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Effect of pH on Growth Rate and Yield of Cucumis sativus

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The effects of pH on growth rate and yield of Cucumis sativus were determined using different treatment media. In this study, there are 3 different treatments media consists of rice husks ash (T1), Lactobacillus (T2) and blank (T3). Each treatment being supplied with 1.9 dS/m electrical conductivity (EC) of nutrient solutions and the pH was being measured every two consecutive days until 31 d of transplanting. Results showed T1 capable in maintaining the pH media average 6.7 followed by T3 with an average pH value of 6.4 and T1 with pH value of 6.3. Cucumis sativus for treatment of rice husks (T1) recorded the fastest growth rate and highest yield as compared with the other treatments. The total yield obtained was 60 of cucumber (22.66 kg) for T1 followed by T3 with 45 of cucumber (17.53 kg) and T2 with 41 of cucumber (15.92 kg). It can be safely concluded that the medium containing treated rice husk was the best for obtaining high yield of cucumber in soilless media. Rice husks can be a local growing media for crop cultivation due to the ability in maintaining the pH. The right pH media needed to provide the best conditions for most agricultural plants to absorb the nutrients efficiently. The uses of rice husk treatment media shows enhance crop production, maintaining the pH and eventually create more sustainable agriculture and environment.

1. Introduction

Cucumber (Cucumis sativus) is one of the most important vegetable crops in the world grown under greenhouses that is has demanded all around the year. Most of the crops grow best in media with a pH in the range of 5.5 to 6.5 (Dewayne, 2014). The growing condition that best suits the cucumber is 27 to 30 °C with a plenty of sunlight and optimum pH range is 6.0 to 7.0. Soil fertility is closely related to the soil pH because it will affect how plants grow. In practice, agricultural activity can accelerate soil acidification process through usage of nitrogen-based fertiliser, removal of agricultural products and organic matter build-up. An optimum media pH provides the best conditions for most agricultural plants where plants will be able to absorb the nutrients efficiently. By measuring the pH, it may give a valuable hint regarding the reasons for poor plant growth and low yield. Maintaining the appropriate level of the media pH is highly important in order to indicate the level of optimal growth of the plants.

There are various approaches have been tried out on the use of available and renewable forms of energy for complementing and supplementing the commercial fertilisers. Instead of using chemical fertilisers, there are various bacteria can promote plant growth. Subsequently, indigenous microbes are used in this study. Such microbes can produce or utilise available nutrients for plants. Lactobacillus is one of the major workhorse beneficial indigenous microorganism used in natural farming. In this study, Lactobacillus, also knew as Lactic Acid Bacteria (LAB), was collected using a simple method. It is the main carbon source from carbohydrate for its substrate in microbial culture. This particular beneficial microorganism is popularly used in composting that specifically arrest foul odors associated with anaerobic decomposition and its application in organic farming is enormous. Recently, by spraying diluted solution of LAB serum to the plant and soil helps plant growth and makes them healthier. As it is applied to the leaves, these beneficial bacteria aid in the decomposition process, thus allowing more food to be available and assimilated by the plant (Ikeda et al., 2013).

Otherwise, previous research found that rice husk ash (RHA) one of the application could be applied in agriculture for its proper utilisation and it also provided nutrition to the agricultural crop as fertiliser. Intense research has focused on the use of RHA in which increases the soil pH that depends on threshold dosage,

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thereby increasing available of nutrients, can affect the hydro-physical properties as well in such it improves the aeration in the crop root zone and also increases the water holding capacity (El Sharkawi et al., 2014).
The aim of this work was to study the effect of LAB and RHA on pH of cocopeat as based growing media in the soilless system and fruit yield of cucumber plants grown.

