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# Performance of Cucumis Melo (Var. Cantalupensis) Growth under Controlled Environment using Rice Husk Ash Media: Effect of Different Quantity of Water Supply

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**ABSTRACT**

*Cucumis melo is a potential crop from an economic perspective. The right amount of water supply to irrigate the Cucumis melo is crucial to get high and maximum crop yield. In this project, four different quantities of water were supplied, which include 250 ml, 500 ml, 650 ml and 750 ml. These amounts were based on the percentage of the evapotranspiration. The treatments were labeled as treatment 1 (T1), 2 (T2), 3 (T3), and 4 (T4). Six parameters were chosen to monitor the performance of the plant growth and the data were collected on a daily basis. The parameters were the height of internodes, plant total height, stem diameter, number of leaves, leaf width and length. The graph plotted showed that the plant growth increases and gave different patterns. Besides that, the effects of different treatments were also determined on the overall performance of plant growth through statistical analysis (ANOVA). It showed that there was a significant difference on the overall performance of Cucumis melo growth. The most optimum water requirement was assessed for the best plant growth. All six measurements were plotted based on the observation with the selected parameters and compared. Results showed that treatment 2 with 500 ml gave the best growth performance for Cucumis melo.*

**Keywords:** Cucumis Melo, Plant Growth, Water Supply, Rice Husk Ash Media.

## 1. INTRODUCTION

*Cucumis melo* var. cantalupensis is also known as rock melon, mainly growing in Europe and Asia. The variety Cantalupensis is having weight in the range from 0.5 to 5 kilograms. It has rough, warty, not netted, rock-like skin appearance, pale green skin colour, and sweet orange flesh. They are tropical annual vines with long and spreading stems, which are springy tendrils. Since they are grown as vines, a large area is needed for them to grow properly. *Cucumis melo* var. cantalupensis takes about 65 to 70 days to harvest, depending on the variety and cultivar. This species is a high perishable plant and very sensitive to the water. Water deficit can cause the reduced fruit yield and fruit quality. Hence, enough amount of water supply is very important for the growth of the *Cucumis melo* var. cantalupensis.

Nowadays, determining the optimal crop water requirements is considered to be one of the most important factors affecting the plant production (Mirabad *et al*., 2013). Therefore, the aim of this work is to study the effect of different quantity of water supply, in order to determine the optimum water requirement, which might give the best performance on plant growth for producing the high and best quality yield.

## METHODS

This experiment was carried out under a controlled environment, which was in a biosphere (greenhouse). The biosphere is a plastic greenhouse located at School of Bioprocess Engineering of Universiti Malaysia Perlis, Jejawi, Perlis (latitude of 6.429708, longitude of 100.269847).

### 1.1 Preparation for the Experiment

In this experiment, rice husk ash (RHA) was used as the media. This media was to replace the use of the soil in planting the *Cucumis melo*. RHA was used because of its ability to hold the water for a long period. The polybags were filled with the RHA. Then, polybags had been arranged properly with appropriate distance because *Cucumis melo* needs space to spread during its growth period. In this experiment, a total of 48 polybags were with 48 plants. There were three replications with three treatments and one control, but the control was also considered as the treatment. Each treatment had four plants per row. The treatments were desired randomly per replication. Table 1 shows the arrangement of the polybags according to the row and column, based on the replication and treatment.

After finished the filling-up with the polybags, the rope was tied-over to the supported steel in the biosphere, thus been connected to tie the polybags. This was to help *Cucumis melo* plant to creep properly during the growth, also to prevent the stem from broking down.

