The potential of seaweed used as hydroponic solution on the growth and yields of lettuce (Lactuca sativa L.)

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Abstract. Lettuce (Lactuca Sativa L.) is one of the most popular leaf vegetables in Indonesia. Hydroponic systems do not require extensive land cultivation. The advantages of using hydroponic systems is that it has higher production with more efficient land use. Seaweeds have been reported to be used as a fertilizer. This study aims to determine the effect of various nutrient solutions on the growth and yield of lettuce plants with hydroponic system. This study used a randomized block design (RBD), with five treatments: N1= OLF (organic liquid fertilizer) solution, N2= OLF solution + spray, N3= Seaweeds extract solution, N4= Seaweeds extract solution+ OLF solution, N5= AB mix (Nutripionik). Each treatment was repeated 4 times, so that there were 20 units of experiment. Each unit of experiment consist of 5 plants so that the total population was 100 plants. The results showed that the AB mix nutrient solution gave the best growth responses. It produced an average plant height, number of leaves, total fresh weight of plant, and total dry weight of plants better than other solutions.

1. Introduction
Lettuce (Lactuca sativa L.) is a leaf vegetable plant that has high economic value. Like other leafy vegetables, lettuce is commonly consumed raw and becomes a salad vegetable. This requires that the production must be clean and free from the use of pesticides. The cultivation system that can produce good quality products is by using hydroponic technology. Lettuce is a suitable plant to be cultivated hydroponically [1]. Lettuce marketing opportunities increase along with the growing number of foreign hotels and restaurants that use lettuce as an ingredient such as in salads, hamburgers, hot dogs and so on. This can increase the demand for lettuce. One of the efforts to continuously increase lettuce production is by using hydroponic technology [2].

Hydroponic systems can provide a more controlled growth environment. With the development of technology, the combination of hydroponic systems and membranes is able to utilize water, nutrients and pesticides significantly more efficient (minimalist system) compared to soil culture (especially for short-lived plants). The use of hydroponic systems is irrelevant to seasons and does not require large areas of land compared to soil culture to produce the same unit of productivity [3]. In addition to planting media, nutrition is also very important for success in hydroponic planting, because without nutrition, of course, you cannot plant hydroponically. Nutrients are macro and micro nutrients that must be present for plant growth. Each type of nutrition has a different composition [4]. Hydroponic system that uses media other than soil such as husk charcoal, sand, and sterile coconut husk powder are called substrate hydroponics. This hydroponic technique is still being used to cultivate vegetables and fruits which have high selling value including lettuce [5, 6].
Liquid organic fertilizers (LOF) can be used as a substitute for hydroponic plant nutrition which is free from chemical because it comes from organic materials that are safe for health. LOF is a solution of decomposing organic matter from plant residues, agro-industrial waste, animal manure, and human waste that contains more than one nutrient [7].

*Ulva* sp. Seaweed is a low-level plant that does not have true roots, stems and leaves [8]. Seaweed habitat is found in the coastal of Indonesia. Unlike inorganic fertilizers, extracts made from seaweed are naturally degradable, non-toxic, non-contaminating, and safe for humans and animals [9]. Utilization of seaweed as fertilizer or fertilizer additive is expected to be an alternative solution to environmental problems [10].

This study aims to determine the effect of various nutrient solutions on the growth and yield of lettuce with the hydroponic system.

2. Materials and methods
This research was conducted from July to September 2018 under the glass house condition in Palu City, Central Sulawesi Province. The tools used in this research were Styrofoam box, flannelette, net pot, rockwool, measuring cup, bucket, hand sprayer, black plastic, ruler, TDS meter, EC meter, Leaf Area Meter (LAM).

The materials used in this study were lettuce seeds, liquid organic fertilizer (OLF), AB mix and seaweed extract.

This study used a randomized block design (RBD) using 5 treatments as follows:

N1 = OLF  
N2 = OLF + spray  
N3 = Seaweed extract  
N4 = Seaweed extract + OLF  
N5 = AB mix

Each treatment was repeated 4 times so that 20 experimental units were obtained, each experimental unit contained 5 plants so that the total population was 100 plants.

2.1 Hydroponic installation
Twenty Styrofoam boxes were prepared and plastic sheets were used as coating material for the inner side of the boxes, then 5 holes were made on the lid of the box.

