The effect of potassium and planting media on production and quality of tomato (Lycopersicon esculentum) on hydroponic drip system

C Hidayat¹,*, A Supriadin² and W F Shohibah¹
¹ Agrotechnology Department, Faculty Science and Technology, UIN Sunan Gunung Djati Bandung, Bandung, Indonesia
² Chemistry Department, Faculty Science and Technology, UIN Sunan Gunung Djati Bandung, Bandung, Indonesia

*cephidayat62@uinsgd.ac.id

Abstract. Tomato is a crop known as nutritious due to its protein, mineral, and vitamins contains. So the application of production inputs should be directed to improve those crop quality. The aim of the research was to know the effect of potassium concentration and type of planting media on production and quality of tomato (Lycopersicon esculentum) on hydroponic drip system. The research was conducted from June to August 2019 at Cileunyi Kulon village, Cilenyi district, Bandung regency, using split-plot design with 2 factors and 3 replications. Main plot was potassium concentration (350 ppm, 400 ppm, and 450 ppm) and sub-plot type of planting media (100 % husk charcoal, 100 % cocopeat, 50 % husk charcoal + 50 % cocopeat). The result showed that there was no interaction effect of potassium concentration and type of planting media on fruit fresh weight and fruit hardness. The potassium application up to 450 ppm as well as the rice husk charcoal and cocopeat media produced the same effect on the fresh weight and the hardness of the fruit of tomatoes and its value were slightly below its potential in plant description. There are also the vitamin C levels obtained is in the low range of the vitamin C level.

1. Introduction
Increasing the production and quality of horticultural commodities requires effective and efficient cultivation technology in the use of land, fertilizer and water. Hydroponic cultivation can be an option due to management of water and nutrient elements in line with the needs of the plants [1]. Hydroponics provide significant advantages: such as control of soil-borne diseases and the supply of nutrient-enriched solution. Cultivation under hydroponics allows for manipulations to obtain high yield and quality of crop [2].

In hydroponic tomato cultivation, to get high fruit production and good quality requires an appropriate supply of potassium. Potassium is an essential nutrient and is also the most abundant cation in plants [3] and plays a role in fruit production, fruit size, increased dissolved solids, colour, and storability [4], increasing the hardness of the fruit [5]. According to Almeselmani et al., [6] application of adequate potassium is necessary to improve yield and quality of tomato and K vailability has a role in improving fruit production and quality [4]. Mardanluo et al., [7] also stated that adequate levels of K can guarantee many quality aspects of crops with maximum beneficial effects. In many fruiting crops...
such as strawberry, tomato and maize, the demand for K uptake is relatively high during fruit development [8].

The level of nutrient uptake is determined by the planting media. Planting media can be selected from organic planting media such as husk charcoal and cocopeat. Husk charcoal is porous, high water holding capacity, C-organic 15.23 %, and N 1.08 %, and eliminates the adverse effects of bacteria [9]. Cocopeat has high water holding capacity [10]. Ahmad et al., [11] shows physicochemical properties of cocopeat: Bulk Density (BD) 0.16 g cm$^{-3}$, pH 6.7, EC 2.9 C mol kg$^{-1}$, porosity 58 %, Water Holding Capacity (WHC) 90.5 %, and C/N 48.47 %.

The aim of this research was to know the interaction effect of potassium concentration and planting media type on production and quality of tomato (Lycopersicon esculentum) on hydroponic drip system.

2. Materials and method

A screen house trial at Cileunyi district, Bandung regency at 750 m above sea level ( -60 56’.33” SL and 107o 44’.71” EL) was carried out from June to August 2019. Materials used were tomato seed variety Victory, AB MIX fertilizer consisted of chemical compound A (CaCO3, KNO3, Fe-EDTA) and chemical compound B (KH2PO4, (NH4)2SO4, K2SO4, MnSO4.4H2O, CuSO4.5H2O, ZnSO4.7H2O, (NH4)6Mo7O24.4H2O, MgSO4.7H2O and H3BO3.), polybag 30 x 35 cm, husk charcoal and cocopeat. drip irrigation installation consisted of: PVC ¾ inch for primer pipe, PVC ½ inch for secondary pipe, and PVC ½ inch tertiary pump, water pump 18 watt, emitter, EC meter, and pH-meter.

The experiment used Completely Randomized Design with Split Plot pattern two treatments and three replications. The main plot was potassium concentration with N-total 250 ppm; 350 ppm, 400 ppm, and 450 ppm. The sub plot was type of planting media; 100 % rice husk charcoal, 100 % cocopeat, 50 % rice husk charcoal + 50 % cocopeat.

Research began with screen house sanitization. Then tomato seeds were planted on the media 50% cocopeat and 50% rice husk charcoal. After growing two leaves (14 days after the seedling) was transferred to the polybag containing the media according to the treatment. Seedlings was planted in 5 cm depth. Fertilization used fertilizer A and fertilizer B which had been dissolved in 5 l of water separately and blended at the time the fertilizer would be given. EC values were 2.0 mS cm$^{-1}$ and pH 6.1 at early vegetative, 2.6 mS cm$^{-1}$ and pH 6.3 at last vegetative. The EC value is gradually increased at the generative phase at intervals of 0.3 mS cm$^{-1}$ m, namely: 2.9 mS cm$^{-1}$, 3.2 mS cm$^{-1}$, and 3.5 mS cm$^{-1}$ with range solution pH 6.3-6.5). The maximum temperature was 34oC and minimum temperature was 20oC and RH was 45-81 %. The tomato was harvested at 63 days after planting.

The parameters observed were fruit fresh weight, fruit hardness using hardness tester, and quantitative analysis of vitamin C using iodometry method. All parameters were measured at the time of harvest. To analyse the data, F Test at 5% level was used and continued with Duncan Multi Range Test at 5% level.

