CHEMICAL ENGINEERING TRANSACTIONS
VOL. 63, 2018
A publication of AIDIC
The Italian Association of Chemical Engineering
Online at www.aidic.it/cet
Guest Editors: Jeng Shiun Lim, Wai Shin Ho, Jiří J. Klemeš

ISBN 978-88-95608-61-7; **ISSN** 2283-9216
DOI: 10.3303/CET1863062

Effect of Indigenous Microorganisms (IMO) and Rice Husk on pH of Soilless Media and Yield of Cucumis Sativus

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A field experiment was conducted to study the effect of Indigenous Microorganisms (IMO) and rice husk on pH of soilless media and yield of Cucumis sativus (cucumber). Ten polybags were provided for each treatment that consisted of IMO treated media (T1), rice husk treated media (T2), and control media (T3). Every treatment was supplied with 1.9 dS/m EC nutrient solutions and the pH was being measured every two consecutive days until the plants had been harvested. Based on the results, there were significant differences in the pH media and the fruit yield between the treatments. The media containing rice husk had a significant increase in the pH media and was consistent in maintaining the average pH media within the range of 6.6 to 6.7, while fruit yield of cucumber recorded the highest number as compared with the other treatments. The findings had revealed that T2 had resulted in 60 cucumbers (22.66 kg) being harvested, followed by T3 with 45 cucumbers (17.53 kg) and T1 with 45 cucumbers (17.11 kg). It can be safely concluded that the medium containing treated RHA was the best for obtaining high yield of cucumber in soilless media as a local growing media due to the superior of its potential constraint of chemical fertiliser while keeping the stability to continue the growth and fruit production for a long period of time.

1. Introduction

Soil is the most important medium for growing plants. In city areas, soil is usually very limited and hardly available for planting purposes. Under such circumstances, soilless culture had been introduced to the world of agriculture and becomes a popular alternative. Nowadays, soilless culture is widely used in research for studying plant nutrition and it is a growth medium that can supply the available nutrients and act as a support system to the plants. The most commonly used materials in soilless cultures are rice husk, peat, wood residues, sand and bagasse. Most of the crops can grow in the soilless culture, and cucumber is one of them.

Cucumis sativus, which is known as cucumber, is a highly demanded fruit and is continually produced on new growth in a short time. 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 plenty of sunlight and with an optimum pH range of 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 the usage of nitrogen-based fertiliser, removal of agricultural products and organic matter build-up. An optimum soil 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. Thus, maintaining the appropriate level of the soil pH is highly important to indicate the level of optimal growth of the plants.

In addition to the above, soil fertility is also related with the chemical and physical properties presence in the soil. However, the microbial part is always being neglected because of the incompatible performance of the soil properties. Normally, the performance depends on the types of crops, soil and the application. Only a few reports had been found with discussions mentioning the inoculation effect of microbes in matured compost and its effect to the microbial surrounding (Kato et al., 2008). There was an alternative way to produce high yield and good quality that Cho (1997) had tried to show by respecting the nature which can replace the

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chemical intensive agriculture. This method utilises the indigenous resources to produce the natural fertilisers which is IMO. The efficiency of the microbes normally depends on the ‘environment’ of the habitat and probably due to competition with indigenous microbes exists in the soil (Illani et al., 2012).
Previous researches had found that Rice Husk Ash (RHA) as one of the application that could be applied in agriculture for its proper utilisation and it also provided nutrition to the agricultural crop as fertiliser. Intense research had been focused on the use of RHA in increasing the soil pH that depends on threshold dosage, thereby increasing the nutrients availability. It can affect the hydro-physical properties as well in such it helps to improve the aeration in the crop root zone and increase the water holding capacity (El Sharkawi et al., 2014).
This report presents some new perspectives on the application of IMO and rice husks on pH soilless media that can enhance crop production, maintaining the pH and eventually create a more sustainable agriculture and environment.

2. Experimental

The field experiment was conducted at the Faculty of Chemical and Energy Engineering, Universiti Teknologi Malaysia (UTM) located in Skudai. The test crop, Cucumis sativus was grown on coco peat as soilless media. The treatment media consist of IMO (T1), rice husks (T2) and control media (T3).

2.1 IMO Preparation and Identification

The selection of materials used to prepare IMO was based on previous studies (Department of Agriculture, 2006).Preparation of IMO was done only after IMO2 was completed. One kg of cooked rice was put into the drainer and was covered with a plastic. The rice was fermented for three days in a closed box full of bamboo leaves. After three days, the white mold appeared around the container and this was called IMO1. Next, molasses was added into the IMO1 with a ratio of 1 : 1. The mixture was stored in a container to be fermented for five days and this was called IMO2 (Rohini, 2011). To apply the IMO2, 100 mL of IMO2 was diluted in 20 L of non-chlorinated water. Every 2 L of the diluted IMO2 was put into each polybag for treatment with IMO (T1). As for identification of microorganisms in IMO, a serial of dilution was used with 1 mL of IMO2. The dilution was spread on nutrient agar plates and incubated for 24 – 48 h at 37 ºC. After incubation, Gram staining was prepared to identify the microbe and observed under the microscope.

