The effects of substrate composition on the growth of *Brassica oleracea* Var. *Acephala* with drip hydroponic

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**Abstract.** The drip hydroponics system has a weakness which at a high evapotranspiration condition can't fulfill plant water requirement properly. Improving the composition of plant growth media with cocopeat and rice husk charcoal is a solution to increase *Kailan* Plant Growth. This research aims to study the effect of a ratio between cocopeat and rice husk charcoal as plant media to increase productivity of *Brassica oleracea* on drip hydroponic. The research was conducted at Jatinangor-Sumedang-West Java from November to December 2017. The method of this research used completely randomized design with five treatment (A=Cocopeat 100%; B=Cocopeat 75%+ Rice Husk Charcoal 25%; C= Cocopeat 50% + Rice Husk Charcoal 50%; D= Cocopeat 25% + Rice Husk Charcoal 75%; E= Rice Husk Charcoal 100%), and five replication. The growth indicator in this research is plant height, number of leaves, leaf area, fresh plant weight, and shoot-root ratio. The ratio of cocopeat and rice husk charcoal as plant growth media affect the plant growth of *kailan*. The result showed that composition grows media Cocopeat 75% + Rice husk charcoal 25% affect plant height, fresh plant weight, and shoot-root ratio. The plant grow substrates with good aeration and water holding capacity can improve *Kailan* plant growth on drip irrigation system.

1. **Introduction**

The popularity of the application of hydroponics as an urban farming system contributes to the increasing need for planting media such as rock wool, spaghnum and husk charcoal [1]. Technically in some hydroponic systems and some plants can grow without the addition of substrate to support its growth. However, adding a substrate to the hydroponic system can increase plant growth [2]. The use of Rockwool as a planting medium, in the long run, causes environmental problems because Rockwool is difficult to decompose.

The use of husk charcoal as a hydroponic substrate is more widely used because it is readily biodegradable; its availability is easily obtained in large quantities. However, roasted husks have high porosity, which requires the more frequent frequency of fertigation Cocopeat is a source of organic substrates derived from the by-products of coconuts. The use of cocopeat as a plant substrate directly is not recommended because cocopeat contains compounds that are toxic and can inhibit plant growth [3]. Chloride (Cl) and sodium (Na+) ions in cocopeat are higher than peat so that the concentrations of Cl- and Na+ ions can cause obstacles to planting growth [4]. The advantages of Cl- elements in plants can inhibit NO3- making, causing plant growth to be inhibited and leaf colour yellowing [5].

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The processing of cocopeat before being used as a planting medium is an attempt to reduce the content of toxic compounds. In addition, combining cocopeat with husk charcoal can also reduce the concentration of toxic compounds in the growing media. The combination of types of media that are porous with the type of media that has a water holding capacity can increase plant growth [6]. This study aims to determine the composition of the fuel husk growing media and the best cocopeat that can increase plant growth

2. Methods
This research was conducted starting from November 2017 until December 2017 at Screen House Unpad Jatinangor Sumedang, West Java, with an altitude of 753 m above sea level (ASL).

The tools and materials used in this research are materials including nutrient solution drums, timers, coco fibre grinders, cocopeat soaking drums, a set of drip irrigation hydroponic installations, water pumps, nipples, emitters, EC-meters, pH meters, buckets, stirrers, analytical scales and ovens while the materials used include kailan seeds, cocopeat planting media and husk charcoal, AB-Mix nutrition. In this study, the cocopeat used was washing and soaking before being used as a planting medium. This immersion and washing process is expected to reduce the concentration of compounds or ions that are toxic more quickly.

