The Growth and Yields of Shallot (*Allium Wakegi Araki*) CV. lembah palu Growing under Hydroponic Substrate Systems

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Abstract. The study was carried out used a Randomized Block Design (RBD) with AB Mix concentration treatments consisting of six levels of concentrations, namely: Concentration of AB Mix solution 3 mL/L water (K1), Concentration of AB Mix solution 5 mL/L water (K2), Concentration of AB solution Mix 7 mL/L water (K3), Concentration of AB solution Mix 9 mL/L water (K4), Concentration of AB solution Mix 11 mL/L water (K5) and Concentration of AB Mix solution of 13 mL/L water (K6). The results showed that use of various concentrations of AB Mix solution did not affect the diameter of bulbs, fresh weight and dry weight of leaves of shallot but significantly affected fresh bulb weight, bulb dry weight, fresh weight roots, and root dry weights. In conclusion, the concentration of AB Mix of 7 mL/L of water gave the highest yield of fresh bulb weight of 17.63 g and dry weight of plant bulb 3.95 g.

1. Introduction

Shallots are one of the priority commodities in the development of lowland vegetables in Indonesia, which have high economic value [1]. In Central Sulawesi, the commodity of shallots is cultivated and developed by farmers in the Palu Valley, especially in Donggala and Sigi Regencies, which are known as lembah palu Variety [2]. This variety was released by the Ministry of the Republic of Indonesia in 2011, as the national superior variety. This shallot is widely known as the main ingredient in the fried onion industry in Central Sulawesi because it has a distinctive taste, aroma, and texture and has good quality even though it is stored for a long time. The average productivity of this variety is still low, namely only around 4.0 - 4.5 tonnes/ha, while the potential yield is 9.7 tonnes/ha [3].

Land conversion is an activity of changing land use from one activity to another. Land conversion occurs as a result of development and an increase in population [4] [5]. In line with [6] the increase in population and the development of the economic structure, the need for land for non-agricultural activities tends to increase. This trend makes the conversion of agricultural land difficult to avoid [7]. However, these problems can still be overcome with several alternative cultivation techniques, especially on a narrow land. One of the efforts that can be done is by using hydroponic technology.

Hydroponics is a plant cultivation system without using soil as a growing medium with the addition of nutrients for growth [8] [9]. The advantages of hydroponic system cultivation include: (1) The plant density per unit area can be doubled, thereby saving land use. (2) Product quality such as shape, size, taste, color, cleanliness can be guaranteed because the nutritional needs of plants are supplied in a controlled manner in the greenhouse.
Substrate hydroponics is a hydroponic system that uses media other than soil such as husk charcoal, sand, and sterile coconut husk powder. This hydroponic technique is still being used to cultivate vegetables and fruits which have high selling value. Hydroponics is a way of farming without using soil. As a substitute for soil, charcoal sand, husks, and sawdust can be used. Besides being used, husk charcoal is easy to obtain, light, and has good porosity[10] [11].

The nutrients provided by plants are very important in hydroponic systems because the success of the hydroponic cultivation system depends on the nutrients provided. AB Mix nutrition is a fertilizer that can be used as a nutrient solution in hydroponic systems [12]. This fertilizer consists of two parts, namely stock A in the form of macronutrients while stock B is in the form of micronutrients [13].

Research has been carried out to determine the concentration of the AB Mix nutrient solution which is suitable for the cultivation of shallot plants of the lembah palu variety. AB mix consist of macro and micro nutrient which can be used by plant for growth and development. This study aims to determine the effect of giving various concentrations of AB Mix solution on the growth and yield of shallot plants by using a hydroponic substrate.

2. Materials and methods
This research was conducted in Dolo District, Sigi Regency, Central Sulawesi Province, from February to April 2019. Plant analysis was carried out at the Agronomy Laboratory of the Faculty of Agriculture, Tadulako University. The tools used in this study are pH meter, TDS meter, polybag size 20 x 18 cm, nutrient storage container. The materials used are AB mix nutrition, distilled water, husk charcoal, shallot of lembah palu variety.