2.2 Preparation of Media and Irrigation System

In preparing the media, 30 polybags sized 36 cm x 36 cm were filled with coconut coco peat in the same quantity. The bags were randomly arranged into three rows. Each of the bags was equipped with one dripper which supplied nutrients solution containing all macronutrients (nitrogen, phosphorus, potassium, calcium, magnesium, and sulphur) and micronutrients (iron, boron, copper, manganese, zinc, and molybdenum) at certain concentration. Table 2.1 shows the mineral content of fertiliser used for growing cucumber plants.

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			

2.3 Sowing of Seeds

The sowing trays were filled with peat moss. After that, cucumber seeds variety 797 from Leckat Company were sowed by placing one seed per one hole. The trays were watered with 1.5 dS /m of EC of nutrients solution. Finally, the grown plants were transplanted to the media after three leaves had grown on each plant.

2.4 Treatment of Cultivation

The nutrient solutions were applied to a fully wet growing medium and caused some drainage since the substrates used have a high degree of porosity that facilitates the requirement. The irrigation system that consisted of one big tank, one operation timer and one aquarium pump (30 W) each was prepared. The outlet was connected to 16 mm LDPE pipe which then connected to 1 mm capillary tube before connecting to a dripper. The macronutrients and micronutrients in the two small tanks respectively were added together into the big tank as nutrient solution at 1 : 1 ratio until the needed EC was achieved. Each treatment will be supplied with 1.9 dS/m EC nutrient solutions. Nevertheless, the T1 media were mixed with IMO (2 L of diluted IMO) before transplanting, while in media T2 were mixed with 4 L of rice husks. A small amount of K_2CO_3 was added to the big tank to maintain the pH level of 6.8. The irrigation operated five times a day at 8.30 am, 10.00 am, 1.00 pm, 3.00 pm and 5.00 pm. The irrigation process will be stopped when drainage emerged from the bottom of the polybags.

2.5 pH Determination of Coco Peat

The pH of each plant from all the treatments was recorded for two consecutive days until the plants had harvested. The pH data which was collected was determined by the drainage of the water from the polybags. The pH was measured by the pH meter and recorded over time. The data from each treatment were compared and analysed.

2.6 Performance of Cucumus Sativus

After about 34 d of transplanting (DAT), the crops were finally harvested and being weighed to determine the yield of the crops. Only the fresh weights of the marketable cucumbers were taken. Data on yield collection and comparison between different types of media are based on these three parameters:

1. Number of marketable fruits.
2. Total fruits per treatment.
3. Total fruits weight per treatment.

3. Results and Discussion

3.1 Identification of Microorganisms in IMO

The microbe in IMO was identified before adding to the soilless media. As the result of Gram staining, stained purple by the crystal violet remained on the glass slide which means the microbe was a gram positive. This is because the bacteria had a thick cell wall made of peptidoglycan. Other than that, the microbe shape observed under the microscope was in the form of rod-shaped as shown in Figure 1a. This can be classified into the genus of bacteria with the name of Bacillus.

(a) (b)

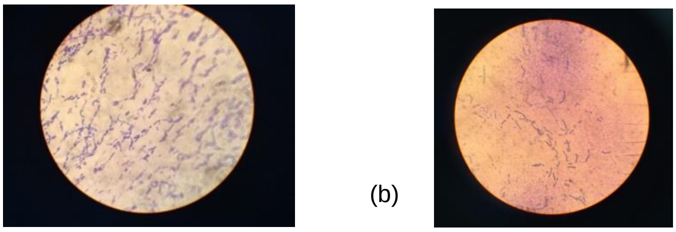

Figure 1: 100x magnification of objective lens with immersion oil

Bacillus species are endospore-forming, chemoheterotrophic rod-shaped bacteria which are usually motile with peritrichous flagella. They are aerobic or facultative anaerobic and catalase positive. Bacillus improves the bioavailability of essential compounds and increases the supply of mineral nutrients to the host plant. These types of the Bacillus genus are representing a wide range of physiological abilities and usually found in soil which allow the organism to grow in every environment (Kuta, 2008). Due to its capability to form extremely resistant spores and produce metabolites that have antagonistic effects on other microorganisms, they can compete desirably with other organisms within the environment. After five weeks the IMO was added to the soilless media, it showed the decreases of microbe in IMO as shown in Figure 1b. Even though the microbe reduced, but it can still be proved that IMO can adapt to the soilless culture. However, there are other microorganisms presented and their numbers are usually more than the applied IMO itself. The survival of the microbial population remained unknown especially after mixing with the soil.

