41 ppm; macro nutrient potassium (K) of 345.29 mg 100 g^{-1}, nitrogen (N) of 0.78%, phosphorous (P) 55.39 mg 100 ml^{-1}, and pH value 7. The positive benefits of seaweed originating from tropical coastal waters when combined with other land plant extracts will provide richer content.

Another plant-based organic material is coconut coir, leucaena, moringa leaves, and African leaves. According to Ramadhani (2011), coconut husk has a very rich element of potassium and also contains 30% fiber. According to Eniolorunda (2011) proximate composition of leucaena are crude protein, crude fibre, ash, and nitrogen free extract. Moringa leaves contain protein, calcium, phosphorus, iron and zinc (Salim et al., 2018). African leaves have several substances that are good for plants such as protein, amino acids, ascorbic acid, carotenoids, fats, carbohydrates, and fiber (Ijeh & Ejika, 2011). African leaves are medicinal plants that can be used as inflammation (Setiani & Rusli, 2020). Researcher Nurjannah et al., (2021) used fermented brown algae extract and showed that the growth of corn was improved.

There have been limited studies concerned on nutrient organic alternative for hydroponic plant nutrition. Therefore, this study was conducted to determine organic nutrition extract mixture of brown seaweed (*Sargassum* sp.) combined with coconut husk, or leucaena leaves, or moringa leaves, and African leaves that match to the nutritional quality of AB-mix as hydroponic nutrition for mustard plants.

MATERIALS AND METHOD

This research was conducted in the greenhouse of the Faculty of Agriculture, University of Lampung located at 220 5°21'55" S and 105°14'32" E with an elevation of 150 meters above mean sea level in November 2019 - March 2020. The microclimate of inside greenhouse was temperature 30.5°C,

RH 69%, and light intensity 10000 lux. The materials used are mustard seeds, seaweed (*Sargassum* sp.) coconut husk, leucaena leaves, AB Mix nutrient solution, water, beef rumen, EM4, and sugar.

The design used was a randomized complete design (RCD) with six replications. The treatments consisted of six types of treatment, namely AB-mix nutrition, brown seaweed, brown seaweed and leucaena leaves, brown seaweed and coconut husk, brown seaweed and moringa leaves, and brown seaweed and African leaves.

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This research was carried out starting from the preparation stage of hydroponic wick system installation. After that the preparation of liquid organic nutrition by preparing 5 kg respectively of brown seaweed, leucaena leaves, coconut husk, moringa leaves, African leaves. -All materials, then, had been chopped into small pieces. Then, the ingredients are blended until smooth for 3 minutes with a 300 g: 1 l of water. All materials were extracted and fermented and added with beef rumen and EM4 as a bioactivator, 80 l of refined sugar and water. Fermentation was carried out for 20 days. Sowing of the seeds is carried out in rice husk and compost for 14 days or until 2 to 3 leaves appear. Then, analysis of nutrients was carried out in the fermented organic nutrient solution to determine the N, P, and K content of each organic nutrient solution. Preparation of AB-mix nutrient solution (*Hydro J.)* consists of nutrients A and B. Nutrients A as much as 500 ml combined with and B as much as 250 ml and add 100 l of water, then stir until blended. Organic nutrition is made by mixing organic matter and water, namely in a ratio of 1: 9.

Planting of mustard plants that are 14 days old or after the mustard plants appear 2-3 leaves to the container with dimensions of 38 cm x 28 cm x 12 cm in hydroponic wick system. Planting distance was 12 cm x 15 cm.- After that, maintenance is carried out by controlling the nutrients in the tube including the volume of the solution, measuring the pH, and measuring the viscosity of the solution (EC) at each installation. Harvesting of mustard greens is carried out at the age of 30 days after planting (DAP) when the plants have reached their maximum growth with the characteristics of the plant height of approximately 26-33 cm, fresh green leaves, light green stems.

The observed variables were number of leaves (14 DAP), leaf greenness (soil plant analysis development, SPAD, at 21 DAP), shoot dry weight (30 DAP), root fresh weight (30 DAP), total plant fresh weight (30 DAP). -Data were analysis using F test then continued with the mean separation with the Honestly Significantly Difference at the 5% level.

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RESULTS AND DISCUSSION

The organic nutrition treatment of the mixture of brown seaweed and leucaena leaf extract resulted in higher root fresh weight among other organic nutrient treatments (Table 1). It is suspected that the availability of nutrients in the organic nutrition of the mixture of brown seaweed and leucaena leaves during the growth process is able to provide the essential macro needs of plants. In addition, the combination of these organic nutrients is thought to be able to support the supply of nutrients in the root area, so that the roots can easily absorb these nutrients. According to Atari et al., (2017), good plant

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roots can affect the photosynthesis process and nutrients can be easily absorbed so that it can increase plant growth which will affect the components of mustard plant production. The greater the weight of the plant roots, the greater the plant will absorb nutrients. -The fact that leucaena is the best plant for the source of extraction is supported by its nutrient content. -Results of the analysis of nutrients N, P, and K showed that the nutrient content of N, P, and K in the organic nutrition of the mixture of brown seaweed and leucaena leaf extract is the highest among other organic nutrients, which is equal to N (216.98 mg L^{-1}), P (16.52 mg L^{-1}), and K (6 mg L^{-1}). The organic nutrient content of the mixture of brown seaweed and coconut husk extract shows that the nutrient content of N, P, and K is N (39.98 mg L^{-1}), P (11.90 mg L^{-1}), and K (4 mg L^{-1}). -The organic nutrient content of the mixture of brown seaweed and moringa leaves shows that the nutrient content of N, P, and K is N (268,01 mg L^{-1}), P (17,52 mg L^{-1}), and K (4 mg L^{-1}). The organic nutrient content of the mixture of brown seaweed and african leaves extract shows that the nutrient content of N, P, and K is N (42,03 mg L^{-1}), P (13,62 mg L^{-1}), and K (5 mg L^{-1}).

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The results showed that AB-mix nutrition resulted in shoot dry weight, root fresh weight and total plant fresh weight, which were significantly different from the mustard plants treated with organic nutrition. -Shoot dry weight in the treatment of organic nutrition mixture of brown seaweed and leucaena leaves and organic nutrition treatment of a mixture of brown seaweed and coconut husk only reached 62.18% of the shoot dry weight in AB-mix nutrient solution treatment. Mustard plants given AB-mix treatment has dry medicine the shoot greater, namely 10.54 g compared to the treatment of organic nutrition mixture of brown seaweed and leaves of leucaena, namely 4.50 g, followed by treatment of organic nutrition mixture of brown seaweed and coconut husk, namely 3.96 g (Table 1).

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The AB-mix nutritional treatment resulted in a 41.11% higher root fresh weight than the root fresh weight of the organic nutrient solution of the mixture of brown seaweed and leucaena leaf extract. The AB-mix nutritional treatment produced the highest root fresh weight, namely 5.01 g compared to 2.95 g (Table 2). The total fresh weight of mustard plants in the organic nutrient treatment of the mixture of brown seaweed and leucaena leaves only reached 51.08% of the total fresh weight of the plants in the AB-mix nutrient solution treatment (Figure 1). The AB-mix nutritional treatment resulted in the total fresh weight of mustard plants in the mustard plant, namely 113.31 g, higher than the treatment of organic nutrient solution mixture of brown seaweed and leucaena leaves which was 57.88 g (Table 2).

Table 1. Effect of organic nutrients from extracts of some organic matter on shoot dry weight, root fresh weight, and total fresh weight variables of mustard plants

Treatment	Shoot dry weight of 3 plants		Root fresh weight of 3 plants		Total fresh weight of mustard plants of 6 plants	
	Original	Trans √ (X + 0.5)	Original	Trans √ (X + 0.5)	Original	Trans √ (X + 0.5)
	g		g		g	
AB-mix	10.54 a	3.20	5.01 a	2.22	113.31 a	10.51
Seaweed	0.24 d	0.47	0.95 e	0.96	2.59 e	1.60
Seaweed + leucaena	4.50 b	2.05	2.95 b	1.71	57.88 b	7.51

leaf						
Seaweed + coconut fiber	3.96 b	1.93	1.89 c	1.36	27.87 b	5.17
Seaweed + moringa leaf	5.16 b	2.25	1.66 d	1.28	23.79 c	4.85
Seaweed + African leaf	1.20 c	1.07	1.31 de	1.14	6.99 d	2.64
HSD 5%	0.40		0.19		1.39	

Notes: The mean value followed by the same letter does not differ at the 5% level.

The organic nutrition of a mixture of brown seaweed and leucaena leaf extract produced a higher canopy dry weight compared to other organic nutrient treatments, this is presumably the treatment has a higher P nutrient content, because phosphorus itself plays an important role in the process of photosynthesis. According to Liferdi (2010) and Malhotra et al., (2018) P plays an important role in the processes of photosynthesis, assimilation, respiration, nucleic acid biosynthesis, and is used as a constituent component of several plant structures such as phospholipids. When photosynthesis is higher, the assimilation rate is high. The rate of assimilation has an effect on the shoot growth rate of the plant which will affect the dry weight of the plant crown. The higher the dry weight of the plant canopy, it shows that the vegetative growth is going well. When photosynthesis is higher, the assimilation rate is high. The rate of assimilation has an effect on the shoot growth rate of the plant which will affect the dry weight of the plant shoot. There is also a positive correlation between root growth and shoot growth in plants (Table 5). Similar trend was also reported by Tolley and Mohammadi (2020).