**Table 1** Arrangement of polybags according to the treatments and replicates

| **Replication 1** | | | | **Replication 2** | | | | **Replication 3** | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $T_4P_4$ | $T_1P_4$ | $T_2P_4$ | $T_3P_4$ | $T_1P_4$ | $T_3P_4$ | $T_4P_4$ | $T_2P_4$ | $T_3P_4$ | $T_4P_4$ | $T_2P_4$ | $T_1P_4$ |
| $T_4P_3$ | $T_1P_3$ | $T_2P_3$ | $T_3P_3$ | $T_1P_3$ | $T_3P_3$ | $T_4P_3$ | $T_2P_3$ | $T_3P_3$ | $T_4P_3$ | $T_2P_3$ | $T_1P_3$ |
| $T_4P_2$ | $T_1P_2$ | $T_2P_2$ | $T_3P_2$ | $T_1P_2$ | $T_3P_2$ | $T_4P_2$ | $T_2P_2$ | $T_3P_2$ | $T_4P_2$ | $T_2P_2$ | $T_1P_2$ |
| $T_4P_1$ | $T_1P_1$ | $T_2P_1$ | $T_3P_1$ | $T_1P_1$ | $T_3P_1$ | $T_4P_1$ | $T_2P_1$ | $T_3P_1$ | $T_4P_1$ | $T_2P_1$ | $T_1P_1$ |

* P1 = Plant 1; P2 = Plant 2; P3 = Plant 3; P4 = Plant 4
* T1 = Treatment 1 (250 ml of water); T2 = Treatment 2 (500 ml of water);
T3 = Treatment 3 (650 ml of water); T4 = Treatment 4 (750 ml of water)

#### *1.1.1 Sowing*

The seed of cultivar Glamour was used for this experiment. Cultivar 'Glamour' will produce the fruit with the striking golden yellow-colour (Zulkarami *et al*., 2012). The seeds were sowed in a tray and a total of 100 seeds of *Cucumis melo* had been sown in a tray containing peat moss. Peat moss was filled into a tray at a rate of 85-90% (full) to let the root freely move when sprouting. Before sowing the seeds, the peat moss was soaked in the water in order to make them wet and moisten.

Then, seeds were sown and placed properly and correctly to avoid slow-growing trees or seedlings die. The seeds had sowed vertically, where sharp edges of the seeds sowed towards the media (root) while less sharp edge was placed towards the top (shoot). The seed was also sown at the centre to let the root get enough space while sprouting. The tray was covered from got direct sunlight after the sowing of the seeds was finished. This was to avoid drying of peat moss by the sunlight exposure. Peat moss was always kept as wet and moistened.

#### *1.1.2 Transplanting of the Seedlings*

On 12 to 15 days after the sowing process, *Cucumis melo* seedlings were transplanted into 16 ×16 cm sized polybag. In the tray, 48 best seedlings were chosen out of 100 seedlings to transplant. Seedlings were ready for transplant once the number of leaves reached four. This showed that seedlings were strong and matured. The seedlings were transplanted into the polybags cautiously to prevent the stem from breaking.

The media in the polybag was compressed around the peat moss so that no empty space between the media. Through this, the seedlings were grown upright and also received the aqueous solution directly to the root zone. The roots spread more efficiently. After transplanting process was finished, the plants have were watered with quantity. It is important to keep the soil moistened but not too wet, this encourages a good root growth and retains the nutrients near the roots (Bird & Horticulturist, 2005).

### 1.2 Application of Treatment

The plants were watered with different amounts twice a day, which was early in the morning and in the evening. There were four treatments with different amounts of water supply per day which were 250, 500, 650, and 750 ml. The amount of water supply was based on the percentage of evapotranspiration of *Cucumis melo* var. Cantalupensis. The percentage is 6.37%, 9.09%, 10.35%, and 10.05% from ET value. The plant with T1 was watered with 250 ml per day, while at T2, they were watered with 500 ml per day, followed by 650 ml of water at T3 and 750 ml of water per day at T4. *Cucumis melo* was watered manually as the amount was given accurate as it was measured before being watered.