3.2 pH Determination of Soilless Media

Figure 2 shows the media treated with rice husk had increased and maintained in average of pH media of 6.7, followed by media treated with IMO and control.

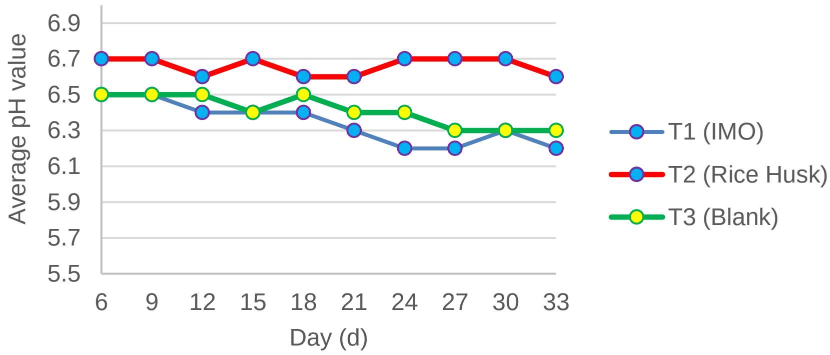

Figure 2: Average pH value for each treatment

For greenhouse production, the recommended pH range of irrigation water and substrate solution are depending on the crops being grown. As for media treated with rice husks, the pH should be maintained at average level of 6.7 since the pH ranging by the rice husks treatment does not have negative influence since the most effective pH was below 7.0 in the effect of protein contents and specific activity of Cucumis sativus (Mobina et al., 2012). In alkalinity situations, symptoms of nutrient deficiency like phosphorus can probably occur (Soares et al., 2016). Cation exchange helps soils to hold the nutrients in plant root zone and to resist changes in pH. Rice husk is capable to maintain the pH media like a buffer as well as increase the uptake of nutrients that is needed for the plants. Besides that, control media had obtained the pH average of 6.4 followed by IMO with an average pH of 6.3. Even though the pH range was not too acidic, it may be due to insufficient amount of IMO applied to the media for the plant growth, as many environmental factors could affect the rate of biodegradation potentially those involving pH, oxygen availability and others. Soil pH could affect the availability of nutrient as nitrogen was readily available at soil pH 6.5. The nitrogen became less available as the pH decreased. When pH decreased, the nutrient uptake by the plants also decreased. It is important to manage and maintain the pH as it is directly related to the nutrients uptake by plant roots to obtain the highest yield.

3.3 Marketable Fruit Yields

According to Figure 3, development of marketable fruits increased gradually after 34 to 47 d of transplanting. Media treated with rice husks showed the highest number of cucumber yield as compared to the media treated with IMO and control (blank).

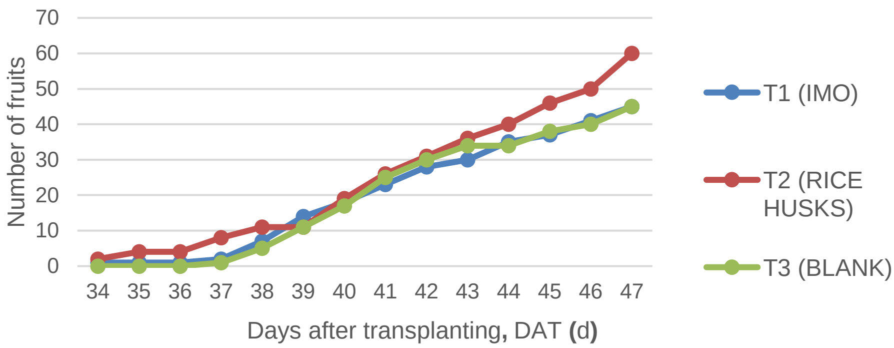

Figure 3: Cumulative number of marketable fruits

During the early stage, only cucumber from treatment with rice husks was harvested. This means that the media had the stability for supporting the plant growth at a faster rate as compared to other media. The growing medium containing rice husks was the best medium for improvement of shoots and roots biomass production (Abouzari et al., 2012). In addition, the medium structure had stability for supporting the cucumber plant and affect physical/chemical properties especially the water/air relationship as compared to other growth media. A good performance of cucumber plants was obtained from those grown in media consisted of rice husks. For media treated with IMO, there was no fruit produced during the early stage as well as control media. This was probably because of the IMO application depended on the ability of microbes that acted as a nutrient synthesiser in nutrient uptake by the plants. Based on Illani et al., (2012), the amount of IMO was insufficient for cell building and other micronutrients required by the plants. The nutrient availability in the soil was better than the nutrient synthesised by the microbes. The quantity of microbe was not enough to help the plant in increasing the nutrient uptake. However, the fruits production from media with IMO is higher during the early stage as compared to control media, as control depended totally on the nutrient solution applied to the media without other treatment. The fruit yield was also related to the crop growth. The crop growth was tested in terms of colour of the fruits and size of the seeds. It can be observed that T2 had smaller size seeds with the average of 0.83 cm followed by IMO with 0.96 cm and control with 1.0 cm. Based on the colour and size of the seeds, it can be concluded that fruits from T2 had the highest growth rate, followed by T1 and T3.