The total fresh weight of the plant is influenced by the large number of leaves, because the leaves where the photosynthesis occurs, if photosynthesis goes well, more photosynthate will be formed so that the plant's fresh weight is greater. According to Efendi et al., (2017), short-lived leaf vegetable crops require large amounts of N as the main nutrient. The availability of sufficient amounts of N nutrient will be responded to maximally by mustard plants, so that the plants are able to form protoplasm in greater numbers and produce a greater plant fresh weight.–

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In the organic nutrition extract mixture of brown seaweed and leucaena leaves, the total plant fresh weight was the highest among other organic nutrients. This is presumably because the content of N, P, and K in the organic nutrients combined with leucaena leaves is quite high. According to Hidayat and Suharyana (2019) and Rop et al., (2019), N contained in liquid organic fertilizer made from leucaena leaves functions as a protein constituent, while the P and K in leucaena leaves can stimulate meristem tissue division, stimulate root growth, leaf development so that N, P, and K increase plant fresh weight and increasing crop production. Rambe (2014) stated that plants will survive if the nutrients needed by plants are available in a balanced proportion, especially macro nutrients such as N, P and K both in soil and in organic matter. The use of different substrates or organic solutions and inorganic solutions can affect the absorption of nutrients in plants, water absorption, oxygen availability, and maximum plant growth Ebrahimi et al. (2012) so that AB-mix nutritional treatment has more total plant fresh weight. compared to organic nutrient treatment.–

Commented [A8]: Please add data simulation of N, P and K from organic fertilizer vs AB mix. Example: in the AB mix N total commonly 250 ppm per liter, and the organic fertilizer such as Leucaena+brownsewed have N total 216 ppm, but the apllication dilluted with water 1:9 of course the plant did not adequate nutrient for growth.

According to Sunarpi et al., (2019) *Sargassum* sp. is one of the largest genera of brown seaweed from the family Sargassaceae with the main component in the talus *Sargassum* sp. are holocellulose (cellulose and hemicellulose), lignin, and alginate. Talus *Sargassum* sp. also contains nutrients (macro and micro nutrients), growth promoting hormones, protein and vitamins. This seaweed is also very potential as a food source of minerals, especially a source of calcium, phosphorus, and iron. Seaweed is also in almost all parts of Indonesia, so it has the potential to be used as organic nutrition for plant growth. According to Basmal et al. (2015), the liquid extract of *Sargassum* sp. can be used as liquid organic fertilizer. Research by Miceli et al. (2021) showed that Ecklonia maxima is a brown algae seaweed between 2 and 4 mL L−1, enhanced plant growth and improved the yield and many morphological and physiological traits of lettuce.

The results showed that the treatment of organic nutrient solutions could not match the quality of AB-mix hydroponic nutrient solutions as hydroponic nutrients for mustard plant cultivation. Mustard plants treated with organic nutrition produced leaf numbers and greenish levels that were significantly different from those treated with AB-mix hydroponic nutrition. This can be seen from the number of mustard leaves in the organic nutrient solution treatment only reached 85.61% of the number of leaves in the AB-mix hydroponic nutrient solution treatment. The number of leaves in the AB-mix hydroponic nutrition treatment was 8.56 leaves, while the average number of leaves in the three types of organic nutrition treatment was only 6.27 leaves (Table 2). The level of leaf greenness in the organic nutrition treatment of the mixture of brown seaweed and leucaena leaf extract and the organic nutrition of the mixture of brown seaweed and coconut husk only reached 88.73% of the greenness level of the leaves in the AB-mix nutrient solution treatment. The highest leaf greenness level variable was obtained in the AB-mix treatment, it was 34.37 unit compared to the organic nutrient treatment of the mixture of brown seaweed and leucaena leaf extract which was only 28.52 unit and followed by the organic nutrition treatment of the mixture of brown seaweed and coconut husk extract which was 25.66 unit (Table 2).

Table 2. Effect of organic nutrients from extracts of several organic materials on the variable number of leaves and SPAD of mustard plants

Treatment	Number of leaves		SPAD	
	Original	Trans $\sqrt{(X + 0.5)}$	Original	Trans $\sqrt{(X + 0.5)}$
	blade		unit	
AB-mix	8.56 a	2.92	34.37 a	5.86
Seaweed	1.64 e	1.28	12.85 c	3.57
Seaweed + leucaena leaf	6.50 b	2.54	28.52 b	5.34
Seaweed + coconut fiber	6.61 c	2.57	25.66 b	5.06
Seaweed + moringa leaf	3.29 c	1.80	33.77 ab	5.80
Seaweed + African leaf	2.58 d	1.58	27.01 b	5.18
HSD 5%	0.33		0.46	

Notes: The mean value followed by the same letter does not differ at the 5% level

Based on the results of observations of the number of leaves and the level of greenness of the leaves, it was shown that the application of organic nutrition resulted in the number of leaves and leaf

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greenness that were significantly different from the mustard plants given AB-mix nutrition. Meanwhile, application of organic nutrition to extract a mixture of brown seaweed with leucaena leaves and mustard greens which were given organic nutrition from a mixture of brown seaweed with coconut husk resulted in the number of leaves and leaf greenness levels that were not significantly different.

Mustard plants that were treated with AB-mix nutrition produced a higher number of leaves compared to the organic nutrition treatment because the nutrients in AB-mix nutrition were readily available in a form that was readily absorbed by plants and their content was in accordance with the plant's needs. One of the highest nutrient elements in the AB-mix nutrient solution is Nitrogen (N). Xing et al., (2019) stated that nitrogen can be used for the synthesis of nucleic acids and proteins, phospholipids, and many secondary metabolites needed by plants. Leaves that are supplied with nitrogen will form wider leaf blades with a higher chlorophyll content, so that plants are able to produce carbohydrates in high amounts to support the vegetative growth of a plant. Fitriani et al., (2020) found that in hydroponic wick system, Nitrogen efficiency could be improved with application of urea and extract of nutrient from organic material derived from vermicompost.

In plants, nitrogen is a macro nutrient needed by plants in large quantities, because nitrogen functions as a form of chlorophyll, which plays an important role in the process of photosynthesis. Chlorophyll functions as a light-capturing pigment for photosynthesis which produces carbohydrates as a source of energy in the respiration process, so that plants can continue their life (Ai & Banyo, 2011). The higher the nitrogen application within the optimum limit, the amount of chlorophyll produced will increase. Nitrogen plays an important role in the photosynthesis process and leaves are green in the presence of chlorophyll. Nitrogen is also the main component in making organic compounds in plants such as nucleic acids, chlorophyll, amino acids, ADP, and ATP (Syofia et al., 2014).

Figure 1. Growth of mustard plants treated with AB-Mix (left) and treated with seaweed and leucaena leaf (right).

The pH value of all treatments are the AB-mix solution ranges from 6.8 -7, brown seaweed extract is 4-4.5, in a mixture of brown seaweed extract and leucaena leaf is 5.2 - 5,5, a mixture of brown seaweed and coconut husk is 4.8 - 5, in a mixture seaweed and moringa leaf is 4.8 – 5.0, and in a mixture seaweed and African leaf is 4.0 – 4.5. In this study, the highest EC value was in the AB-mix nutrient solution, which ranged from 1,082 to 1,111 ppm, while the EC value in organic nutrient solutions of all treatments ranged from 550-701 ppm.

The quality of water indicated by pH and EC in this experiment is favorable for mustard growth (Table 3 and 4). According to Mengel et al., (2001), a nutrient solution that has a pH value of 6 or an optimum pH makes all nutrients dissolve easily and is sufficiently available for plants so that plant growth will be better. At high EC values, organic nutrients cause the plant to have insufficient nutrient needs or decrease the concentration of fertilizers in plants (Argo, 2004) so that plant growth is inhibited.

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Table 3. Concentration parameters of the nutrient solution of mustard plants

Treatment	EC (ppm)			
	7 DAP	14 DAP	21 DAP	28 DAP
AB-mix	1082.00	1101.00	1103.00	1092.00
Seaweed	508.00	500.00	502.00	500.00
Seaweed + leucaena leaf	562.00	619.00	620.00	701.00
Seaweed + coconut fiber	520.00	500.00	610.00	625.00
Seaweed + moringa leaf	501.00	571.00	600.00	602.00
Seaweed + African leaf	510.00	520.00	511.00	507.00

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Table 4. pH parameter of mustard plants

Treatment	pH			
	7 DAP	14 DAP	21 DAP	28 DAP
AB-mix	6.9	6.8	7.0	6.9
Seaweed	4.1	4.0	4.3	4.5
Seaweed + leucaena leaf	5.2	5.2	5.5	5.4
Seaweed + coconut fiber	4.9	5.0	4.8	5.0
Seaweed + moringa leaf	5.0	4.9	4.9	4.8
Seaweed + African leaf	4.3	4.0	4.5	4.4

The results of the correlation test for vegetative and generative variables through the Pearson correlation test (Table 5) showed that the vegetative variable i.e. the number of leaves resulted in a significantly different positive correlation with the generative variables i.e., shoot dry weight, root fresh weight, and shoot fresh weight. Likewise, there is a significant correlation between root fresh weight and shoot fresh weight.

Table 5. Correlation coefficient between vegetative and generative traits

~~Variabels~~Variables	Number of leaves	SPAD	Shoot dry weight	Root fresh weight	Shoot fresh weight
Number of leaves	1				

SPAD	0.58	1			
Shoot dry weight	0.84*	0.78	1		
Root fresh weight	0.88*	0.62	0.93**	1	
Shoot fresh weight	0.88*	0.62	0.94**	0.99**	1

Note: * = Significant at P<0.05; ** = highly significant at P<0.01

The organic nutrient solution not being able to match the quality of AB-mix hydroponic nutrition is thought to be caused by several factors, namely the extraction process, fermentation results, and the hydroponic system used. In the observation that the organic nutrient solution in the anaerobic fermentation method which was carried out for 20 days was not yet perfect (smells like alcohol), so that microorganisms were still active in the organic nutrient solution. In addition to that, this were supported by a nutrient solution that did not move using in the hydroponic axis system. Active microorganisms would cause low pH during fermentation process, so that root development in mustard plants to be stunted.