2. Experimental

2.1 Lactobacillus preparation

LAB was prepared by the following method. Rice grains was washed and the first two rinses of cloudy water was collected. A clean glass jar (1,000 mL) was filled about 700 mL full with the rice rinse water and the glass jar was labelled with date and contents. The mouth of the jar was covered with a breathable cloth, it tied to keep out pests and stored at room temperature away from direct light. After 3 days, LAB was multiply and give off a slightly sour odor. There was a mat of semi-solid material floating on the top of the cloudy liquid in the jar. The fermented rice wash was strained with cheese cloth to get a clean liquid. 100 mL of fermented rinse-water was added with 600 mL of fresh milk into the glass jar (100 mL) and the mouth of the jar was covered with a breathable cloth, it tied to keep out pests and stored at room temperature away from direct light again. After 3 days, the contents of the jar were separated into a floating solid fraction (carbohydrate, fat, and protein) and a yellow liquid fraction. It may take longer in cooler climates because optimum temperature for fermentation in the range of 40 °C. The yellow liquid was the LAB culture, which must be kept alive. The liquid fraction was poured off and being careful any solids not to mix back into the LAB culture. LAB culture was stored in a loosely capped plastic or glass bottle labelled with the date and contents.

2.2 Preparation of media

RHA used in this study was supplied by local factory in Benut, Pontian, Johor. Thirty polybags size of 36 cm x 36 cm were filled with the cocopeat in the same quantity. The bags then were arranged randomly. Each bag was equipped with one dripper as shown in Figure 1.

Figure 1: The field of experiment

2.3 Irrigation of nutrient solution

Fertigation doses were applied according to the plant's requirements. In this experiment, each of plants was irrigated with a nutrient solution of the following concentration in ppm (mg/L). The mineral content used for cucumber plants were shown in Table 1.

Table 1: Mineral content of nutrient solution

Elements	Concentration (mg/L)	Elements	Concentration (mg/L)
N	200 – 240	Zn	0.20 – 0.40
K	250 – 300	B	0.20 – 0.40
P	35 – 50	Cu	0.03 – 0.10
Mg	40 – 70	Mo	0.05 – 0.10
Ca	120 – 160	Mn	0.20 – 0.60
S	40 – 70	Fe	1.40 – 2.00
Final EC value (dS/m) = 1.9			

2.4 Sowing of seeds

The sowing tray was filled with peat moss. Then, cucumber seeds variety 797 from Leckat company were sowed; one seed per one hole. The trays were watered with 1.5 dS/m EC of nutrient solution. Grown plants were transplanted to media after three leaves were grown.

2.5 Irrigation system and scheduling

The irrigation system which consisted of one tank, one operation timer, and one aquarium pump (30 W) each were prepared. The pump outlet was connected to 16 mm LDPE pipe which then to connect to 1 mm capillary tube before inserting to dripper. The macronutrients and micronutrients in the two small tanks were added together into the big tank as a nutrient solution at 1 : 1 ratio until the needed electric conductivity (EC) was achieved. The final EC value of water should be 1.9 dS/m. The irrigation was operated five times a day at 8.30 am, 10.00 am, 1.00 pm, 3.00 pm and 5.00 pm and an identical amount of fertiliser solution were applied to all polyethylene bags. Every time irrigation operated, it was stopped when drainage from the bottom of polybags occur. In order to avoid error in watering the crops and to reduce the risk of disease development, these cultivations were grown in the greenhouse.

2.6 Pruning and training of cultivation

A non-hydrated rope was tied up from 2 m height cable to each plant in day 7 after transplanting. The crops were only allowed to grow one stem. This was done by removing all slide shoots. The plants were trained to wind up the rope. Side shoots were no longer be removed when the plants reach the cable.

2.7 Data collection

Data collection and analysis are including determination of pH soilless media at every two consecutive days until 31 days of transplanting, characteristics of microorganisms and the crop performances between each treatment media. After 33 days from transplanting, the crop was harvested and weighed until the end of the season (47 days). Data on yield attributes: number of fruit per plant and fruit weight (kg) were collected for each row of crop. Only the fresh weight of marketable cucumbers with fixed length (20 cm) was taken. The yield of cucumber crop as influenced by different treatments were compared and analysed.

3. Results and Discussion

3.1 Lactobacillus under the microscope

Figure 2 showed isolated Lactobacillus bacteria were observed by a light microscope at an early stage. It was clear that the bacteria was gram positive, rod shaped coccobacilli, occurring singly or in chains. The gram staining results indicated that the isolated bacteria could be identified as lactobacilli.