3.4 Total Fruits and Weight for Each Treatment

Based on Figure 4, the total fruits from T2 gave the highest result with 60 number of fruits. There was no significant difference in the results for T1 and T3, where both treatments had produced 45 cucumbers each. However, the results could potentially generate a significant difference over a longer period. The ability of microbes depends on the application of IMO itself.

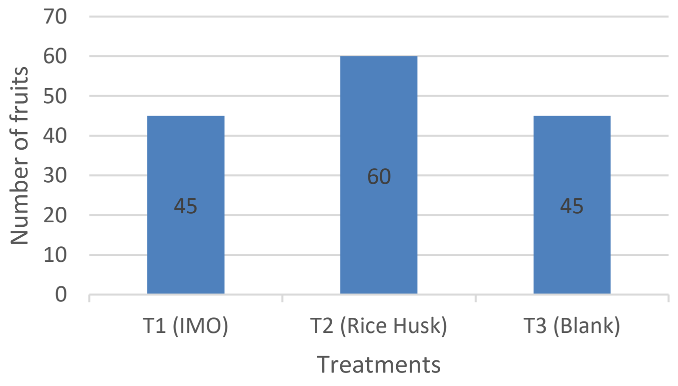

Figure 4: Total fruits for each treatment

The total of fruits related to the weight from each treatment. By referring to Figure 5, the result shows the highest fruit weight was 22.66 kg by T2. Likewise, the least fruit weight was 17.108 kg by T1. Even though the total fruits yield for T1 and T3 were the same, but T3 had slightly higher weight of total fruits. Since the size of cucumber was not being included as a parameter in this study, the weight of the cucumber was not significant between those two treatments.

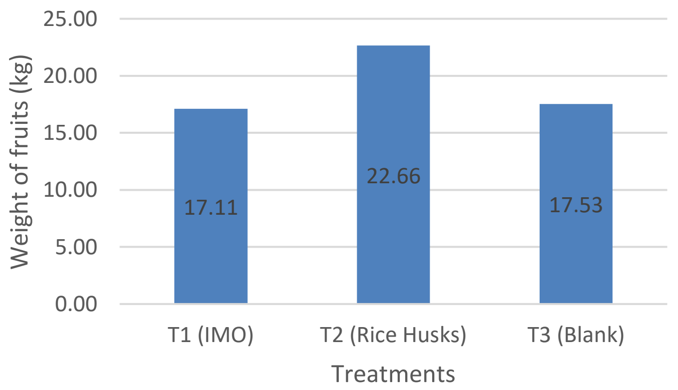

Figure 5: Total weight for each treatment

T2 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 et al., 2015). The roots had absorbed and deposited on the outer walls of epidermal cells as silica gel which were resistance to pathogens and insects. It also reduced the loss of water through transpirations, keeping the leaves more erect and stiffened the cell walls (Rambo et al., 2011). These materials affect physical properties in term of the air and water relationships. The aeration porosity was defined as large pores of media where it increased the demand for oxygen by roots and increased the production of carbon dioxide (El Sharkawi et al., 2014). 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, the total yield obtained was 60 cucumbers (22.66 kg) for T2, followed by T3 with 45 cucumbers (17.532 kg) and T1 also with 45 cucumbers (17.108 kg). It was clearly showed that T2 (rice husk) had the best performance of Cucumis sativus plant growth with the maintained value of pH within the range of 6.6 and 6.7 when compared with other treatments. The media under treatment of rice husk was capable to maintain the pH media like a buffer as well as increasing the uptake of nutrients needed by the plants. Besides that, the results had also revealed that there was no significant effect on yield of cucumber with the treatment of T1 (IMO) and T3 (control) because of the decreased in microbial population in media with IMO treatment within the period of time. The identification of microbe in IMO had been identified which was classified as Bacillus (rod shape).

Acknowledgments

The authors would like to thank the Universiti Teknologi Malaysia (UTM) and Ministry of Education (MOE) in providing the research funds (Vote No. R.J130000.7846.4F896) (Q.J130000.2546.18H38).

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