Microorganisms that are still active in the fermentation of organic nutrients make microbes and plant roots compete with each other for oxygen. Root growth that lacks oxygen will result in stunted plants and black/brown roots. According to Surtinah (2016), respiration produces the energy needed by plants so that it can be used for assimilation in water absorption, ion absorption and nutrient absorption so that oxygen is very important for the growth and function of plant cells, without oxygen that is sufficient for respiration, water and ion absorption stops, and dead plant roots. Lack of oxygen caused by disturbances in the roots can cause imperfect plant growth and reduce crop yields in plants (Pratiwi et al., 2015).

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Fermentation is a way to change the organic substrate with the help of microorganisms (Sharma et al., 2020), one of the microorganisms that can be used to help composting organic material, namely using EM4 (Effective Microorganism-4) as liquid organic fertilizer because it contains microorganisms that are useful for the composting process and using cattle rumen as an activator for helps speed up composting (Bunga & Lewar, 2009).

This experiment used the hydroponic wix system. -The drawback of this system is the absence of movement of the nutrient solution. According to Akasiska et al., (2014), roots that are immersed in immobile nutrient solutions cause stunted plant growth due to lack of oxygen which causes root activity in the absorption process of water and mineral nutrients to be disturbed. This results in the organic nutrient solution to be difficult to dissolve, making it difficult for the mustard plant to absorb.

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Many resources could be utilized as the substitutes of AB Mix nutrition, such as vegetable waste (Faruq et al., 2021) and seaweed extract as shown from this research. -Further research is still needed by testing various extract methods, namely the first stage of the aerobic fermentation method and the second stage of the anaerobic fermentation method in order to obtain a more effective method for dissolving nutrients from organic matter. We suggest also using another method of hydroponic system and not using the wick system. This is because, in the fermentation method and the hydroponic wick

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system used in this study, the nutrient absorption process is still not effective for the growth of mustard plants.

CONCLUSION

The organic nutrient solution extract of the mixture of brown seaweed, leucaena leaf, or coconut fiber, or moringa, or African leaves has not been able to match the nutritional quality of AB-mix for mustard plants in the hydroponic system. The organic nutrition of the mixed extract of brown seaweed and leucaena leaf was better than other organic nutrients by producing 57.88 g of fresh weight of mustard plants, but only 51.08% of the fresh weight of mustard plants in AB-mix treatment which was 113.31 g. Further research to find the best organic nutrition which has the same quality as AB Mix is needed.

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ACKNOWLEDGMENT

Thank you for supporting from the staff of the greenhouse and laboratory at Faculty of Agriculture, Universitas Lampung.

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THE EFFECT OF COMBINATION OF SEAWEED (*SARGASSUM* SP.) AND PLANT EXTRACT ON THE GROWTH OF MUSTARD PLANT (*BRASSICA JUNCEA* L.) GROWN BY HYDROPONIC WICK SYSTEM

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The Effect of Seaweed (*Sargassum* sp.) and Plant Extract Combination on the Growth of Mustard Plant (*Brassica juncea* L.) Grown by Hydroponic Wick System

Abstract

Nutrient solution is an important factor for the growth and quality of hydroponic plants; however, the price is getting more expensive. Seaweed is abundantly available along tropical coast. The study was conducted to determine the best combination of extract of brown seaweed (*Sargassum* sp.) combined with coconut husk or leucaena leaves or moringa leaves or African leaves that match to the nutritional quality of AB-mix as hydroponic nutrition for mustard plants. This research was conducted in the greenhouse of the Faculty of Agriculture, Universitas Lampung. The design used was a Randomized Block Design (RBD) with six replications. The treatments consisted of six types of treatment, namely AB-mix nutrition, brown seaweed, seaweed and leucaena leaf, seaweed and coconut fiber, seaweed and moringa leaf, seaweed and African leaf. Research showed that the organic nutrient solution extracting from the mixture of brown seaweed with leucaena leaf, or coconut fiber or moringa leaves or African leaves has not been able to match the quality of AB-mix nutrition for mustard plants in the hydroponic system. However, among those treatments, the best fresh weight of mustard was found on the treatment of the combination of brown seaweed and leucaena leaf namely 51.08% from total fresh weight from control AB Mix.

Keywords: fresh weight of plants, organic nutrition, plant extract, plant nutrition, seedling growth

INTRODUCTION

Farmers usually use the land for media in developing their agricultural products. The utilization of non-agricultural land can be supported by agricultural intensification, one of which is hydroponic technology. Hydroponics is an agricultural cultivation land without using soil media, so that it uses water as a nutrient medium that will be directly absorbed by plants to support plant growth (Resh, 2013). According to Vidianto *et al*. (2013), hydroponic technology does not have to require a large area of land so that hydroponic cultivation is suitable to be developed on a narrow land.

One of the hydroponic techniques used is the wicks system hydroponics technology. The advantages of this hydroponic system do not require electrical resources, the amount of fertilizer, plants grow optimally, and are easy to control. The weakness of the hydroponic axis system is that the nutrient solution is not circulating so that plant growth slowly Kamalia *et al*., (2017). The essential part that needs to be considered in hydroponic cultivation is nutrient solutions.

Nutrient solution is an important factor for the growth and quality of hydroponic plants, so it must be precise in terms of the amount of nutrient ion composition and temperature (Trejo-Téllez & Gómez-Merino, 2012). The source of nutrition used in hydroponic cultivation generally uses inorganic nutrients, one of which is AB-mix nutrient solution. AB-mix nutrient solution contains macro and micro elements. Treatment using AB-mix nutrition gave higher yields and plant quality. AB-mix nutrition increased growth and production in spinach, pakcoy, and lettuce (Nugraha & Susila, 2015) and spinach, caisin, and kalian (Ramadiani & Susila, 2014). In terms of cost, AB-mix nutrition has a relatively more expensive price (Nugraha & Susila, 2015) because the use and purchase of AB Mix nutrients must be in one package. Therefore, a solution is needed to overcome this problem, namely obtaining organic nutrients by utilizing plant-based organic material sources. Utilization of plant-based organic materials

will support sustainable tropical agriculture to provide cheap and easily available nutrients (Martínez-Alcántara *et al*., 2016; Timsina, 2018).

Ideally, the composition of organic hydroponic nutrition should approach the quality of inorganic nutrients from AB Mix. Those organic materials that will be used need to be extracted and fermented as shown by several researchers (Kamla *et al*., 2008; Ndubuaku *et al*., 2014) so that their nutritional content can be released as a source of organic nutrition for hydroponic nutrient solution. The advantage of agricultural organic products harvested here will be free from chemicals that are harmful to human health and are safe for consumption.

Organic materials that can be used as a source of organic nutrition for hydroponic nutrient solutions are brown seaweed, coconut husk, leucaena leaves, moringa leaves, or African leaves. According to the study of Nasmia *et al*., (2021), seaweed can be used as organic fertilizer because it contains growth regulators including auxins, cytokines, gibberellin, abscisic acid and ethylene and is rich in trace minerals (Fe, B, Ca, Cu, Cl, K, Mg, and Mn). This is reinforced by the results of research by Basmal *et al*. (2015), which found that the liquid extract of seaweed contained auxin of 127.48 ppm, gibberellin 131.11 ppm, cytokinin-kinetin 68.77 ppm, cytokinin-zeatin 82.41 ppm; macro nutrient potassium (K) of 345.29 mg 100 g^{-1}, nitrogen (N) of 0.78%, phosphorous (P) 55.39 mg 100 ml^{-1}, and pH value 7. The positive benefits of seaweed originating from tropical coastal waters when combined with other land plant extracts will provide richer content.

Another plant-based organic material is coconut coir, leucaena, moringa leaves, and African leaves. According to Ramadhani (2011), coconut husk has a very rich element of potassium and also contains 30% fiber. According to Eniolorunda (2011) proximate composition of leucaena are crude protein, crude fibre, ash, and nitrogen free extract. Moringa leaves contain protein, calcium, phosphorus, iron and zinc (Salim *et al*., 2018). African leaves have several substances that are good for plants such as protein, amino acids, ascorbic acid, carotenoids, fats, carbohydrates, and fiber (Ijeh & Ejika, 2011). African leaves are medicinal plants that can be used as inflammation (Setiani & Rusli, 2020). Researcher Nurjannah *et al*., (2021) used fermented brown algae extract and showed that the growth of corn was improved.

There have been limited studies concerned on nutrient organic alternative for hydroponic plant nutrition. Therefore, this study was conducted to determine organic nutrition extract mixture of brown seaweed (*Sargassum* sp.) combined with coconut husk, or leucaena leaves, or moringa leaves, and African leaves that match to the nutritional quality of AB-mix as hydroponic nutrition for mustard plants.

MATERIALS AND METHOD

This research was conducted in the greenhouse of the Faculty of Agriculture, University of Lampung located at 220 5°21'55" S and 105°14'32" E with an elevation of 150 meters above mean sea level in November 2019 - March 2020. The microclimate of inside greenhouse was temperature 30.5°C,

RH 69%, and light intensity 10000 lux. The materials used are mustard seeds, seaweed (*Sargassum* sp.) coconut husk, leucaena leaves, AB Mix nutrient solution, water, beef rumen, EM4, and sugar.

The design used was a completely randomized design with six replications. The treatments consisted of six types of treatment, namely AB-mix nutrition, brown seaweed, brown seaweed and leucaena leaves, brown seaweed and coconut husk, brown seaweed and moringa leaves, and brown seaweed and African leaves.