Before that, water and fertilizer had been mixed up in the tank. The fertilizer given was constant and same for all treatments, each plant supplied with 100 ml of liquid fertilizer. The fertilizer was given to the plant as a supplement to ensure the plant fertility. Stock A and stock B fertilizer at 50 ml each had been supplied to the plant. Stock A contained calcium nitrate and iron chelate. Meanwhile, stock B contained mono potassium hidgorren phosphate, magnesium sulphate, potassium nitrate, manganese sulphate, zinc sulphate, copper sulphate, sodium molybdate, and tibor. These stocks A and B were mixed-up with water. Then, the concentration of the fertilizer was checked by using EC meter. Table 2 shows the reading of EC meter according to the day after *Cucumis melo* was planted and Table 3 shows the total irrigation per day after transplantation process.

**Table 2** EC meter reading according to the day after transplant

| EC meter reading (mS) | Days of planting |
|---|---|
| 2.5 | 1 - 20 |
| 2.6 | 21 - 25 |
| 2.8 - 3.0 | 26 - 40 |
| 3.0 - 3.2 | 40 - 45 |
| 3.4 - 3.8 | 45 - 75 |

**Table 3** Total irrigation per day

| Days after transplant | Total irrigation per day |
|---|---|
| 1 – 3 | 1 |
| 4 – 75 | 2 |

### 1.3 Data Collection

The growth of the plant was observed from the first day, until the last day of transplanting process. The parameters observed were the diameter of the stem, leaf width, and total height of the plant, number of leaves, leaf length, and height of the internodes. The data were collected daily-basis in the evening.

The diameter of the stem was measured by using a digital caliper. A digital caliper was also been used to measure the leaf width and length. The first leaf of the plant was chosen to measure and had been standardized to all the plants with all four treatments. The height of the plant was measured by using a ruler at the beginning stage of the plant growth and measuring tape was used as the plants were grown higher. The plant height was measured from the media until the first shoot of the plant. The height of internodes was being measured by using a ruler. The first internode had been chosen for all plant to be measured. The data observed was recorded to show the effect of the water supply towards the growth performance of the plant. It was because different amounts of water supply gave different effects to the plant.

### 1.4 Statistical Analysis of ANOVA

The experiments were based on the complete randomized block design (RBD) with three replications. In this experiment, ANOVA had been used to determine the effect of different amounts of water on the performance of plant growth. ANOVA is a statistical technique that assesses the potential differences in a scale-level dependent variable by a nominal-level variable having two or more categories. According to the experiment, it was suggested to use two-way ANOVA without replications. When experiments were conducted which involve two factors, and it was not possible to obtain repeat readings for a given set of experimental conditions, a two-way analysis of variance had been used.

## 2. RESULTS AND DISCUSSION

This chapter deals with all the results obtained from the experiments conducted. The purpose of this study is to monitor the plant growth based on different water treatments. The data or results have represented the height of the plant, diameter of the stem, leaf width, leaf length, number of the leaf, and the height of internodes. All the data were measured in centimeter (cm). The most optimum water requirement for the best plant growth performance was assessed.

### 2.1 Growth Parameter Analysis

In this experiment, six parameters were measured. They were the height of the plant, diameter of the stem, leaf width, leaf length, number of the leaf, and height of the internodes. This was to monitor the plant growth based on different water treatments. The data were recorded daily basis in the evening at 4 p.m. started from 9th March until 1st April 2017. Once the data was recorded, the average was calculated. Six graphs were expressed as shown in the Figures 1- 6.