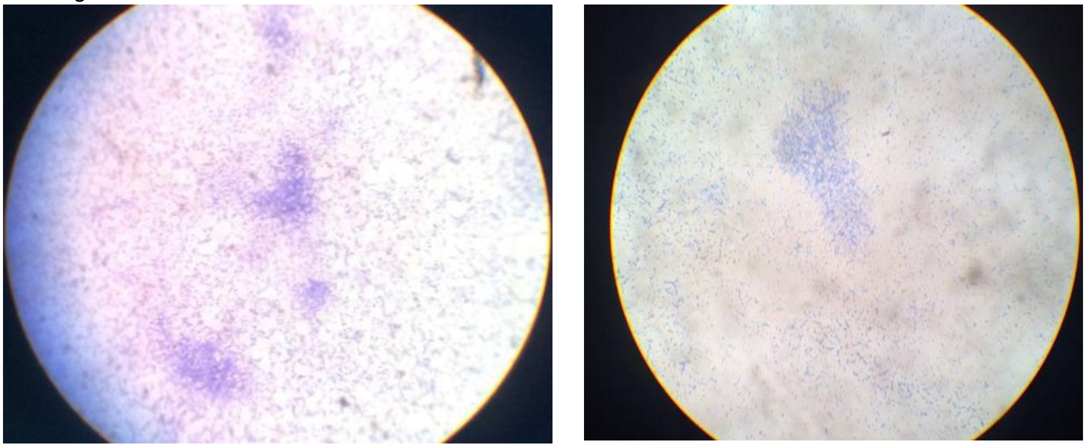

Figure 2: Lactobacillus bacteria under light microscope pre-stage and post-stage

At post stage analysis, the population of strains that survive was represented in Figure 2. It was found that the majority of strains could not survive in the cocopeat media. This may be due to the bacteria could not withstand highest resistance or tolerance in this regard. The average pH media treated with Lactobacillus (Figure 3) was slightly closed to neutral at the early stage of transplanting. A study found that good probiotic strain should withstand at least pH 3.0. One of the most important standards for selection of LAB as probiotic is potential viability at low pH (Limanska et al., 2013).

3.2 pH of cocopeat

According to Figure 3, the obtained results has been observed that media treated with RHA brought about an increase in the average of pH media over time as compared with media treated with LAB and blank. However, results showed that there were no significant differences on the average of pH value for Lactobacillus treated media and blank media. This trend indicates that the acidity of the media was increased over time. The appropriate treatments application maintained pH at an optimum level which eventually no addition of buffer solution is needed to reach the desired pH for the crop. RHA is the best as alter management methods to prevent media acidity increasing over time from continuing.

A soil pH of 5.2 to 8.0 provides optimum conditions for most agricultural plants. Cucumbers are better able to absorb the nutrients they need in media with a pH of 6.0 to 7.0, which is slightly acidic to neutral. Medium pH affects the availability of nutrients and how the nutrients react with each other. It can be seen that nitrogen is readily available to plants when the soil pH is around 6.5. As the pH decreases to 5.5, nitrogen becomes much less available. As medium pH decreases, the activity of beneficial nitrogen-fixing bacteria slows down significantly, making nitrogen less available to plants. Disease-causing fungi and other harmful organisms can function rather well under low pH conditions, further compounding problems for desired crops. It is important to know the optimal pH range for the crops and to manage pH to obtain the highest crop vigor and disease resistance (Fernandez and Hoeft, 2009).