This research was carried out starting from the preparation stage of hydroponic wick system installation. After that the preparation of liquid organic nutrition by preparing 5 kg respectively of brown seaweed, leucaena leaves, coconut husk, moringa leaves, African leaves. All materials, then, had been chopped into small pieces. Then, the ingredients are blended until smooth for 3 minutes with a 300 g: 1 l of water. All materials were extracted and fermented and added with beef rumen and EM4 as a bioactivator, 80 l of refined sugar and water. Fermentation was carried out for 20 days. Sowing of the seeds is carried out in rice husk and compost for 14 days or until 2 to 3 leaves appear. Then, analysis of nutrients was carried out in the fermented organic nutrient solution to determine the N, P, and K content of each organic nutrient solution. Preparation of AB-mix nutrient solution (*Hydro J.)* consists of nutrients A and B. Nutrients A as much as 500 ml combined with and B as much as 250 ml and add 100 l of water, then stir until blended. Organic nutrition is made by mixing organic matter and water, namely in a ratio of 1: 9.

Planting of mustard plants that are 14 days old or after the mustard plants appear 2-3 leaves to the container with dimensions of 38 cm x 28 cm x 12 cm in hydroponic wick system. Planting distance was 12 cm x 15 cm. After that, maintenance is carried out by controlling the nutrients in the tube including the volume of the solution, measuring the pH, and measuring the viscosity of the solution (EC) at each installation. Harvesting of mustard greens is carried out at the age of 30 days after planting (DAP) when the plants have reached their maximum growth with the characteristics of the plant height of approximately 26-33 cm, fresh green leaves, light green stems.

The observed variables were number of leaves (14 DAP), leaf greenness (soil plant analysis development, SPAD, at 21 DAP), shoot dry weight (30 DAP), root fresh weight (30 DAP), total plant fresh weight (30 DAP) and correlation analysis. Data were analysis using F test then continued with the mean separation with the Honestly Significantly Difference at the 5% level.

RESULTS AND DISCUSSION

The organic nutrition treatment of the mixture of brown seaweed and leucaena leaf extract resulted in higher root fresh weight among other organic nutrient treatments (Table 1). It is suspected that the availability of nutrients in the organic nutrition of the mixture of brown seaweed and leucaena leaves during the growth process is able to provide the essential macro needs of plants. In addition, the combination of these organic nutrients is thought to be able to support the supply of nutrients in the root area, so that the roots can easily absorb these nutrients. According to Atari *et al*., (2017), good plant

roots can affect the photosynthesis process and nutrients can be easily absorbed so that it can increase plant growth which will affect the components of mustard plant production. The greater the weight of the plant roots, the greater the plant will absorb nutrients. The fact that leucaena is the best plant for the source of extraction is supported by its nutrient content. Results of the analysis of nutrients N, P, and K showed that the nutrient content of N, P, and K in the organic nutrition of the mixture of brown seaweed and leucaena leaf extract is the highest among other organic nutrients, which is equal to N (216.98 mg L^{-1}), P (16.52 mg L^{-1}), and K (6 mg L^{-1}). The organic nutrient content of the mixture of brown seaweed and coconut husk extract shows that the nutrient content of N, P, and K is N (39.98 mg L^{-1}), P (11.90 mg L^{-1}), and K (4 mg L^{-1}). The organic nutrient content of the mixture of brown seaweed and moringa leaves shows that the nutrient content of N, P, and K is N (268,01 mg L^{-1}), P (17,52 mg L^{-1}), and K (4 mg L^{-1}). The organic nutrient content of the mixture of brown seaweed and african leaves extract shows that the nutrient content of N, P, and K is N (42,03 mg L^{-1}), P (13,62 mg L^{-1}), and K (5 mg L^{-1}).

The results showed that AB-mix nutrition resulted in shoot dry weight, root fresh weight and total plant fresh weight, which were significantly different from the mustard plants treated with organic nutrition. Shoot dry weight in the treatment of organic nutrition mixture of brown seaweed and leucaena leaves and organic nutrition treatment of a mixture of brown seaweed and coconut husk only reached 62.18% of the shoot dry weight in AB-mix nutrient solution treatment. Mustard plants given AB-mix treatment has dry weight of the shoot greater, namely 10.54 g compared to the treatment of organic nutrition mixture of brown seaweed and leaves of leucaena, namely 4.50 g, followed by treatment of organic nutrition mixture of brown seaweed and coconut husk, namely 3.96 g (Table 1).

The AB-mix nutritional treatment resulted in a 41.11% higher root fresh weight than the root fresh weight of the organic nutrient solution of the mixture of brown seaweed and leucaena leaf extract. The AB-mix nutritional treatment produced the highest root fresh weight, namely 5.01 g compared to 2.95 g (Table 2). The total fresh weight of mustard plants in the organic nutrient treatment of the mixture of brown seaweed and leucaena leaves only reached 51.08% of the total fresh weight of the plants in the AB-mix nutrient solution treatment (Figure 1). The AB-mix nutritional treatment resulted in the total fresh weight of mustard plants in the mustard plant, namely 113.31 g, higher than the treatment of organic nutrient solution mixture of brown seaweed and leucaena leaves which was 57.88 g (Table 2).

Table 1. Effect of organic nutrients from extracts of some organic matter on shoot dry weight, root fresh weight, and total fresh weight variables of mustard plants

Treatment	Shoot dry weight of 3 plants		Root fresh weight of 3 plants		Total fresh weight of mustard plants of 6 plants	
	Original	Trans √ (X + 0.5)	Original	Trans √ (X + 0.5)	Original	Trans √ (X + 0.5)
	g		g		g	
AB-mix	10.54 a	3.20	5.01 a	2.22	113.31 a	10.51
Seaweed	0.24 d	0.47	0.95 e	0.96	2.59 e	1.60
Seaweed + leucaena leaf	4.50 b	2.05	2.95 b	1.71	57.88 b	7.51
Seaweed + coconut fiber	3.96 b	1.93	1.89 c	1.36	27.87 b	5.17
Seaweed + moringa leaf	5.16 b	2.25	1.66 d	1.28	23.79 c	4.85
Seaweed + African leaf	1.20 c	1.07	1.31 de	1.14	6.99 d	2.64
HSD 5%	0.40		0.19		1.39	

Notes: The mean value followed by the same letter does not differ at the 5% level.

The organic nutrition of a mixture of brown seaweed and leucaena leaf extract produced a higher canopy dry weight compared to other organic nutrient treatments, this is presumably the treatment has a higher P nutrient content, because phosphorus itself plays an important role in the process of photosynthesis. According to Liferdi (2010) and Malhotra *et al*., (2018) P plays an important role in the processes of photosynthesis, assimilation, respiration, nucleic acid biosynthesis, and is used as a constituent component of several plant structures such as phospholipids. When photosynthesis is higher, the assimilation rate is high. The rate of assimilation has an effect on the shoot growth rate of the plant which will affect the dry weight of the plant crown (Table 1). The higher the dry weight of the plant canopy, it shows that the vegetative growth is growing optimally (Huang *et al*., 2019). When photosynthesis is higher, the assimilation rate is high. The rate of assimilation has an effect on the shoot growth rate of the plant which will affect the dry weight of the plant shoot. There is also a positive correlation between root growth and shoot growth in plants (Table 5). Similar trend was also reported by Tolley and Mohammadi (2020).

The total fresh weight of the plant is influenced by the large number of leaves, because the leaves where the photosynthesis occurs, if photosynthesis goes well, more photosynthate will be formed so that the plant's fresh weight is greater. According to Efendi *et al.,* (2017), short-lived leaf vegetable crops require large amounts of N as the main nutrient. The availability of sufficient amounts of N nutrient will be responded to maximally by mustard plants, so that the plants are able to form protoplasm in greater numbers and produce a greater plant fresh weight.

In the organic nutrition extract mixture of brown seaweed and leucaena leaves, the total plant fresh weight was the highest among other organic nutrients. This is presumably because the content of N, P, and K in the organic nutrients combined with leucaena leaves is quite high. The N content in hydroponics was 545 ppm (Arianandа *et al.*, 2020), while the nitrogen content in the extract of

Leucaena + brownseaweed is 216 ppm. After dilution of organic extract, plant is still did not receive adequate nutrient for growth. However. the content of leucaena extract is relatively close to the content of AB Mix. Further research to find the best organic nutrition which has the same quality as AB Mix is needed. According to Hidayat and Suharyana (2019) and Rop *et al*., (2019), N contained in liquid organic fertilizer made from leucaena leaves functions as a protein constituent, while the P and K in leucaena leaves can stimulate meristem tissue division, stimulate root growth, leaf development so that N, P, and K increase plant fresh weight and increasing crop production. Rambe (2014) stated that plants will survive if the nutrients needed by plants are available in a balanced proportion, especially macro nutrients such as N, P and K both in soil and in organic matter. The use of different substrates or organic solutions and inorganic solutions can affect the absorption of nutrients in plants, water absorption, oxygen availability, and maximum plant growth Ebrahimi *et al*. (2012) so that AB-mix nutritional treatment has more total plant fresh weight. compared to organic nutrient treatment.

According to Sunarpi *et al*., (2019) *Sargassum* sp. is one of the largest genera of brown seaweed from the family Sargassaceae with the main component in the talus *Sargassum* sp. are holocellulose (cellulose and hemicellulose), lignin, and alginate. Talus *Sargassum* sp. also contains nutrients (macro and micro nutrients), growth promoting hormones, protein and vitamins. This seaweed is also very potential as a food source of minerals, especially a source of calcium, phosphorus, and iron. Seaweed is also in almost all parts of Indonesia, so it has the potential to be used as organic nutrition for plant growth. According to Basmal *et al*. (2015), the liquid extract of *Sargassum* sp. can be used as liquid organic fertilizer. Research by Miceli *et al*. (2021) showed that Ecklonia maxima is a brown algae seaweed between 2 and 4 mL L^{-1}, enhanced plant growth and improved the yield and many morphological and physiological traits of lettuce.