This study used a Completely Randomized Design (CRD) consisting of 5 treatments, namely: A = Cocopeat 100%, B = Cocopeat 75% + 25% husk charcoal, C = Cocopeat 50% + Husk charcoal 50%, D = Cocopeat 25% + 75% husk charcoal, and E = 100% husk charcoal. In this study, the stages of observation are divided into two parts. The first observations are temperature, humidity, electrical conductivity, and substrate water holding capacity. Both are the main parameters (growth), namely plant height, number of leaves, fresh palm weight, and shoot-root ratio. Statistical analysis was carried out for the data generated in the main observation using analysis of variance at the level of error $\alpha = 5\%$ if the results of the analysis of variance for each real parameter will be continued with a different test the Duncan average value at the level of $\alpha = 5\%$.

The research implementation consists of several stages, namely: nursery, preparation of planting media, making drip irrigation installation, making plant nutrition, planting, carrying the plant, and harvest the plant.

3. Result and discussion

3.1. Temperature and humidity of the greenhouse
The results of measurements of the average temperature and daily humidity in the greenhouse are presented in Figure 1. The average daily temperature of 28, 60°C and humidity of 73.34%. Kailan plants grow optimally at temperatures of 16-22 °C, but at temperatures of 22-28°C Kailan, plants can still grow well [7]. Figure 1 shows that temperature fluctuations in the tropics are relatively constant while humidity fluctuates every day.

Humidity influences evapotranspiration so that the daily water requirements of plants can fluctuate. Planting media that can hold water can support plants to maintain root moisture and meet water requirements under conditions of descending moisture.
3.2. Electrical Conductivity (EC) and pH of Nutrient
EC values and pH of nutrient solutions in hydroponic systems need to be regulated so that plants can absorb minerals to support optimum plant growth [8]. The nutrient solution given has a pH of 6.08 - 6.50. High and low pH values will affect the availability of some minerals needed by plants. The EC value of the nutrient solution given is divided into two phases, namely vegetative-I (1-21 DAP) EC 2 mS cm\(^{-1}\) and vegetative-II EC 2.5 mS cm\(^{-1}\) [9]. Application EC values in stages based on the growth phase can increase plant growth and the efficient use of nutrient solutions [10].

![Figure 1. Average daily temperature and humidity of greenhouse.](image1)

3.3. Water holding capacity
The results of laboratory analysis of the ability to store water for each medium showed that 100% cocopeat could store water five times higher than its initial weight. Fuel husk is a medium that has high porosity, so the ability to store water is only 1.5 times the initial weight. The results of this laboratory analysis confirm the studies that have been done previously [11]. The combination of cocopeat and roasted husk overlap the weaknesses of each type of media so that it can increase the growth of Kailan plants.

![Figure 2. EC and pH values of Nutrients solution.](image2)
Remarks: A= cocopeat 100%, B= cocopeat 75%+ Rice husk charcoal 25%, C= cocopeat 50%+ Rice husk charcoal 50%, D= cocopeat 25%+ Rice husk charcoal 75%, E= Rice husk charcoal 100%

![Water Holding Capacity Chart](chart.png)

**Figure 3.** Water holding capacity of The Substrat.

### 3.4. Plant height (cm)
At the age of 14, 21, 28, and 35 DAP the use of the composition of planting media B provides the best results compared to other treatments. The composition of the growing media of treatment B is a media composition that can increase the shelf life of water and nutrients around the roots and can increase aeration so that the planting media can store and release water optimally [3,11]. Addition of plant height is influenced by the availability of water, nutrition and sunlight [12].

#### Table 1. Plant height of Kailan at 14, 21, 28, and 35 Day After Plant (DAP).

| Treatment | 14 DAP | 21 DAP | 28 HST | 35 HST |
|-----------|--------|--------|--------|--------|
| A         | 7,60 b | 10,26 bc | 14,14 b | 20,26 ab |
| B         | 7,66 b | 10,62 c  | 14,60 b | 21,78 b  |
| C         | 6,60 a | 9,22 a   | 13,06 a | 19,26 a  |
| D         | 7,64 b | 9,54 ab  | 13,54 ab | 19,02 a  |
| E         | 7,32 ab| 9,80 abc | 14,20 b | 18,98 a  |

Remarks: The number followed by the same letter (lower case) on the same column indicate significant difference based Duncan Multiple Range test α=5%.