This study used a randomized block design consisting of six levels of treatment with three replications to obtain 18 experimental units. Each experimental unit consisted of three plants, resulting in 54 populations of shallot plants. The treatment to be tested was various concentrations of AB Mix solution as follows:

K1 = concentration of AB Mix solution 3 mL/ L water
K2 = concentration of AB Mix solution 5 mL/ L water
K3 = concentration of AB Mix solution 7 mL/ L water
K4 = concentration of AB Mix solution 9 mL/ L water
K5 = concentration of AB Mix solution 11 mL/ L water
K6 = Concentration of AB Mix solution 13 mL/ L water

2.1. Preparation of plant media.
The planting medium used is ready-to-use husk charcoal media which is purchased at a selling point for ornamental plants in the city of Palu. Furthermore, the husk charcoal is weighed as much as 500 g per poly bag.

2.2. Nutritional preparation
The nutrient solution used is the AB Mix type solution. Preparation of AB Mix nutrient solution first by preparing concentration A and concentration B which is done by preparing 2 containers, each marked with containers A and B, then both containers are filled with 250 ml of clean water. Furthermore, nutrients A and B which are still in powder form are dissolved in the respective containers that have been marked previously. After completely dissolving the two containers, add water to 500 ml of concentrated solution A and B, so that the concentrated solutions A and B are ready for use. To be applied to plants first, namely by making the concentration of the solution according to the concentration to be given.

2.3. Preparation of seeds.
The shallot seeds used are grouped based on bulb weight (g), namely large bulbs weighing 4-5 g, medium bulbs weighing 3-4 g, and small bulbs weighing 2-3 g. The onion seeds used are seeds that are in good condition, healthy and have been stored for about 3–4 months. To facilitate the germination process, 1/4 of the tip of the bulb is cut using a cutter.

2.4. Planting.
Planting shallot seeds is carried out by immersing some of the onion bulbs in the planting medium, leaving only the top of the bulb above the substrate surface.
2.5. Harvest.
Harvesting is done when the plants are 65 days after planting (DAP), which is marked by a change in the color of old leaves that turn yellow or the bulbs have been slightly raised to the surface. The shallot bulbs are harvested by removing the plant bulbs and all the roots.

3. Result and discussion

3.1. Bulbs diameter
AB Mix solution given did not affect the bulb diameter of the shallot. The trend of the effect of treatment on the average bulb diameter is presented in Figure 1. It shows that the concentration of the AB Mix 3 mL/L water solution tends to give better results than all the treatments given.

\begin{figure}
\centering
\includegraphics[width=\textwidth]{figure1}
\caption{The average diameter of a bulb of shallots at various AB Mix Concentration Treatments.}
\end{figure}

3.2. Leaf fresh weight
The concentration of the AB Mix solution did not affect the fresh weight of the leaves of the shallot plants. The trend of the effect of treatment on the average fresh weight of plant leaves is presented in Figure 2. It shows that the concentration of AB Mix 3 mL/l water solution tends to be better than all the treatments.

\begin{figure}
\centering
\includegraphics[width=\textwidth]{figure2}
\caption{Average leaf fresh weight (g) of shallot plants with various concentrations of AB Mix solution treatment.}
\end{figure}

3.3. Leaf dry weight
The analysis of variance showed that the concentration of the AB Mix solution did not affect the dry weight of the leaves of the shallot. The trend of the effect of the treatment on the average dry weight of plant leaves is presented in Figure 3. Based on the results shows that the concentration of AB Mix 3 mL/L water solution tends to be better than all the treatments.
3.4. **Fresh bulbs weight**

The concentration of the AB Mix solution had a significant effect on the fresh weight of the shallot bulb. The average fresh weight of plant bulbs is presented in Table 1 shows that the concentration of AB Mix 7 ml/l water solution gave the highest average fresh weight of the bulb, namely 17.63 g.

| Treatments | Average bulb fresh weight (g) |
|------------|-------------------------------|
| K1         | 14.49<sup>a</sup>            |
| K2         | 16.22<sup>b</sup>            |
| K3         | 17.63<sup>c</sup>            |
| K4         | 17.10<sup>c</sup>            |
| K5         | 13.95<sup>a</sup>            |
| K6         | 13.99<sup>a</sup>            |
| BSD 5%     | 2.03                          |

Note: The mean value followed by the letter with the same super script do not show significant difference in the BSD test at a 5% level.