2.2. Preparation of nutritional solutions
The nutrient solution was made according to the predetermined treatment. In the seaweed extract treatment, 100 grams of seaweed and 2 liters of distilled water were mixed and then stirred at a temperature of 70°C, stirred for 1 hour and a half and let it cool and then filtered. In the OLF Nasa treatment, 80-120 ml of Nasa OLF per liter of water was used; adjusting the nutritional needs of lettuce based on the ppm value and for additional spray treatment, namely by spraying the OLF Nasa solution at the bottom of the leaves of the lettuce plant with a dose of 6 ml / liter of water. Whereas in AB MIX treatment, stock A and stock B were both granular, each dissolved in 500 ml of water. The concentration used in the mixture was 5 ml of stock A + 5 ml of stock B then dissolved in 1 liter of water.

2.3. Nursery
Rockwool was cut into squares (2 cm), then soaked in plain water. Make a small hole above the soaked rockwool. Then put the lettuce seeds into the rockwool that has been perforated, then cover it with black plastic. Flush the nursery with enough water until the seeding age is 10 days.

2.4. Planting
Seedlings that have 3-5 leaf leaves were placed in the net-pot that has been provided; then move the net-pot containing the seedling to the hydroponic installation planting hole which water had been
dissolved by hydroponic nutrients. Plant caring activities include controlling the total dissolved solids (TDS), pH, replanting, and protecting plants from the pests. The total value of dissolved solids (TDS) at the beginning of planting was 560 ppm, while for mature plants it was 700-800 ppm and up to harvest was 900 ppm. Meanwhile, pest control was done manually without using pesticides so that the plants were not contaminated with other chemicals.

2.5. Harvest
Lettuce plants harvested at 35 DAS. Harvest was done in the morning to maintain the freshness and moisture content of the lettuce.

3. Results and discussion

3.1. Plant height
Based on the observation data on plant height (cm) of lettuce at the age of 7, 14, 21, 28 and 35 DAS, it shows that the AB mix solution produces the highest average plant height, this treatment is significantly different from other treatments. The average value of plant height can be seen in Table 1.

| Treatments | 7 DAS | 14 DAS | 21 DAS | 28 DAS | 35 DAS |
|------------|-------|--------|--------|--------|--------|
| N₁         | 2.15<sup>a</sup> | 2.30<sup>a</sup> | 2.64<sup>a</sup> | 3.43<sup>a</sup> | 3.95<sup>a</sup> |
| N₂         | 2.43<sup>a</sup> | 2.57<sup>a</sup> | 3.57<sup>a</sup> | 4.10<sup>a</sup> | 5.36<sup>a</sup> |
| N₃         | 2.22<sup>a</sup> | 2.25<sup>a</sup> | 2.93<sup>a</sup> | 3.31<sup>a</sup> | 5.11<sup>a</sup> |
| N₄         | 2.17<sup>a</sup> | 2.30<sup>a</sup> | 2.73<sup>a</sup> | 3.08<sup>a</sup> | 3.33<sup>a</sup> |
| N₅         | 3.15<sup>b</sup> | 7.68<sup>b</sup> | 14.94<sup>b</sup> | 20.01<sup>b</sup> | 31.38<sup>b</sup> |

HSD 5% 0.72 0.84 1.80 2.44 3.99

Note: The average followed by the same letter in the same column shows no difference at the 5% HSD test.

3.2. Number of leaves
Based on the observation data, the number of leaves of lettuce at the age of 7, 14, 21, 28 and 35 DAS showed that the AB mix solution produced the highest average number of leaves, this treatment was different from other treatments. The average number of leaves is presented in Table 2.

| Treatments | 7 DAS | 14 DAS | 21 DAS | 28 DAS | 35 DAS |
|------------|-------|--------|--------|--------|--------|
| N₁         | 3.80<sup>a</sup> | 4.50<sup>a</sup> | 3.85<sup>a</sup> | 3.70<sup>a</sup> | 3.25<sup>a</sup> |
| N₂         | 4.00<sup>a</sup> | 4.30<sup>a</sup> | 4.65<sup>a</sup> | 4.30<sup>a</sup> | 4.45<sup>a</sup> |
| N₃         | 3.85<sup>a</sup> | 3.95<sup>a</sup> | 4.45<sup>a</sup> | 4.05<sup>a</sup> | 4.85<sup>a</sup> |
| N₄         | 4.05<sup>a</sup> | 3.70<sup>a</sup> | 4.95<sup>a</sup> | 3.90<sup>a</sup> | 3.70<sup>a</sup> |
| N₅         | 4.60<sup>a</sup> | 6.05<sup>b</sup> | 7.20<sup>b</sup> | 8.50<sup>b</sup> | 12.45<sup>b</sup> |

HSD 5% 0.41 0.95 1.75 1.91 1.50

Note: The average followed by the same letter in the same column shows no difference at the 5% HSD test level.