The results showed that the treatment of organic nutrient solutions could not match the quality of AB-mix hydroponic nutrient solutions as hydroponic nutrients for mustard plant cultivation. Mustard plants treated with organic nutrition produced leaf numbers and greenish levels that were significantly different from those treated with AB-mix hydroponic nutrition. This can be seen from the number of mustard leaves in the organic nutrient solution treatment only reached 85.61% of the number of leaves in the AB-mix hydroponic nutrient solution treatment. The number of leaves in the AB-mix hydroponic nutrition treatment was 8.56 leaves, while the average number of leaves in the three types of organic nutrition treatment was only 6.27 leaves (Table 2). The level of leaf greenness in the organic nutrition treatment of the mixture of brown seaweed and leucaena leaf extract and the organic nutrition of the mixture of brown seaweed and coconut husk only reached 88.73% of the greenness level of the leaves in the AB-mix nutrient solution treatment. The highest leaf greenness level variable was obtained in the AB-mix treatment, it was 34.37 unit compared to the organic nutrient treatment of the mixture of brown seaweed and leucaena leaf extract which was only 28.52 unit and followed by the organic nutrition treatment of the mixture of brown seaweed and coconut husk extract which was 25.66 unit (Table 2).

Table 2. Effect of organic nutrients from extracts of several organic materials on the variable number of leaves and SPAD of mustard plants

Treatment	Number of leaves		SPAD	
	Original	Trans √ (X + 0.5)	Original	Trans √ (X + 0.5)
	blade		unit	
AB-mix	8.56 a	2.92	34.37 a	5.86
Seaweed	1.64 e	1.28	12.85 c	3.57
Seaweed + leucaena leaf	6.50 b	2.54	28.52 b	5.34
Seaweed + coconut fiber	6.61 c	2.57	25.66 b	5.06
Seaweed + moringa leaf	3.29 c	1.80	33.77 ab	5.80
Seaweed + African leaf	2.58 d	1.58	27.01 b	5.18
HSD 5%	0.33		0.46	

Notes: The mean value followed by the same letter does not differ at the 5% level

Based on the results of observations of the number of leaves and the level of greenness of the leaves, it was shown that the application of organic nutrition resulted in the number of leaves and leaf greenness that were significantly different from the mustard plants given AB-mix nutrition. Meanwhile, application of organic nutrition to extract a mixture of brown seaweed with leucaena leaves and mustard greens which were given organic nutrition from a mixture of brown seaweed with coconut husk resulted in the number of leaves and leaf greenness levels that were not significantly different.

Mustard plants that were treated with AB-mix nutrition produced a higher number of leaves compared to the organic nutrition treatment because the nutrients in AB-mix nutrition were readily available in a form that was readily absorbed by plants and their content was in accordance with the plant's needs. One of the highest nutrient elements in the AB-mix nutrient solution is Nitrogen (N). Xing *et al*., (2019) stated that nitrogen can be used for the synthesis of nucleic acids and proteins, phospholipids, and many secondary metabolites needed by plants. Leaves that are supplied with nitrogen will form wider leaf blades with a higher chlorophyll content, so that plants are able to produce carbohydrates in high amounts to support the vegetative growth of a plant. Fitriani *et al.*, (2020) found that in hydroponic wick system, Nitrogen efficiency could be improved with application of urea and extract of nutrient from organic material derived from vermicompost.

In plants, nitrogen is a macro nutrient needed by plants in large quantities, because nitrogen functions as a form of chlorophyll, which plays an important role in the process of photosynthesis. Chlorophyll functions as a light-capturing pigment for photosynthesis which produces carbohydrates as a source of energy in the respiration process, so that plants can continue their life (Ai & Banyo, 2011). The higher the nitrogen application within the optimum limit, the amount of chlorophyll produced will increase. Nitrogen plays an important role in the photosynthesis process and leaves are green in the presence of chlorophyll. Nitrogen is also the main component in making organic compounds in plants such as nucleic acids, chlorophyll, amino acids, ADP, and ATP (Syofia *et al.*, 2014).

Figure 1. Growth of mustard plants treated with AB-Mix (left) and treated with seaweed and leucaena leaf (right).

The pH value of all treatments are the AB-mix solution ranges from 6.8 -7, brown seaweed extract is 4-4.5, in a mixture of brown seaweed extract and leucaena leaf is 5.2 - 5,5, a mixture of brown seaweed and coconut husk is 4.8 - 5, in a mixture seaweed and moringa leaf is 4.8 – 5.0, and in a mixture seaweed and African leaf is 4.0 – 4.5. In this study, the highest EC value was in the AB-mix nutrient solution, which ranged from 1,082 to 1,111 ppm, while the EC value in organic nutrient solutions of all treatments ranged from 550-701 ppm.

The quality of water indicated by pH and EC in this experiment is favorable for mustard growth (Table 3 and 4). According to Prado (2021), a nutrient solution that has a pH value of 6 or an optimum pH makes all nutrients dissolve easily and is sufficiently available for plants so that plant growth will be better. At high EC values, organic nutrients cause the plant to have insufficient nutrient needs or decrease the concentration of fertilizers in plants (Ding *et al*., 2018) so that plant growth is inhibited.

Table 3. EC value of the nutrient solution

Treatment	EC (ppm)			
	7 DAP	14 DAP	21 DAP	28 DAP
AB-mix	1082.00	1101.00	1103.00	1092.00
Seaweed	508.00	500.00	502.00	500.00
Seaweed + leucaena leaf	562.00	619.00	620.00	701.00
Seaweed + coconut fiber	520.00	500.00	610.00	625.00
Seaweed + moringa leaf	501.00	571.00	600.00	602.00
Seaweed + African leaf	510.00	520.00	511.00	507.00

Table 4. pH value of nutrient solution

Treatment	pH			
	7 DAP	14 DAP	21 DAP	28 DAP
AB-mix	6.9	6.8	7.0	6.9
Seaweed	4.1	4.0	4.3	4.5
Seaweed + leucaena leaf	5.2	5.2	5.5	5.4
Seaweed + coconut fiber	4.9	5.0	4.8	5.0
Seaweed + moringa leaf	5.0	4.9	4.9	4.8
Seaweed + African leaf	4.3	4.0	4.5	4.4

The results of the correlation test for vegetative and generative variables through the Pearson correlation test (Table 5) showed that the vegetative variable i.e. the number of leaves resulted in a significantly different positive correlation with the generative variables i.e., shoot dry weight, root fresh weight, and shoot fresh weight. Likewise, there is a significant correlation between root fresh weight and shoot fresh weight.

Table 5. Correlation coefficient between vegetative and generative traits

Variables	Number of leaves	SPAD	Shoot dry weight	Root fresh weight	Shoot fresh weight
Number of leaves	1				
SPAD	0.58	1			
Shoot dry weight	0.84*	0.78	1		
Root fresh weight	0.88*	0.62	0.93**	1	
Shoot fresh weight	0.88*	0.62	0.94**	0.99**	1

Note: * = Significant at P<0.05; ** = highly significant at P<0.01

The organic nutrient solution not being able to match the quality of AB-mix hydroponic nutrition is thought to be caused by several factors, namely the extraction process, fermentation results, and the hydroponic system used. In the observation that the organic nutrient solution in the anaerobic fermentation method which was carried out for 20 days was not yet perfect (smells like alcohol), so that microorganisms were still active in the organic nutrient solution. In addition to that, this were supported by a nutrient solution that did not move using in the hydroponic axis system. Active microorganisms would cause low pH during fermentation process, so that root development in mustard plants to be stunted.

Microorganisms that are still active in the fermentation of organic nutrients make microbes and plant roots compete with each other for oxygen. Root growth that lacks oxygen will result in stunted plants and black/brown roots. According to Surtinah (2016), respiration produces the energy needed by plants so that it can be used for assimilation in water absorption, ion absorption and nutrient absorption so that oxygen is very important for the growth and function of plant cells, without oxygen that is sufficient for respiration, water and ion absorption stops, and dead plant roots. Lack of oxygen caused

by disturbances in the roots can cause imperfect plant growth and reduce crop yields in plants (Pratiwi *et al.*, 2015).

Fermentation is a way to change the organic substrate with the help of microorganisms (Sharma *et al*., 2020), one of the microorganisms that can be used to help composting organic material, namely using EM4 (Effective Microorganism-4) as liquid organic fertilizer because it contains microorganisms that are useful for the composting process and using cattle rumen as an activator for helps speed up composting (Bunga & Lewar, 2009).

This experiment used the hydroponic wix system. The drawback of this system is the absence of movement of the nutrient solution. According to Akasiska *et al*., (2014), roots that are immersed in immobile nutrient solutions cause stunted plant growth due to lack of oxygen which causes root activity in the absorption process of water and mineral nutrients to be disturbed. This results in the organic nutrient solution to be difficult to dissolve, making it difficult for the mustard plant to absorb.

Many resources could be utilized as the substitutes of AB Mix nutrition, such as vegetable waste (Faruq *et al.*, 2021) and seaweed extract as shown from this research. Further research is still needed by testing various extract methods, namely the first stage of the aerobic fermentation method and the second stage of the anaerobic fermentation method in order to obtain a more effective method for dissolving nutrients from organic matter. We suggest also using another method of hydroponic system and not using the wick system. In the fermentation method and the hydroponic wick system used in this study, the nutrient absorption process is still not effective for the optimal growth of mustard plants.

CONCLUSION

The organic nutrient solution extract of the mixture of brown seaweed, leucaena leaf, or coconut fiber, or moringa, or African leaves has not been able to match the nutritional quality of AB-mix for mustard plants in the hydroponic system. The organic nutrition of the mixed extract of brown seaweed and leucaena leaf was better than other organic nutrients by producing 57.88 g of fresh weight of mustard plants, but only 51.08% of the fresh weight of mustard plants in AB-mix treatment which was 113.31 g. Further research to observe the nutrient uptake per plant and efficiency of water use/nutrient solution is needed.

