UNIVERSITI PUTRA MALAYSIA

POTENTIAL OF USING SEA WATER IN FERTIGATION SYSTEM FOR ROCK MELON CULTIVATION

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POTENTIAL OF USING SEA WATER IN FERTIGATION SYSTEM FOR ROCK MELON CULTIVATION

By

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for the Degree of Bachelor Science Bioindustry in the
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ABSTRACT

Rock Melon is a high value fruit that are commonly grown using fertigation system. Due to high fertilizer cost alternative fertilizer or nutrients sources for plant needs to be explore. Therefore, the objectives of this study are to determine the potential of using sea water in fertigation system and to determine the roles of diverse media on growth and fruit quality of Rock Melon. This research was design to use diluted sea water as a source of minerals and applied to the melon grown on different types of growth medium : coco peat (CP), coco peat + biochar (CPB), coco peat + humic acid (CPHA) and CPBHA. The plants were arranged in a Split Plot arrangement and put under protective structure. From the results, it showed that, there was no significant different between the various medium used but significant different in fruit weight, root biomass and the sugar content of the fruits due to the different concentrations of the sea water used. The different concentration decreased the fruits size, mineral uptake and the root biomass, but increased the sugar content as the concentration increased. Smaller fruits were obtained from plant treated with 3000 ppm (600 g) compared to the control which is 0 ppm (1200 g). Thus this study revealed that sea water has the potential to be used in fertigation system and should be balance with good organic growth medium.

ABSTRAK

Rock Melon merupakan sejenis tanaman buah bermutu yang sering ditanam menggunakan sistem fertigasi. Disebabkan kos pembajaan yang tinggi, baja atau sumber nutrien alternatif perlu diterokai. Oleh itu, objektif utama kajian ini dijalankan adalah untuk menentukan potensi air laut dalam membekalkan nutrien di dalam sistem fertigasi dan menentukan kesan pelbagai media terhadap kualiti buah Rock Melon. Kajian ini telah dijalankan dengan menggunakan kepekatan air laut yang berbeza yang diaplikasikan terhadap media tanaman yang berbeza: habuk kelapa (CP), habuk kelapa + arang (CPB), habuk kelapa + asid humik (CPHA) dan habuk kelapa + arang + asid humik (CPBHA). Semua tanaman disusun mengikut susunan 'Split Plot' dan diletakkan di bawah struktur lindungan hujan. Keputusan kajian menunjukkan penggunaan media yang berbeza tidak menunjukkan perbezaan yang ketara tetapi perbezaan terhadap saiz buah, biojisim akar, dan kandungan gula dalam buah dapat dilihat hasil daripada penggunaan kepekatan air laut yang berlainan. Peningkatan kepekatan air laut yang digunakan menyebabkan penurunan saiz buah, pengambilan mineral dan biojisim buah tetapi akan meningkatkan kandungan gula dalam buah. Saiz buah yang lebih kecil diperoleh daripada tanaman yang menerima rawatan 3000 ppm (600 g) berbanding tanaman kawalan 0 ppm (1200 g). Justeru, kajian ini telah membuktikan bahawa air laut berpotensi digunakan dalam sistem fertigasi dan perlu diseimbangkan dengan penggunaan medium tanaman organik yang baik.

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APPROVAL SHEET

I certify that this research project entitled "Potential of Using Sea Water in Fertigation System for Rock Melon Cultivation" has been examined and approved as a partial fulfillment of the requirement for the degree of Bachelor Science Bioindustry in the Faculty of Agricultural and Food Sciences, Universiti Putra Malaysia Bintulu Sarawak Campus.