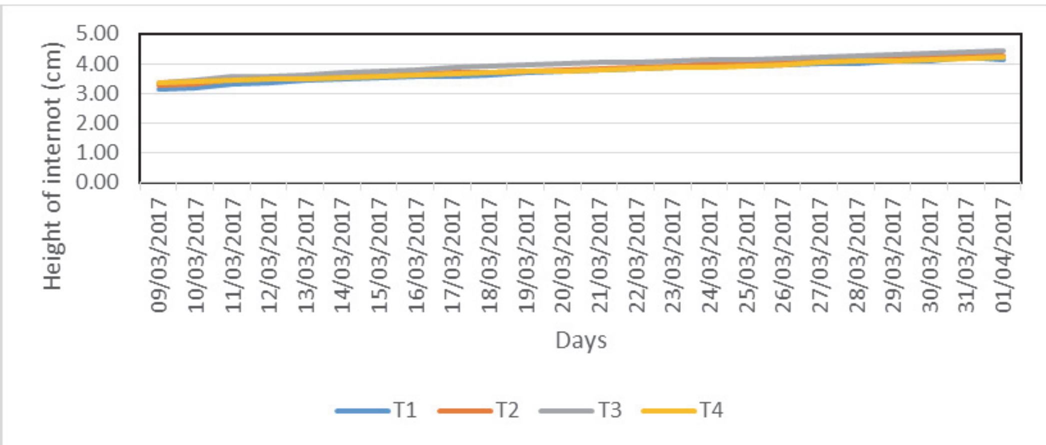


**Figure1.** Height of the internodes versus days.

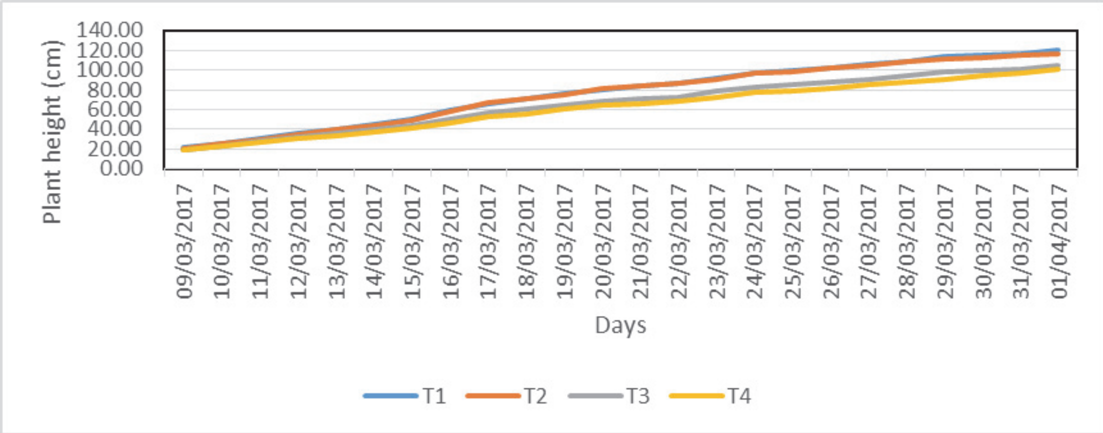


**Figure 2.** Plant height of the *Cucumis melo* versus days.

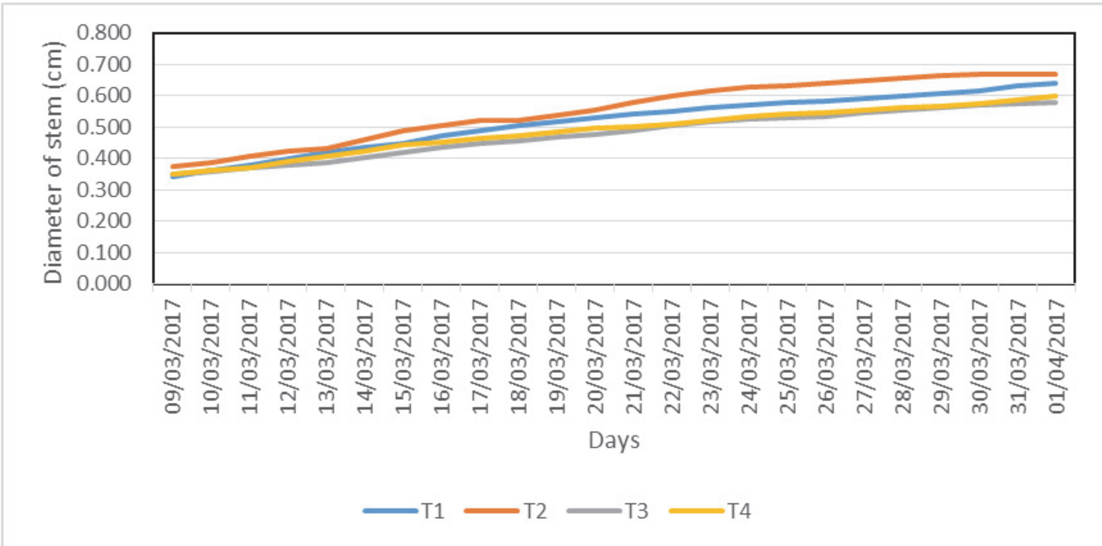


**Figure 3.** Diameter of the stem versus days.

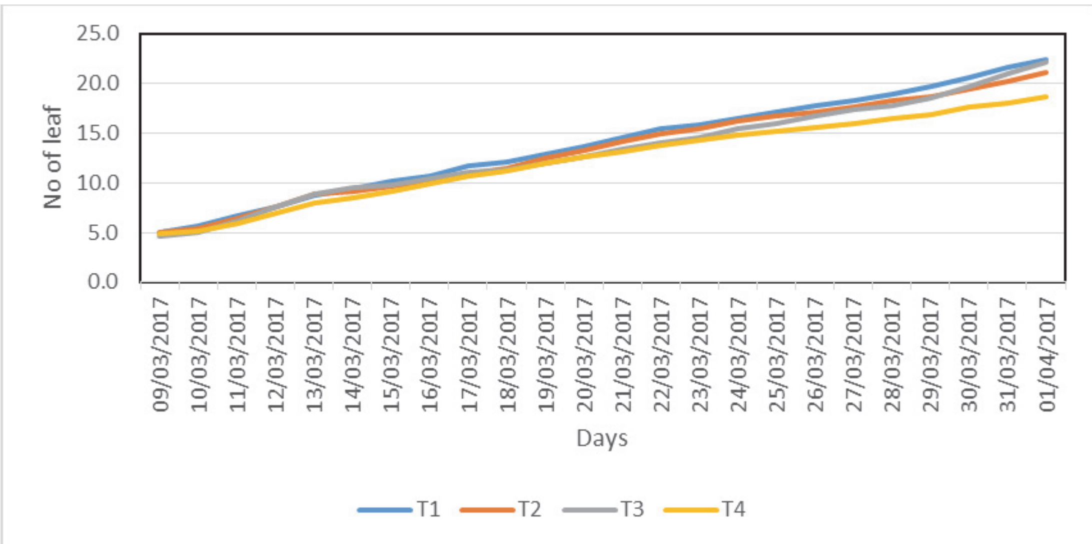


**Figure 4.** Graph for the number of leaf against days.

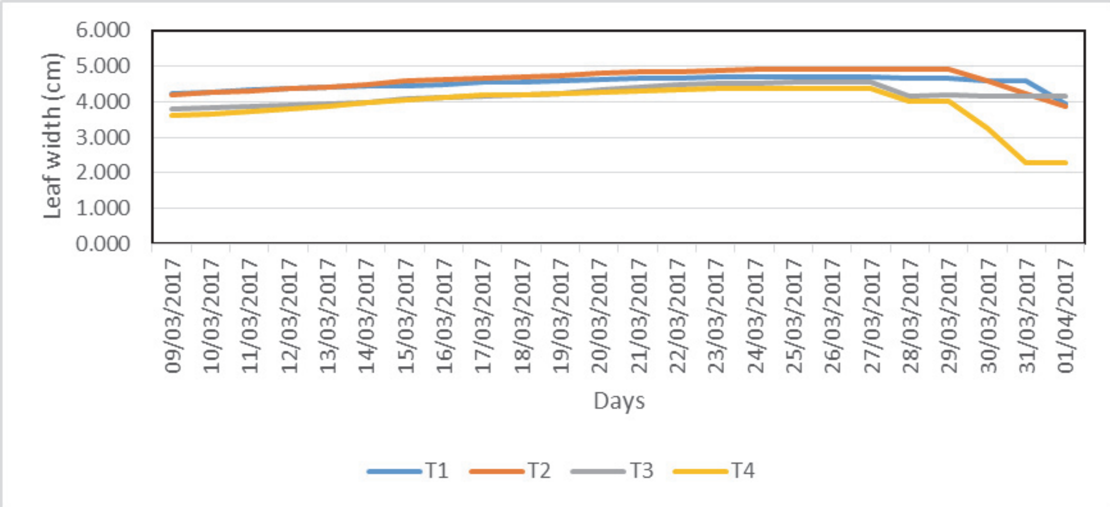


**Figure 5.** Graph for the leaf width against days.

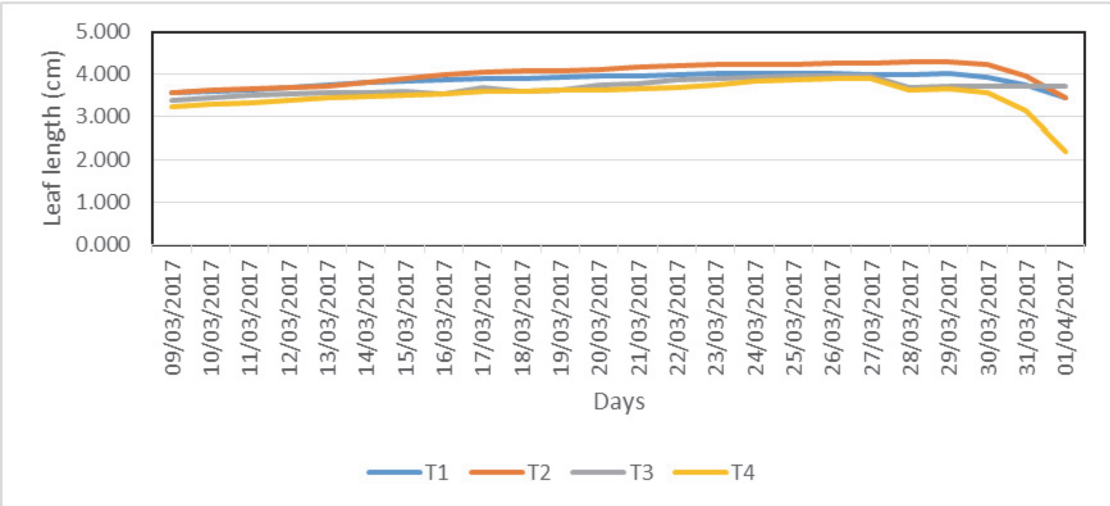


**Figure 6.** Graph for the leaf length versus days.

The first internode had been chosen from all 48 plants to be measured for their height and ruler was used to complete the measurement. The data was recorded and the graph was plotted as displayed in Figure 1, to show the performance pattern of the internode