ACKNOWLEDGMENT

Thank you for supporting from the staff of the greenhouse and plant laboratory at Faculty of Agriculture, Universitas Lampung.

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THE EFFECT OF COMBINATION OF SEAWEED (*SARGASSUM* SP.) AND PLANT EXTRACT ON THE GROWTH OF MUSTARD PLANT (*BRASSICA JUNCEA* L.) GROWN BY HYDROPONIC WICK SYSTEM

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The Effect of Seaweed (*Sargassum* sp.) and Plant Extract Combination on the Growth of Mustard Plant (*Brassica juncea* L.) Grown by Hydroponic Wick System

Abstract

Nutrient solution is an important factor for the growth and quality of hydroponic plants; however, the price is getting more expensive. Seaweed is abundantly available along tropical coast. The study was conducted to determine the best combination of extract of brown seaweed (*Sargassum* sp.) combined with coconut husk or leucaena leaves or moringa leaves or African leaves that match to the nutritional quality of AB-mix as hydroponic nutrition for mustard plants. This research was conducted in the greenhouse of the Faculty of Agriculture, Universitas Lampung. The design used was a Randomized Block Design (RBD) with six replications. The treatments consisted of six types of treatment, namely AB-mix nutrition, brown seaweed, seaweed and leucaena leaf, seaweed and coconut fiber, seaweed and moringa leaf, seaweed and African leaf. Research showed that the organic nutrient solution extracting from the mixture of brown seaweed with leucaena leaf, or coconut fiber or moringa leaves or African leaves has not been able to match the quality of AB-mix nutrition for mustard plants in the hydroponic system. However, among those treatments, the best fresh weight of mustard was found on the treatment of the combination of brown seaweed and leucaena leaf namely 51.08% from total fresh weight from control AB Mix.

Keywords: fresh weight of plants, organic nutrition, plant extract, plant nutrition, seedling growth

INTRODUCTION

Farmers usually use the land for media in developing their agricultural products. The utilization of non-agricultural land can be supported by agricultural intensification, one of which is hydroponic technology. Hydroponics is an agricultural cultivation land without using soil media, so that it uses water as a nutrient medium that will be directly absorbed by plants to support plant growth (Resh, 2013). According to Vidianto *et al*. (2013), hydroponic technology does not have to require a large area of land so that hydroponic cultivation is suitable to be developed on a narrow land.

One of the hydroponic techniques used is the wicks system hydroponics technology. The advantages of this hydroponic system do not require electrical resources, the amount of fertilizer, plants grow optimally, and are easy to control. The weakness of the hydroponic axis system is that the nutrient solution is not circulating so that plant growth slowly Kamalia *et al*., (2017). The essential part that needs to be considered in hydroponic cultivation is nutrient solutions.

Nutrient solution is an important factor for the growth and quality of hydroponic plants, so it must be precise in terms of the amount of nutrient ion composition and temperature (Trejo-Téllez & Gómez-Merino, 2012). The source of nutrition used in hydroponic cultivation generally uses inorganic nutrients, one of which is AB-mix nutrient solution. AB-mix nutrient solution contains macro and micro elements. Treatment using AB-mix nutrition gave higher yields and plant quality. AB-mix nutrition increased growth and production in spinach, pakcoy, and lettuce (Nugraha & Susila, 2015) and spinach, caisin, and kalian (Ramadiani & Susila, 2014). In terms of cost, AB-mix nutrition has a relatively more expensive price (Nugraha & Susila, 2015) because the use and purchase of AB Mix nutrients must be in one package. Therefore, a solution is needed to overcome this problem, namely obtaining organic nutrients by utilizing plant-based organic material sources. Utilization of plant-based organic materials

will support sustainable tropical agriculture to provide cheap and easily available nutrients (Martínez-Alcántara *et al*., 2016; Timsina, 2018).

Ideally, the composition of organic hydroponic nutrition should approach the quality of inorganic nutrients from AB Mix. Those organic materials that will be used need to be extracted and fermented as shown by several researchers (Kamla *et al*., 2008; Ndubuaku *et al*., 2014) so that their nutritional content can be released as a source of organic nutrition for hydroponic nutrient solution. The advantage of agricultural organic products harvested here will be free from chemicals that are harmful to human health and are safe for consumption.

Organic materials that can be used as a source of organic nutrition for hydroponic nutrient solutions are brown seaweed, coconut husk, leucaena leaves, moringa leaves, or African leaves. According to the study of Nasmia *et al*., (2021), seaweed can be used as organic fertilizer because it contains growth regulators including auxins, cytokines, gibberellin, abscisic acid and ethylene and is rich in trace minerals (Fe, B, Ca, Cu, Cl, K, Mg, and Mn). This is reinforced by the results of research by Basmal *et al*. (2015), which found that the liquid extract of seaweed contained auxin of 127.48 ppm, gibberellin 131.11 ppm, cytokinin-kinetin 68.77 ppm, cytokinin-zeatin 82.41 ppm; macro nutrient potassium (K) of 345.29 mg 100 g^{-1}, nitrogen (N) of 0.78%, phosphorous (P) 55.39 mg 100 ml^{-1}, and pH value 7. The positive benefits of seaweed originating from tropical coastal waters when combined with other land plant extracts will provide richer content.

Another plant-based organic material is coconut coir, leucaena, moringa leaves, and African leaves. According to Ramadhani (2011), coconut husk has a very rich element of potassium and also contains 30% fiber. According to Eniolorunda (2011) proximate composition of leucaena are crude protein, crude fibre, ash, and nitrogen free extract. Moringa leaves contain protein, calcium, phosphorus, iron and zinc (Salim *et al*., 2018). African leaves have several substances that are good for plants such as protein, amino acids, ascorbic acid, carotenoids, fats, carbohydrates, and fiber (Ijeh & Ejika, 2011). African leaves are medicinal plants that can be used as inflammation (Setiani & Rusli, 2020). Researcher Nurjannah *et al*., (2021) used fermented brown algae extract and showed that the growth of corn was improved.

There have been limited studies concerned on nutrient organic alternative for hydroponic plant nutrition. Therefore, this study was conducted to determine organic nutrition extract mixture of brown seaweed (*Sargassum* sp.) combined with coconut husk, or leucaena leaves, or moringa leaves, and African leaves that match to the nutritional quality of AB-mix as hydroponic nutrition for mustard plants.

MATERIALS AND METHOD

This research was conducted in the greenhouse of the Faculty of Agriculture, University of Lampung located at 220 5°21'55" S and 105°14'32" E with an elevation of 150 meters above mean sea level in November 2019 - March 2020. The microclimate of inside greenhouse was temperature 30.5°C,

RH 69%, and light intensity 10000 lux. The materials used are mustard seeds, seaweed (*Sargassum* sp.) coconut husk, leucaena leaves, AB Mix nutrient solution, water, beef rumen, EM4, and sugar.

The design used was a completely randomized design with six replications. The treatments consisted of six types of treatment, namely AB-mix nutrition, brown seaweed, brown seaweed and leucaena leaves, brown seaweed and coconut husk, brown seaweed and moringa leaves, and brown seaweed and African leaves.

This research was carried out starting from the preparation stage of hydroponic wick system installation. After that the preparation of liquid organic nutrition by preparing 5 kg respectively of brown seaweed, leucaena leaves, coconut husk, moringa leaves, African leaves. All materials, then, had been chopped into small pieces. Then, the ingredients are blended until smooth for 3 minutes with a 300 g: 1 l of water. All materials were extracted and fermented and added with beef rumen and EM4 as a bioactivator, 80 l of refined sugar and water. Fermentation was carried out for 20 days. Sowing of the seeds is carried out in rice husk and compost for 14 days or until 2 to 3 leaves appear. Then, analysis of nutrients was carried out in the fermented organic nutrient solution to determine the N, P, and K content of each organic nutrient solution. Preparation of AB-mix nutrient solution (*Hydro J.)* consists of nutrients A and B. Nutrients A as much as 500 ml combined with and B as much as 250 ml and add 100 l of water, then stir until blended. Organic nutrition is made by mixing organic matter and water, namely in a ratio of 1: 9.

Planting of mustard plants that are 14 days old or after the mustard plants appear 2-3 leaves to the container with dimensions of 38 cm x 28 cm x 12 cm in hydroponic wick system. Planting distance was 12 cm x 15 cm. After that, maintenance is carried out by controlling the nutrients in the tube including the volume of the solution, measuring the pH, and measuring the viscosity of the solution (EC) at each installation. Harvesting of mustard greens is carried out at the age of 30 days after planting (DAP) when the plants have reached their maximum growth with the characteristics of the plant height of approximately 26-33 cm, fresh green leaves, light green stems.

The observed variables were number of leaves (14 DAP), leaf greenness (soil plant analysis development, SPAD, at 21 DAP), shoot dry weight (30 DAP), root fresh weight (30 DAP), total plant fresh weight (30 DAP) and correlation analysis. Data were analysis using F test then continued with the mean separation with the Honestly Significantly Difference at the 5% level.