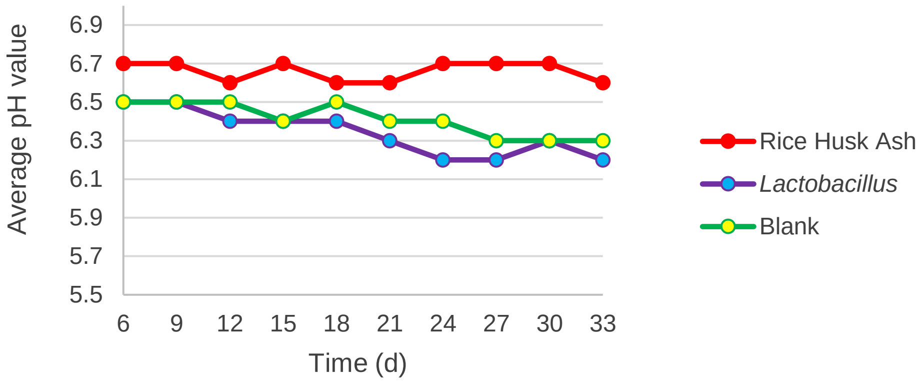

Figure 3: Graph of average of pH value for each treatments media

3.3 Fruits yield

Results in Figure 4 illustrated that media treated with RHA brought about an increase in a number of fruit yield of cucumber as compared with media treated with LAB and blank. The highest accumulated fruit weight in this season was obtained with a growth media of RHA followed by the blank media and Lactobacillus treated media. Figure 4 showed also the development of fruit yield throughout the season which was increased gradually after 34 to 47 days of transplanting but at an early stage of 34 d the marketable cucumber fruits harvested only in growth media under RHA. This means that the medium's structure has stability for supporting the cucumber plant for growth at a faster rate compared to the other growth media under study. The very good performance of cucumber plants grown on media consisting of treated rice husk. These materials affect the physical properties, especially the air/water relationships. The aeration in the crop root zone and water-holding capacity of the medium were improved by RHA application treatment. Hence, there was an increase in the level of exchangeable of nutrients taken by roots (El Sharkawi et al., 2014).

On the other hand, in RHA treated media the number of fruits harvested also started increasing dramatically which shows the strong relation among the average of pH media within the range from 6.6 to 6.7 that provided an optimum condition to grow the cucumber plant and prevented from acidic in media as shown in Figure 3 above. The increases of the number marketable fruits related to the crop growth. The crop growth was tested in terms of the size of seeds and also the color of the fruits. Figure 5 and 6 show the cutting slice of cucumber fruits for each treatment. Based on the different in size of seeds and color, it can be concluded that fruits from T1 has highest growth rate followed by T3 and T2.

According to the obtained results in Figure 7 it has been observed that maximum 60 fruits were recorded in Rice Husk Ash treated media. Minimum 41 fruits were recorded in Lactobacillus treated media. However, results showed that there was no significant differences on the total number of fruits of the cucumber plant for Lactobacillus treated media and blank media. Hence, the appropriate treatments application boosted up the growth of cucumber plant which eventually increases the number of fruits per plant accordingly.