height. Based on Figure 1, the height of internodes was increased significantly against days. From the four treatments, Figure 1 shows that T3 has the best effect towards the height of the internodes compare to T1, T2 and T4. Nevertheless, the line pattern of different treatments towards the height of the internodes had no significant difference. As stated before, the plant growth was influenced with the amount of water applied to the treatments (Management, 2009). The greatest length and the number of internodes were obtained, showing that both characteristics are important for the establishment of plant height (Finger & Cecon, 2011).

Data of the plant height was recorded and Figure 2 shows the graph pattern on the height of the plant against days. Based on Figure 8, the graph pattern, it shows that the plant height from all four treatments had linear increment against days. The plant height increases faster after irrigation and further increment was with the higher amounts of water supply, as indicated before (Li *et al.*, 2012). On 15$^{th}$ March 2017, the plant height differences with the different treatments were shown, where the height of plant measured with T1 was 50.40 cm, T2 with 48.44 cm, 43.65 cm for T3 and 40.46 cm for T4. Overall, among the four treatments, plant height gave the effect to T1. It was clearly noticed that the increase in water quantities increased the plant growth and yield. The increment in plant growth is due to the favorable influence of water quantity on cell division, multiplication and tissue enlargement and development (Sonnenberg & Town, 2012). Hence, different water quantities had a greater influence on *Cucumis melo* plant growth and yield.