3. Results and discussion

3.1. Fruit fresh weight

Applying different potassium concentration and type of planting media gave no significant interaction effect on fruit fresh weight. Increasing potassium concentration showed increasing fruit fresh weight non-significantly. Cocopeat 100 % media showed better fruit fresh weight than rice husk charcoal and the mixing media cocopeat and rice husk charcoal also showed better fruit fresh weight than husk charcoal, but the value under the cocopeat 100 % (Table 1).

The planting media needed to support the growth of tomato crops on the hydroponic substrate system was high water holding capacity and nutrient exchange capacity. Rice husk charcoal is porous so the root grows well and absorption of nutrients including K goes smoothly, but the water loss is large in the day temperature 34oC. On the other side cocopeat has more micro pores and high water holding capacity, so it can reduce the evapotranspiration. When the two materials were combined the water holding capacity was below 100% cocopeat resulting decreasing of fruit fresh weight.
### Table 1. The influence of potassium concentration and planting media type on tomato fruit fresh weight.

| Treatment                        | Fruit Fresh Weight | g     |
|----------------------------------|--------------------|-------|
| **Potassium Concentration (ppm):** |                    |       |
| k1 (350 ppm)                     | 188.41 a           |       |
| k2 (400 ppm)                     | 231.08 a           |       |
| k3 (450 ppm)                     | 217.70 a           |       |
| **Planting Media Type:**         |                    |       |
| m1 (Rice husk charcoal 100 %)    | 191.16 a           |       |
| m2 (Cocopeat 100 %)             | 228.89 a           |       |
| m3 (Rice husk charcoal 50 % + Cocopeat 50 %) | 217.14 a |       |

Remarks: Numbers followed by same small letter in vertical are not significantly different based on Duncan’s Multiple Range Test at 5% level.

According to Woldemariam et al., [12] application of K fertilizer has significant and positive influence on yield. Mardanluo et al., [7] found an experiment with 150, 300, or 450 mg L⁻¹ K in nutrient solution for three cultivars of tomato, increasing K levels. Increased K in the plant makes the element involved in the metabolism of plants ranging from the process of photosynthesis until the photosynthate translocation to the harvest organ.

### 3.2. Fruit hardness

Application of different potassium concentrations and different types of planting media showed no significant effect on fruit hardness (Table 2). Increasing of potassium concentration and applying different type of planting media resulting fruit hardness below its genetic potential.

### Table 2. The influence of potassium concentration and planting media type on tomato fruit hardness.

| Treatment                        | Average of Fruit Hardness | N     |
|----------------------------------|---------------------------|-------|
| **Potassium Concentration (ppm):** |                           |       |
| K1 (350 ppm)                     | 0.85 a                    |       |
| K2 (400 ppm)                     | 1.05 a                    |       |
| K3 (450 ppm)                     | 1.14 a                    |       |
| **Planting Media Type:**         |                           |       |
| m1 (Rice husk charcoal 100 %)    | 0.91 a                    |       |
| m2 (Cocopeat 100 %)             | 1.09 a                    |       |
| m3 (Husk charcoal 50 % + Cocopeat 50 %) | 1.04 a |       |

Remarks: Numbers followed by same small letter in vertical are not significantly different based on Duncan’s Multiple Range Test at 5% level.

Çolpan et al., [5] said that potassium plays a role in increasing the strength of cell walls that will affect fruit hardness. According to Wang et al., [3] potassium adequacy will increase the synthesis of high molecular weight molecular compounds such as proteins, starches and cellulose and reduce the synthesis of low molecular weight compounds such as organic acids, amino acids, and amides, thereby increasing the formation of thicker lignin compounds and affecting the hardness of fruit. Based on data in Table 2 which shows that the application of potassium to 450 ppm did not induce hardness of tomatoes, this means that the potassium concentration given was insufficient, as in the case of the fresh fruit parameters (Table 1) which did not increase significantly with the addition of potassium concentration.

The type of media used has advantages and disadvantages. Rice husk charcoal and cocopeat have good porosity, but cocopeat with more micro pores makes the water holding capacity higher and
maintain the soil moisture needed for potassium diffusion. This condition makes fruit hardness slightly higher than other media.

### 3.3. Vitamin C level

Based on the testing of vitamin C using iodimetry method of nine tomato fruit samples from each unit plot at the time of harvest showed the addition of concentrations of potassium and cocopeat increased vitamin C levels (Table 3).

**Table 3.** The influence of potassium concentration and planting media type on vitamin C levels.

| Treatment | Vitamin C Levels (mg 5g⁻¹) |
|-----------|---------------------------|
| K1m1      | 0.5914                    |
| K1m2      | 0.6758                    |
| K1m3      | 0.5914                    |
| K2m1      | 0.6758                    |
| K2m2      | 0.7603                    |
| K2m3      | 0.7603                    |
| K3m1      | 0.8448                    |
| K3m2      | 0.8448                    |
| K3m3      | 0.8448                    |

The range of vitamin C in ripe tomato fruit is 13–23 100 g⁻¹. In this study vitamin C levels obtained was 11.83-16.90 mg 100 g⁻¹. Potassium plays a role in protein synthesis through its necessity as a cofactor [13]. With high protein content in tomato fruit, vitamin C content also increases due to vitamin C is derived from protein synthesis. Taber et al., [13] states the adequacy of potassium in the plant tissue will improve enzyme function in increasing protein synthesis. Cocopeat media provides more potassium due to better moisture than others.

### 4. Conclusion

Applying potassium up to 450 ppm as well as the rice husk charcoal and cocopeat media produced the fresh weight and the hardness of the fruit of tomatoes were slightly below its potential in plant description. There are also the vitamin C levels obtained is in the low range of the vitamin C level.

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