3.3. Plant fresh weight
Based on the observation data, the fresh weight of lettuce plants showed that the nutrient solution AB mix (N5) produced the highest total fresh weight of lettuce. This treatment is different from other treatments. The average value of total plant fresh weight is presented in Table 3.
Table 3. Average total fresh weight (g) of lettuce in various nutrient solutions

| Treatments | Fresh weight |
|------------|--------------|
| N1         | 1.37a        |
| N2         | 1.94a        |
| N3         | 2.23a        |
| N4         | 1.79a        |
| N5         | 8.39b        |
| HSD 5%     | 0.89         |

Note: The average followed by the same letter in the same column shows no difference at the 5% HSD test.

3.4. Plant dry weight
Based on the observation data, the total dry weight of lettuce plants showed that the nutrient solution AB mix (N5) produced the highest total dry weight of lettuce plants. This treatment is different from other treatments. The average value of total plant dry weight is presented in Table 4.

Table 4. Average total dry weight (g) of lettuce in various nutrient solutions

| Treatments | Mean |
|------------|------|
| N1         | 0.78a |
| N2         | 0.79a |
| N3         | 0.80a |
| N4         | 0.80a |
| N5         | 1.12b |
| HSD 5%     | 0.28  |

Note: The average followed by the same letter in the same column shows no difference at the 5% HSD test.

3.5. Leaf area
Based on the observation data on the total leaf area of lettuce plants, it showed that the nutrient solution AB mix (N5) produced the highest leaf area of lettuce plants. This treatment is different from other treatments. The average value of plant area is presented in Table 5.

Table 5. Average leaf area of lettuce plants in various nutrient solutions

| Treatments | Mean |
|------------|------|
| N1         | 54.14a |
| N2         | 55.76a |
| N3         | 66.21a |
| N4         | 54.48a |
| N5         | 154.16b |
| HSD 5%     | 33.54 |

Note: The average followed by the same letter in the same column shows no difference at the 5% HSD test level.

Based on the results of the research on the high of plant, the number of leaves, leaf area, total fresh weight of plants, total dry weight of plants, the treatment with AB mix nutrient solution produced the highest average of all parameter. This is due to the amount of nutrient content contained in AB mix suitable for the lettuce growth.
The results showed that AB mix solution produced the highest plant, this is because the height of the plant is affected by the nitrogen content in the AB mix nutrient solution. Nitrogen for plants plays an important role in stimulating overall plant growth, especially stems, branches and leaves[11]. In the number of leaves AB mix also produced the largest number of leaves this is because AB mix contains high N. If the element N is available in large quantities then more protein is formed so that plant growth can be better [12].

Wet weight and dry weight are influenced by the number of leaves. Increasing the number of leaves of plants then it will automatically increase the fresh weight of plants, because the leaves are a sink for plants. In addition, the leaves on vegetable crops are organs that contain a lot of water, so with the increasing number of leaves then the water content of the plant will be high and cause the fresh weight of the plant to be higher as well [3].

If nutrient content is available enough then the leaf area of a plant will be higher, where most of the assimilate is allocated for the formation of leaves which results in increased leaf area. The amount of AB mix nutrients given, resulting in an increasing amount of nutrients especially nitrogen that can be utilized by plants [13].

OLF is a complete organic fertilizer [14], but the nutrient content in organic fertilizer is difficult to predict so that the plant response to liquid organic fertilizer is slower, it can be seen from all research parameters that this OLF is not suitable as a nutritional solution for hydroponics [15].

Seaweed has good prospects for organic fertilizer due to nutrients and especially regulating growth. regulators of plant growth that contain auxins, cytokines, and gibberellin [16]. The results of this study showed that the EC value of the seaweed extract nutrient solution was 1.7 mS/cm which indicates that the solution is concentrated [17]. Concentrated solutions difficult be absorbed directly by plants, this is because the osmotic pressure of the cell is smaller compared to the osmotic pressure outside the cell due to the flow of fluid from the plant cells. The nutritional value of hydroponic lettuce plants was EC 0.8-1.2 mS/cm. High EC values result in plants not being able to absorb nutrients because high salt concentrations can damage plant roots.

4. Conclusion
It can be concluded that the AB mix nutrient solution gave the best growth response using hydroponic system.

Acknowledgments
The authors would like to thank the Ministry of Research, Technology, and Higher Education of the Republic of Indonesia for financial support.

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