Figure 3 shows that the diameter of the stem increases significantly towards the progression with days. It was also shown that the stem diameter increased with plant growth and these results were consistent with the data recorded. The stem diameter was increased with the plant growth (Management, 2009). The diameter of the stem in T2 showed a higher increment and bigger in size than the diameter of stem from T1, T3 and T4. It reveals the stem diameter was affected mostly by T2. Through this, the conclusion about the diameter of the stem can be made where T2 was the optimum with water requirement for the stem growth performance.

Based on Figure 4, the graph shows that the number of leaf increases in a linear fashion against the days. Leaf numbers were increased with increasing water levels as revealed previously (Sonnenberg & Town, 2012). The incrementing pattern for all four treatments was almost the same but the highest number of the leaf was reported at T1 and the lowest number was with T4. It was a natural behavior for a plant in increasing the leaf number, as it is a part of their growth process. Along the data recorded, there was also a minor accident occurred that causes the reducing number of the leaf by different processes, such as wilt, dry and brokage caused by a human. However, the minor accident did not affect the data as the broken leaf was replaced with a new one.

Based on Figures 5 and 6, they display that the graph pattern of both parameters was same. It was due to the leaf length and leaf width, both gave effect to each other. As if the leaf length increases, the leaf width also increases. Figures 5 and 6 had shown the drop point for T3 and T4 on 27$^{th}$ March 2017. This happened because the leaf started to wilt, dried and lastly died. The reason for this decreasing point was because of the natural occurrence. This phenomenon is a normal process for the plant along their growth performance as the leaf died to be replaced with the new leaf grows.

### 3.2 Statistical Analysis on Performance Parameter

Statistical analysis was performed with the use of two-way analysis of variance (ANOVA) and the calculations were computed by using the software Microsoft Excel. The two-way ANOVA was used to compares the mean differences among groups that have been split on two independent variables and also to understand if there is an interaction between two independent variables on the dependent variable. The ANOVA was to calculate the significance of results. Data of experimental parameters for all four treatments were presented and the sum, average and variance were calculated.

Based on the data, the average plant height was increased from 19.85 to 110.50. So that, the plant height increases with varied days of increment. The diameter of the stem also increases but slowly and steadily from 0.35 until 0.63. Thus, the treatments gave effect to the stem diameter. For the leaf width, the average was decreased where data showed decrement from 3.96 to 3.55. The decreases of average data occurred because there was a minor natural occurrence of an accident, such as the leaf was wilted, dried and died. As the leaf width decreases, it was also affected the leaf length, as it decreases from 3.44 to 3.21. Leaf width and length influence each other. As if the leaf length decreases, the leaf width also decreases. For the next parameter, with the leaf number the average data from ANOVA calculation showed the increment. The average data of the leaf number increases from 4.85 to 21.08 for 9$^{th}$ March until 1$^{st}$ April 2017. The average data for the height of the internode increases from 3.28 until 4.27. As the height of the internodes increase, the plant height also increases. Plant height was simply the sum of the lengths of each of the internode (Berghage & Lily, 1998). Table 4 shows the obtained ANOVA result of the current experiments.

**Table 4** Statistical analysis of the ANOVA

| ***Source of Variation*** | ***SS*** | ***df*** | ***MS*** | ***F*** | ***P-value*** | ***F crit*** |
|---|---|---|---|---|---|---|
| Rows | 427046.9042 | 143 | 2986.341987 | 340.0284901 | 0 | 1.243432 |
| Columns | 825.1076304 | 3 | 275.0358768 | 31.31591569 | 2.53E-18 | 2.625699 |
| Error | 3767.745204 | 429 | 8.782622853 | | | |
| Total | 431639.757 | 575 | | | | |

According to Table 4, the rows were representing the average of four treatments, which were T1, T2, T3 and T4 for a single day. Meanwhile, the columns represent the average data for a parameter from 9th March until 1st April 2017 for all four treatments. Table 5 shows the null hypothesis made for this experiment.