3.5. **Dry weight of bulbs**

The concentration of the AB Mix solution had a significant effect on the dry weight of shallot plant bulbs. The average dry weight of plant bulbs is presented in Table 2. The show that the concentration of AB Mix 7 ml/l water solution gave the highest average dry weight of the bulbs.

| Treatments | Average bulb dry weight (g) |
|------------|-------------------------------|
| K1         | 3.35<sup>a</sup>            |
| K2         | 3.85<sup>b</sup>            |
| K3         | 3.95<sup>b</sup>            |
| K4         | 3.94<sup>b</sup>            |
| K5         | 2.48<sup>a</sup>            |
| K6         | 2.09<sup>a</sup>            |
| BSD 5%     | 1.31                          |

Note: The mean value followed by the letter with the same super script do not show significant difference in the BSD test at a 5% level.
3.6. Root Fresh Weight.
The concentration of AB Mix solution given a very significant effect on the fresh weight of the roots of the shallot. The average plant root fresh weight is presented in Table 3. The results show that the concentration of AB Mix 3 mL/L water solution gave the highest average root fresh weight.

Table 3. Average root fresh weight (g) of shallot plants in various AB mix concentration treatments.

| Treatments | Average Root Fresh Weight (g) |
|------------|-------------------------------|
| K1         | 6.14<sup>c</sup>             |
| K2         | 3.17<sup>b</sup>             |
| K3         | 3.27<sup>b</sup>             |
| K4         | 1.86<sup>a</sup>             |
| K5         | 2.03<sup>a</sup>             |
| K6         | 1.26<sup>a</sup>             |
| BSD 5%     | 0.91                          |

Note: The mean value followed by the letter with the same super script do not show significant difference in the BSD test at a 5% level.

3.7. Root Dry Weight.
The concentration of the AB Mix solution gave a significant effect on the dry weight of the roots of the shallot. The average dry weight of plant roots is presented in Table 4. The results showed that the concentration of AB Mix solution 3 mL/L water gave the highest average root dry weight.

Table 4. The average root dry weight (g) of shallot plants in various AB mix concentration treatments.

| Treatments | Average Root Dry Weight (g) |
|------------|----------------------------|
| K1         | 0.98<sup>c</sup>           |
| K2         | 0.56<sup>b</sup>           |
| K3         | 0.54<sup>b</sup>           |
| K4         | 0.32<sup>a</sup>           |
| K5         | 0.31<sup>a</sup>           |
| K6         | 0.25<sup>a</sup>           |
| BSD 5%     | 0.23                        |

Note: The average value followed by the letter with the same super script do not show significant difference in the BSD test at the 5% level.

Hydroponic solution given has a composition of macro and micronutrient content by the recommended standards. The lack of availability of nutrients and water in hydroponic techniques results in root elongation which is one of the efforts of plants to meet their needs. Nutrients are needed by plants to stimulate plant growth. If the plant can develop properly, the absorption of nutrients will run smoothly. This activity results in better growth and development of plants and their parts, resulting in high wet and dry weight [14]. The results of this study indicated that AB Mix treatment with various concentrations had no effect on bulb diameter, leaves fresh weight, and leaves dry weight, but had an effect on bulb fresh weight, bulb dry weight, root fresh weight, and root dry weight. Table 1 and Table 2 show that watering the AB Mix solution concentration of 7 mL/L water gives the average value of the fresh weight and dry weight of bulbs higher than all the treatments given. However, the addition of the higher AB Mix solution concentration gave the fresh weight and dry weight of the plant bulbs lower [15]. This indicates that the amount of nutrients in the treatment is appropriate for shallot growth. The higher the concentration of the AB Mix solution given, the lower the bulb weight was.
Fertilization that is not suitable for plant requirement is inefficient, it makes plants unable to absorb these nutrients. Nutrients may become toxic to plants. Fertilization must be done appropriately to provide optimal growth and results for plants [16][17][18]. Plant growth and production will reach optimum if the supporting factors that support the growth are at optimal conditions, balanced elements, the right dose of fertilizer, and the nutrients needed are available to plants. Application of fertilizers by the dosage and needs can increase yields, on the other hand, excessive nutrient add will reduce crop yields.

4. Conclusions
Watering plants with various concentrations of AB Mix solution did not affect bulb diameter, fresh weight, and leaf dry weight but had a significant effect on fresh bulb weight, bulb dry weight, root fresh weight, and root dry weight. Giving concentration of AB Mix 3 mL/L water solution gave better results than other treatments as indicated by the average plant root fresh weight and plant root dry weight while giving 7 mL/L of water provided the highest yield of bulb fresh weight.

5. References
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