RESULTS AND DISCUSSION

The organic nutrition treatment of the mixture of brown seaweed and leucaena leaf extract resulted in higher root fresh weight among other organic nutrient treatments (Table 1). It is suspected that the availability of nutrients in the organic nutrition of the mixture of brown seaweed and leucaena leaves during the growth process is able to provide the essential macro needs of plants. In addition, the combination of these organic nutrients is thought to be able to support the supply of nutrients in the root area, so that the roots can easily absorb these nutrients. According to Atari *et al*., (2017), good plant

roots can affect the photosynthesis process and nutrients can be easily absorbed so that it can increase plant growth which will affect the components of mustard plant production. The greater the weight of the plant roots, the greater the plant will absorb nutrients. The fact that leucaena is the best plant for the source of extraction is supported by its nutrient content. Results of the analysis of nutrients N, P, and K showed that the nutrient content of N, P, and K in the organic nutrition of the mixture of brown seaweed and leucaena leaf extract is the highest among other organic nutrients, which is equal to N (216.98 mg L^{-1}), P (16.52 mg L^{-1}), and K (6 mg L^{-1}). The organic nutrient content of the mixture of brown seaweed and coconut husk extract shows that the nutrient content of N, P, and K is N (39.98 mg L^{-1}), P (11.90 mg L^{-1}), and K (4 mg L^{-1}). The organic nutrient content of the mixture of brown seaweed and moringa leaves shows that the nutrient content of N, P, and K is N (268,01 mg L^{-1}), P (17,52 mg L^{-1}), and K (4 mg L^{-1}). The organic nutrient content of the mixture of brown seaweed and african leaves extract shows that the nutrient content of N, P, and K is N (42,03 mg L^{-1}), P (13,62 mg L^{-1}), and K (5 mg L^{-1}).

The results showed that AB-mix nutrition resulted in shoot dry weight, root fresh weight and total plant fresh weight, which were significantly different from the mustard plants treated with organic nutrition. Shoot dry weight in the treatment of organic nutrition mixture of brown seaweed and leucaena leaves and organic nutrition treatment of a mixture of brown seaweed and coconut husk only reached 62.18% of the shoot dry weight in AB-mix nutrient solution treatment. Mustard plants given AB-mix treatment has dry weight of the shoot greater, namely 10.54 g compared to the treatment of organic nutrition mixture of brown seaweed and leaves of leucaena, namely 4.50 g, followed by treatment of organic nutrition mixture of brown seaweed and coconut husk, namely 3.96 g (Table 1).

The AB-mix nutritional treatment resulted in a 41.11% higher root fresh weight than the root fresh weight of the organic nutrient solution of the mixture of brown seaweed and leucaena leaf extract. The AB-mix nutritional treatment produced the highest root fresh weight, namely 5.01 g compared to 2.95 g (Table 2). The total fresh weight of mustard plants in the organic nutrient treatment of the mixture of brown seaweed and leucaena leaves only reached 51.08% of the total fresh weight of the plants in the AB-mix nutrient solution treatment (Figure 1). The AB-mix nutritional treatment resulted in the total fresh weight of mustard plants in the mustard plant, namely 113.31 g, higher than the treatment of organic nutrient solution mixture of brown seaweed and leucaena leaves which was 57.88 g (Table 2).

Table 1. Effect of organic nutrients from extracts of some organic matter on shoot dry weight, root fresh weight, and total fresh weight variables of mustard plants

Treatment	Shoot dry weight of 3 plants		Root fresh weight of 3 plants		Total fresh weight of mustard plants of 6 plants	
	Original	Trans √ (X + 0.5)	Original	Trans √ (X + 0.5)	Original	Trans √ (X + 0.5)
	g		g		g	
AB-mix	10.54 a	3.20	5.01 a	2.22	113.31 a	10.51
Seaweed	0.24 d	0.47	0.95 e	0.96	2.59 e	1.60
Seaweed + leucaena leaf	4.50 b	2.05	2.95 b	1.71	57.88 b	7.51
Seaweed + coconut fiber	3.96 b	1.93	1.89 c	1.36	27.87 b	5.17
Seaweed + moringa leaf	5.16 b	2.25	1.66 d	1.28	23.79 c	4.85
Seaweed + African leaf	1.20 c	1.07	1.31 de	1.14	6.99 d	2.64
HSD 5%	0.40		0.19		1.39	

Notes: The mean value followed by the same letter does not differ at the 5% level.

The organic nutrition of a mixture of brown seaweed and leucaena leaf extract produced a higher canopy dry weight compared to other organic nutrient treatments, this is presumably the treatment has a higher P nutrient content, because phosphorus itself plays an important role in the process of photosynthesis. According to Liferdi (2010) and Malhotra *et al*., (2018) P plays an important role in the processes of photosynthesis, assimilation, respiration, nucleic acid biosynthesis, and is used as a constituent component of several plant structures such as phospholipids. When photosynthesis is higher, the assimilation rate is high. The rate of assimilation has an effect on the shoot growth rate of the plant which will affect the dry weight of the plant crown (Table 1). The higher the dry weight of the plant canopy, it shows that the vegetative growth is growing optimally (Huang *et al*., 2019). When photosynthesis is higher, the assimilation rate is high. The rate of assimilation has an effect on the shoot growth rate of the plant which will affect the dry weight of the plant shoot. There is also a positive correlation between root growth and shoot growth in plants (Table 5). Similar trend was also reported by Tolley and Mohammadi (2020).

The total fresh weight of the plant is influenced by the large number of leaves, because the leaves where the photosynthesis occurs, if photosynthesis goes well, more photosynthate will be formed so that the plant's fresh weight is greater. According to Efendi *et al.,* (2017), short-lived leaf vegetable crops require large amounts of N as the main nutrient. The availability of sufficient amounts of N nutrient will be responded to maximally by mustard plants, so that the plants are able to form protoplasm in greater numbers and produce a greater plant fresh weight.

In the organic nutrition extract mixture of brown seaweed and leucaena leaves, the total plant fresh weight was the highest among other organic nutrients. This is presumably because the content of N, P, and K in the organic nutrients combined with leucaena leaves is quite high. The N content in hydroponics was 545 ppm (Arianandа *et al.,* 2020), while the nitrogen content in the extract of

Leucaena + brownseaweed is 216 ppm. After dilution of organic extract, plant is still did not receive adequate nutrient for growth. However. the content of leucaena extract is relatively close to the content of AB Mix. Further research to find the best organic nutrition which has the same quality as AB Mix is needed. According to Hidayat and Suharyana (2019) and Rop *et al*., (2019), N contained in liquid organic fertilizer made from leucaena leaves functions as a protein constituent, while the P and K in leucaena leaves can stimulate meristem tissue division, stimulate root growth, leaf development so that N, P, and K increase plant fresh weight and increasing crop production. Rambe (2014) stated that plants will survive if the nutrients needed by plants are available in a balanced proportion, especially macro nutrients such as N, P and K both in soil and in organic matter. The use of different substrates or organic solutions and inorganic solutions can affect the absorption of nutrients in plants, water absorption, oxygen availability, and maximum plant growth Ebrahimi *et al.* (2012) so that AB-mix nutritional treatment has more total plant fresh weight. compared to organic nutrient treatment.

According to Sunarpi *et al*., (2019) *Sargassum* sp. is one of the largest genera of brown seaweed from the family Sargassaceae with the main component in the talus *Sargassum* sp. are holocellulose (cellulose and hemicellulose), lignin, and alginate. Talus *Sargassum* sp. also contains nutrients (macro and micro nutrients), growth promoting hormones, protein and vitamins. This seaweed is also very potential as a food source of minerals, especially a source of calcium, phosphorus, and iron. Seaweed is also in almost all parts of Indonesia, so it has the potential to be used as organic nutrition for plant growth. According to Basmal *et al*. (2015), the liquid extract of *Sargassum* sp. can be used as liquid organic fertilizer. Research by Miceli *et al*. (2021) showed that Ecklonia maxima is a brown algae seaweed between 2 and 4 mL L^{-1}, enhanced plant growth and improved the yield and many morphological and physiological traits of lettuce.

The results showed that the treatment of organic nutrient solutions could not match the quality of AB-mix hydroponic nutrient solutions as hydroponic nutrients for mustard plant cultivation. Mustard plants treated with organic nutrition produced leaf numbers and greenish levels that were significantly different from those treated with AB-mix hydroponic nutrition. This can be seen from the number of mustard leaves in the organic nutrient solution treatment only reached 85.61% of the number of leaves in the AB-mix hydroponic nutrient solution treatment. The number of leaves in the AB-mix hydroponic nutrition treatment was 8.56 leaves, while the average number of leaves in the three types of organic nutrition treatment was only 6.27 leaves (Table 2). The level of leaf greenness in the organic nutrition treatment of the mixture of brown seaweed and leucaena leaf extract and the organic nutrition of the mixture of brown seaweed and coconut husk only reached 88.73% of the greenness level of the leaves in the AB-mix nutrient solution treatment. The highest leaf greenness level variable was obtained in the AB-mix treatment, it was 34.37 unit compared to the organic nutrient treatment of the mixture of brown seaweed and leucaena leaf extract which was only 28.52 unit and followed by the organic nutrition treatment of the mixture of brown seaweed and coconut husk extract which was 25.66 unit (Table 2).

Table 2. Effect of organic nutrients from extracts of several organic materials on the variable number of leaves and SPAD of mustard plants

Treatment	Number of leaves		SPAD	
	Original	Trans √ (X + 0.5)	Original	Trans √ (X + 0.5)
	blade		unit	
AB-mix	8.56 a	2.92	34.37 a	5.86
Seaweed	1.64 e	1.28	12.85 c	3.57
Seaweed + leucaena leaf	6.50 b	2.54	28.52 b	5.34
Seaweed + coconut fiber	6.61 c	2.57	25.66 b	5.06
Seaweed + moringa leaf	3.29 c	1.80	33.77 ab	5.80
Seaweed + African leaf	2.58 d	1.58	27.01 b	5.18
HSD 5%	0.33		0.46	

Notes: The mean value followed by the same letter does not differ at the 5% level

Based on the results of observations of the number of leaves and the level of greenness of the leaves, it was shown that the application of organic nutrition resulted in the number of leaves and leaf greenness that were significantly different from the mustard plants given AB-mix nutrition. Meanwhile, application of organic nutrition to extract a mixture of brown seaweed with leucaena leaves and mustard greens which were given organic nutrition from a mixture of brown seaweed with coconut husk resulted in the number of leaves and leaf greenness levels that were not significantly different.