**Table 5** Null hypothesis

| **Number** | **Null hypothesis** |
|---|---|
| $H_{01}$ | All the averages of four treatments are equal. |
| $H_{02}$ | All the averages of the parameters are equal. |

Based on Tables 4 and 5, we can conclude the acceptance or reject of the null hypothesis. Since the p-value for the rows is $0 < 0.05$, the null hypothesis was rejected, and at 95% level of confidence, it can conclude that there is a significant difference with four treatments in a day. Meanwhile, for the columns, since the p-value is $2.53^{-18} < 0.05$, the null hypothesis was rejected, and at 95% level of confidence, it can conclude that there are significant differences in the six parameters.

### 3.3 Most Optimum Water Requirement

Growth can be defined as an unalterable growth or increase of cells in size. Cell enlargement cannot be maintained without simultaneous synthesis of membranes, which is the process involving complex reactions supported by water and other metabolites (Sonnenberg & Town, 2012). The plant requires an optimum amount of water in order to perform well in their growth process.

Based on Figure 1, T3 gave more effect to the height of the internodes, followed by T2. For the plant height, Figure 2 showed that T1 performed more for the growth performance of the *Cucumis melo*, and then followed by T2, where the graph pattern showed not a great difference between those two treatments. Next, Figure 3 showed that T2 gave a higher reading for the diameter of the stem compared with T1, T3 and T4. As shown in Figure 4, *Cucumis melo* in T1 has a higher number of leaves. Leaf width and length showed the higher reading at T2 compared to T1, T3 and T4 (Figures 5 and 6).

For the overall collected data and graph plotted from six chosen parameters of *Cucumis melo* from 9th March until 1st April 2017, T2 with 500 ml of water supply was the most optimum requirement for the best performance of *Cucumis melo* growth. It was due to as in all the figures above, most parameters showed with T2, as the higher results. Table 6 shows how the most optimum water requirement was decided. Even though height internodes, plant height, and a number of leaves showed T1 and T3 as the higher result, but the difference in result against T2 is not a greater value. So, it was valid to claim that T2 was the most optimum for water requirement.

**Table 6** Most optimal water requirement

| | **Treatment 1** | **Treatment 2** | **Treatment 3** | **Treatment 4** |
|---|---|---|---|---|
| Height of internodes | | | **O** | |
| Plant height | **O** | | | |
| Stem diameter | | **O** | | |
| Number of leaves | **O** | | | |
| Leaf length | | **O** | | |
| Leaf width | | **O** | | |

## 3. CONCLUSION

Under the controlled environment, the effect of different amounts of water supply towards the growth of *Cucumis melo* inside the biosphere was evaluated. Results obtained from the study indicated that the different amounts of water treatment had a significant influence on the *Cucumis melo* growth. The height of the internodes, total plant height, the diameter of the stem, number of leaves, leaf width and leaf length were measured and the data were recorded, thus graph was plotted to monitor the plant growth performance. The graph showed that all the parameters increase against the days. The plant showed their effect based on the amount of water received. Different water quantities had a greater influence on *Cucumis melo* growth. Increasing water quantity was associated with the improved growth. Results from this study clearly suggest, the range of water supply, may provide the best results for *Cucumis melo* growth.

Next, the effect of different water treatments on the overall plant growth performance was able to determine. Statistical analysis of ANOVA had been used to determine the growth performance. There was a significant difference recorded for all four treatments in a day. In addition, there was also a significant difference for the six parameters recorded from the date of 9$^{th}$ March until 1$^{st}$ April 2017. However, different water treatments give different effects towards the growth performance.

Lastly, the most optimum water requirement for the best plant growth performance was being able to assess. The graph plotted being observed for each of the selected parameters to assess the best water requirement for plant growth performance. As to conclude from all six graphs, treatment 2 (T2) with 500 ml of water was the most optimum requirement for the *Cucumis melo* to grow well and give out the best performance growth.

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