### 3.5. Number of Leaves

Based on Table 2 the composition of the planting medium did not affect the number of leaves at 14, 21, 28, and 35 DAP.

#### Table 2. Number of leaves Kailan plant.

| Treatment | 14 DAP | 21 DAP | 28 HST | 35 HST |
|-----------|--------|--------|--------|--------|
| A         | 4,56 a | 6,36 a | 9,16 a | 10,48 a |
| B         | 4,92 a | 6,88 a | 9,52 a | 10,84 a |
| C         | 4,60 a | 6,48 a | 9,20 a | 10,80 a |
| D         | 4,84 a | 6,32 a | 9,12 a | 10,60 a |
| E         | 4,76 a | 6,44 a | 9,08 a | 10,28 a |

Remarks: The number followed by the same letter (lower case) on the same column indicate significant difference based Duncan Multiple Range test α=5%.
3.6. Leaf area (cm²)
Based on Table 3 the composition of the planting medium shows all treatments have no significant effect on the area of leaf growth of Kailan plants. The availability of water influences the increase in leaf area [13], but in this study excessive concentrations of Cl and Na in cocopeat were thought to affect optimal plant growth [4].

Table 3. Leaf area of Kailan plant.

| Treatments | Leaf Area (cm²) |
|------------|----------------|
| A          | 646.80 a       |
| B          | 764.80 a       |
| C          | 648.80 a       |
| D          | 604.40 a       |
| E          | 725.20 a       |

Remarks: The number followed by the same letter (lower case) on the same column indicate significant difference based Duncan Multiple Range test α=5%.

3.7. Fresh plant weight (g)
Table 4 shows that the composition of the planting medium has a significant effect on the fresh weight of Kailan plants. Treatment B is significantly different compared to treatment C, and D. But it is not significantly different compared to treatment A and E. The process of formation and development of plant organs was significantly influenced by the availability of water and nutrients in the growing media. The formation and development of plant organs are related to the process of growing plant cells [14]. The fresh weight in this study (114.34 g) was lower than the previous study (176.30 g) on the NFT hydroponic system. The type of substrate used in this study affects nutrient uptake and Cl and Na contained in cocopeat affect the growth of Kailan plants [15,4].

Table 4. Fresh plant weight of Kailan plant.

| Treatments | Fresh Plant Weight (g) |
|------------|------------------------|
| A          | 93.29 ab               |
| B          | 114.34 b               |
| C          | 88.57 a                |
| D          | 78.20 a                |
| E          | 98.38 ab               |

Remarks: The number followed by the same letter (lower case) on the same column indicate significant difference based Duncan Multiple Range test α=5%.

3.8. Shoot-root ratio
Treatment B differed not significantly with treatment A but was significantly different from treatment C, D, and E. The shoot-root ratio showed that the proportion of plant photosynthates was higher for plant canopy development. In treatment D and E with the composition of husk charcoal more than the cocopeat value shoot-root ratio decreases.
Table 5. Shoot-root Ratio of Kailan Plant.

| Treatments | Shoot-root Ratio |
|------------|------------------|
| A          | 9.07 bc          |
| B          | 10.80 c          |
| C          | 8.02 ab          |
| D          | 6.21 a           |
| E          | 6.43 a           |

Remarks: The number followed by the same letter (lower case) on the same column indicate significant difference based on Duncan Multiple Range test $\alpha=5\%$.

4. Conclusion
The result showed that composition grows media Cocopeat 75% + Rice husk charcoal 25% affect plant height, fresh plant weight, and shoot-root ratio. The plant substrates combination Cocopeat 75% + Rice husk charcoal 25% increase yield *Brassica oleraceae* Var. Achepala 16-23% higher compare application cocopeat and rice husk charcoal without combination.

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