Mustard plants that were treated with AB-mix nutrition produced a higher number of leaves compared to the organic nutrition treatment because the nutrients in AB-mix nutrition were readily available in a form that was readily absorbed by plants and their content was in accordance with the plant's needs. One of the highest nutrient elements in the AB-mix nutrient solution is Nitrogen (N). Xing *et al*., (2019) stated that nitrogen can be used for the synthesis of nucleic acids and proteins, phospholipids, and many secondary metabolites needed by plants. Leaves that are supplied with nitrogen will form wider leaf blades with a higher chlorophyll content, so that plants are able to produce carbohydrates in high amounts to support the vegetative growth of a plant. Fitriani *et al.,* (2020) found that in hydroponic wick system, Nitrogen efficiency could be improved with application of urea and extract of nutrient from organic material derived from vermicompost.

In plants, nitrogen is a macro nutrient needed by plants in large quantities, because nitrogen functions as a form of chlorophyll, which plays an important role in the process of photosynthesis. Chlorophyll functions as a light-capturing pigment for photosynthesis which produces carbohydrates as a source of energy in the respiration process, so that plants can continue their life (Ai & Banyo, 2011). The higher the nitrogen application within the optimum limit, the amount of chlorophyll produced will increase. Nitrogen plays an important role in the photosynthesis process and leaves are green in the presence of chlorophyll. Nitrogen is also the main component in making organic compounds in plants such as nucleic acids, chlorophyll, amino acids, ADP, and ATP (Syofia *et al.,* 2014).

Figure 1. Growth of mustard plants treated with AB-Mix (left) and treated with seaweed and leucaena leaf (right).

The pH value of all treatments are the AB-mix solution ranges from 6.8 -7, brown seaweed extract is 4-4.5, in a mixture of brown seaweed extract and leucaena leaf is 5.2 - 5,5, a mixture of brown seaweed and coconut husk is 4.8 - 5, in a mixture seaweed and moringa leaf is 4.8 – 5.0, and in a mixture seaweed and African leaf is 4.0 – 4.5. In this study, the highest EC value was in the AB-mix nutrient solution, which ranged from 1,082 to 1,111 ppm, while the EC value in organic nutrient solutions of all treatments ranged from 550-701 ppm.

The quality of water indicated by pH and EC in this experiment is favorable for mustard growth (Table 3 and 4). According to Prado (2021), a nutrient solution that has a pH value of 6 or an optimum pH makes all nutrients dissolve easily and is sufficiently available for plants so that plant growth will be better. At high EC values, organic nutrients cause the plant to have insufficient nutrient needs or decrease the concentration of fertilizers in plants (Ding *et al*., 2018) so that plant growth is inhibited.

Table 3. EC value of the nutrient solution

Treatment	EC (ppm)			
	7 DAP	14 DAP	21 DAP	28 DAP
AB-mix	1082.00	1101.00	1103.00	1092.00
Seaweed	508.00	500.00	502.00	500.00
Seaweed + leucaena leaf	562.00	619.00	620.00	701.00
Seaweed + coconut fiber	520.00	500.00	610.00	625.00
Seaweed + moringa leaf	501.00	571.00	600.00	602.00
Seaweed + African leaf	510.00	520.00	511.00	507.00

Table 4. pH value of nutrient solution

Treatment	pH			
	7 DAP	14 DAP	21 DAP	28 DAP
AB-mix	6.9	6.8	7.0	6.9
Seaweed	4.1	4.0	4.3	4.5
Seaweed + leucaena leaf	5.2	5.2	5.5	5.4
Seaweed + coconut fiber	4.9	5.0	4.8	5.0
Seaweed + moringa leaf	5.0	4.9	4.9	4.8
Seaweed + African leaf	4.3	4.0	4.5	4.4

The results of the correlation test for vegetative and generative variables through the Pearson correlation test (Table 5) showed that the vegetative variable i.e. the number of leaves resulted in a significantly different positive correlation with the generative variables i.e., shoot dry weight, root fresh weight, and shoot fresh weight. Likewise, there is a significant correlation between root fresh weight and shoot fresh weight.

Table 5. Correlation coefficient between vegetative and generative traits

Variables	Number of leaves	SPAD	Shoot dry weight	Root fresh weight	Shoot fresh weight
Number of leaves	1				
SPAD	0.58	1			
Shoot dry weight	0.84*	0.78	1		
Root fresh weight	0.88*	0.62	0.93**	1	
Shoot fresh weight	0.88*	0.62	0.94**	0.99**	1

Note: * = Significant at P<0.05; ** = highly significant at P<0.01

The organic nutrient solution not being able to match the quality of AB-mix hydroponic nutrition is thought to be caused by several factors, namely the extraction process, fermentation results, and the hydroponic system used. In the observation that the organic nutrient solution in the anaerobic fermentation method which was carried out for 20 days was not yet perfect (smells like alcohol), so that microorganisms were still active in the organic nutrient solution. In addition to that, this were supported by a nutrient solution that did not move using in the hydroponic axis system. Active microorganisms would cause low pH during fermentation process, so that root development in mustard plants to be stunted.

Microorganisms that are still active in the fermentation of organic nutrients make microbes and plant roots compete with each other for oxygen. Root growth that lacks oxygen will result in stunted plants and black/brown roots. According to Surtinah (2016), respiration produces the energy needed by plants so that it can be used for assimilation in water absorption, ion absorption and nutrient absorption so that oxygen is very important for the growth and function of plant cells, without oxygen that is sufficient for respiration, water and ion absorption stops, and dead plant roots. Lack of oxygen caused

by disturbances in the roots can cause imperfect plant growth and reduce crop yields in plants (Pratiwi *et al.,* 2015).

Fermentation is a way to change the organic substrate with the help of microorganisms (Sharma *et al*., 2020), one of the microorganisms that can be used to help composting organic material, namely using EM4 (Effective Microorganism-4) as liquid organic fertilizer because it contains microorganisms that are useful for the composting process and using cattle rumen as an activator for helps speed up composting (Bunga & Lewar, 2009).

This experiment used the hydroponic wix system. The drawback of this system is the absence of movement of the nutrient solution. According to Akasiska *et al*., (2014), roots that are immersed in immobile nutrient solutions cause stunted plant growth due to lack of oxygen which causes root activity in the absorption process of water and mineral nutrients to be disturbed. This results in the organic nutrient solution to be difficult to dissolve, making it difficult for the mustard plant to absorb.

Many resources could be utilized as the substitutes of AB Mix nutrition, such as vegetable waste (Faruq *et al.,* 2021) and seaweed extract as shown from this research. Further research is still needed by testing various extract methods, namely the first stage of the aerobic fermentation method and the second stage of the anaerobic fermentation method in order to obtain a more effective method for dissolving nutrients from organic matter. We suggest also using another method of hydroponic system and not using the wick system. In the fermentation method and the hydroponic wick system used in this study, the nutrient absorption process is still not effective for the optimal growth of mustard plants.

CONCLUSION

The organic nutrient solution extract of the mixture of brown seaweed, leucaena leaf, or coconut fiber, or moringa, or African leaves has not been able to match the nutritional quality of AB-mix for mustard plants in the hydroponic system. The organic nutrition of the mixed extract of brown seaweed and leucaena leaf was better than other organic nutrients by producing 57.88 g of fresh weight of mustard plants, but only 51.08% of the fresh weight of mustard plants in AB-mix treatment which was 113.31 g. Further research to observe the nutrient uptake per plant and efficiency of water use/nutrient solution is needed.

ACKNOWLEDGMENT

Thank you for supporting from the staff of the greenhouse and plant laboratory at Faculty of Agriculture, Universitas Lampung.

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Dr. Ir. Mujiyo, S.P., M.P. <jurnal@mail.uns.ac.id>
to me, Yohannes, Rugayah, Rosi, Echa

Tue, Jun 14, 11:14 AM

The following message is being delivered on behalf of Caraka Tani: Journal of Sustainable Agriculture.

Dear Dr. Darwin Habinsaran Pangaribuan,

We have reached a final decision regarding your submission to Caraka Tani: Journal of Sustainable Agriculture, "The Effect of Seaweed (Sargassum sp.) and Plant Extract Combination on the Growth of Mustard Plant (Brassica juncea L.) Grown by Hydroponic Wick System".

Our decision is to: Accept Your Article for the Publication

You will be duly informed about the next procedure. You can view the status of your article at any time by checking your Author's account after logging.

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[Caraka Tani] Article has been completely published in Vol 37 No 2 October 2022

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Caraka Tani: Journal of Sustainable Agriculture <carakatani@mail.uns.ac.id> Thu, Sep 29, 10:26 PM

to me, yohannesginting, rugayahbw, sisioktiya289, echadessya31

Dear Ir. Darwin Habinsaran Pangaribuan, M.Sc., Ph.D.,

We are pleased to inform you that your article entitled “The Effect of Seaweed (Sargassum sp.) and Plant Extract Combinations on the Growth of Mustard Plant (Brassica juncea L.) Grown in Hydroponic Wick System” has been completely published in Vol 37 No 2 October 2022.
Article website link: https://jurnal.uns.ac.id/carakatani/article/view/59668
Please promote your article by sharing its link with your students, colleagues, and friends.
Caraka Tani still needs a more solid citation record of its articles in journals/conferences already indexed in Scopus and Web of Science.
We will highly appreciate it if your article has a high citation performance. It will be precious for Caraka Tani: Journal of Sustainable Agriculture as a reputable international journal.
Thank you.

Yours sincerely,
Dr. Ir. Mujiyo
Chief Editor of Caraka Tani: Journal of Sustainable Agriculture
Faculty of Agriculture, Universitas Sebelas Maret, Surakarta, Indonesia
ISSN: 2613-9456 (Print) | ISSN: 2599-2570 (Online) | DOI parent: 10.20961/carakatani.
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