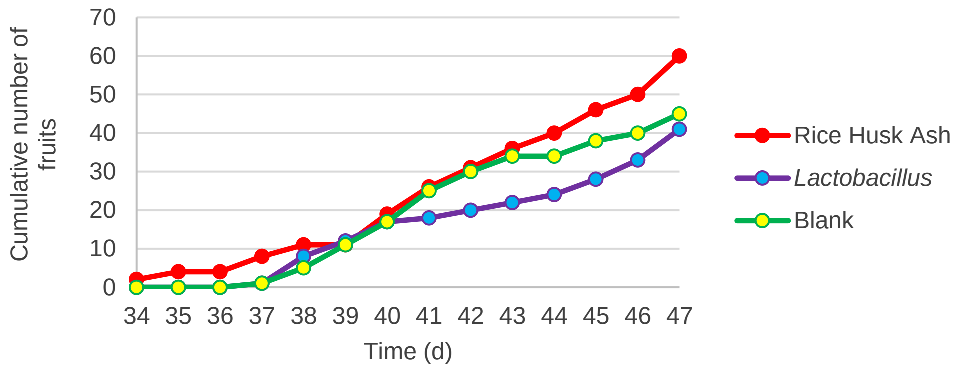

Figure 4: Graph of cumulative number of fruits per d for each treatments media

Figure 5: Seed of the cucumber

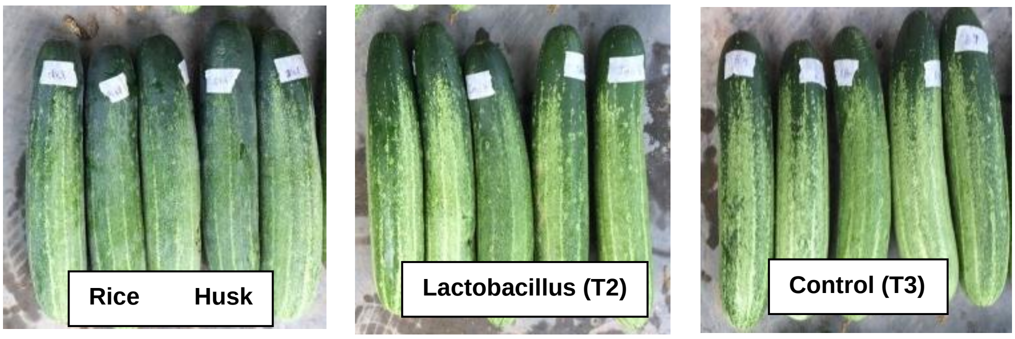

Figure 6: Color of the cucumber

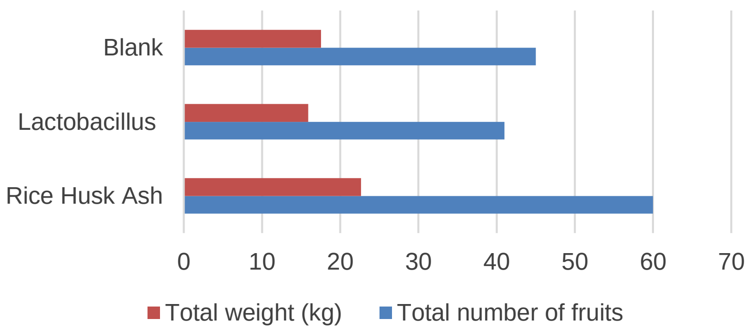

Figure 7: Graph of total number of fruits and weight for each treatments media

From Figure 7, the graph shows that the total weight of the cucumber for Rice Husk Ash (RHA) treated media was significantly increased compared Lactobacillus treated media and blank media. It had been observed that due to the application of different treatments media there was a very significant increase in fruit weight in RHA treated media with 22.66 kg of cucumber. Likewise, the least fruit weight 15.92 kg was observed in Lactobacillus treated media. There was no significant difference showed between total weights of cucumber for Lactobacillus treated media and blank media. Plus, the observed results proved that by RHA treated media the fruit weight also started increasing dramatically which shows the strong relation among the increment of the total number of fruits for each treatments media of the cucumber plant as shown in Figure 7 above. Overall, T1 gave a better performance of cucumber plants grown on media as compared to other treatments because the media was treated with rice husk that were full with silicon which contributed to 90 % of the composition of rice husk (Montanez and Pena, 2015). The roots had absorbed and deposited on the outer walls of epidermal cells as silica gel which were resistance to pathogens and insects. The performance of cucumber plant in T2 eventually increased with the increasing number of marketable fruits due to the effective role of rice husk in regulating the pH of soilless media and providing sufficient nutrients required by the plant.

4. Conclusion

In conclusion, this study is clearly showed that the media treated rice husk brought about a significant increase in pH value and yield of cucumber. Significant differences in yield could be found among treatments. Application of rice husk ash treated media, T1 was 60 of cucumber (22.66 kg) followed by T3 with 45 of cucumber (17.53 kg) and T2 with 41 of cucumber (15.92 kg). These findings suggest that the utilisation of rice husk ash in cucumber cultivation fields may represent a valuable tool for enhancing plant growth and promoting sustainable agriculture as it capable to maintain the pH media as well as increase the uptake of nutrients that needed for the plants. There is an increasing demand by growers and consumers for new environmentally friendly methods to replace, or at least supplement, the existing chemical-based strategies thereby achieving safer, rice husk ash application will be applied.

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