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CHAPTER 1

INTRODUCTION

1.1 Background of Research

Rock Melon is originated from the family of Cucurbitaceae. It is a well known fruit in Europe especially in Mediterranean region. It is also very popular in USA with different variety which is called muskmelon. Rock Melon fruits are always consumed in summer and are popular due to its sweet pulp and pleasant aroma. In Malaysia, the cantaloupe type especially the cultivar 'Glamour' with the striking golden yellow colour is the most popular. They are fast growing popular fruit among locals and has very good in demand. According to Cantliffe *et al.* 2000, high value crop such as Rock Melon could open new markets for greenhouse farmers in Malaysia and give consumers the choice of new and high quality commodities. However, most of the farmers are still using conventional method to plant the Rock Melon such as the uses of soil as planting media. When they used soil as planting media, it will cause many problems related to fungus and soil disease which are affecting the quality of the plant and fruit. Therefore many farmers and researches nowadays are started to find ways and the best technique as solution regarding to Rock Melon cultivation. Soilless culture in greenhouse may be an alternative to traditional field production for high-value vegetable crops (Cantliffe *et al.* 2001). Using soilless system such as fertigation technique can be an alternative to reduce any disease related to Rock Melon. Yields of chillies, rock melons and tomatoes cultivated in soilless system increased 3 – 5 times compared to those using conventional method (D'Amico *et al.* 2003). Alternative substrates that are cheaper and locally available such as coconut fibres and burnt paddy husks should be used as alternative media. Burnt paddy husk is also a coarse material that can give aeration to soil for plantation. According to Karmakar *et al.* (2009), The application of biochar made up of burnt paddy husk ash improved soil properties by decreasing soil bulk density and increasing soil pH, organic carbon and available nutrient. The ability of rice husk and rice husk ash to remove heavy metals from the system has also been investigated by Mahvi (2008). Based on the benefits that can be obtained by the usage of biochar, this study is conducted to determine the effects of soilless substrate such as biochar from burnt paddy husk and cocopeat on growth and yield of Rock Melon.

Enriched sea water contains salt which can be act as mineral fertilizer for the fertigation of the Rock Melon. Irrigation with saline water shows some effects on the growth, production and the quality of crop plant throughout the world (Pasternak *et al.*1978). The question of the quality of agricultural products irrigated with saline water is important for the future of Malaysia agriculture development and farmer's income. Rock Melon has been described by various authors as moderately salt tolerance. Salinity has to be managed to ensure that quality and yield that will be produce by the Rock Melon is well maintained. To achieve this, detailed knowledge of the crops respond toward salinity is required. Based on this issue, the present experiment was design to use enriched sea water with different salinity level for the irrigation of the Rock Melon and to examine its effects on yield and fruit quality.

1.2 Objectives

1. To determine the effect of enriched sea water on Rock melon fruit quality under fertigation system.
2. To determine the effects of soilless substrate such as biochar from burnt paddy husk and coco peat on growth and yield of Rock Melon.

1.3 Significance of Study

The significance of this study is to know effect of enriched sea water on melon fruit quality under fertigation system. Sea water contain amount of salt that can be acted as fertilizer for the plant and as the source of minerals and nutrients. This research is also conducted to determine effects of soilless substrate such as biochar from burnt paddy husk and coco peat on growth and yield of Rock Melon.

CHAPTER 2

LITERATURE REVIEW

2.1 Melon Salinity Tolerance

Research on the melon salinity tolerance has been done by several researchers (Shani and Dudely 2001; Mendlinger and Pasternak 1992a, 1992b; Mangal *et al.* 1988; Meiri *et al.* 1981). Melons are considered to be moderately tolerance towards water salinity and soluble solid content increased as water salinity rose. However the yield and fruit size were both decrease by the saline water (Shannon and Francois 1978). Field experiments have shown that melons are the crops that have potential to be irrigated with saline water (Pasternak *et al.* 1978). Under greenhouse conditions, salinity reduced the weight more compared to the number of fruits (Meiri *et al.* 1981; Nukaya *et al.* 1983). Mavrogianopoulus *et al.* (1999) found that irrigation with saline water caused the total yield of two *Cucumis melo* cultivar to decrease the mean of fruit weight but not the fruit number. At moderate salinity level, fruit size was the first indicator of reduced yield, while at higher salinity the number of fruit is also decreased (Mavrogianopoulus *et al.* 1999). Different levels of salt tolerance have been reported among muskmelon varieties (Mendlinger and Pansternak 1992b; Mangal *et al.* 1988; Shannon *et al.* 1978). In salty medium, Seed germination is always used as an index of resistance towards salinity stress in several crops. A close relationship has been established to link the influence of salinity on seedling growth and towards the yield of muskmelon during hydroponic culture (Nukaya *et al.* 1983).

2.2 Biochar as Planting Media

Biochar can be defined as the high carbon materials produced from the slow pyrolysis of biomass (Sitio *et al.* 2007). Biochar can be produced from variety of organic materials and under different condition resulting different varieties of product with different properties (Guerrero *et al.* 2005; Nguyen *et al.* 2004). Sitio *et al.* (2007) use biochar made from burnt rice husk for the improvement of rice growth and yield in the peat soil of Sumatra. Karkamar *et al.* (2009) also studied the effect of rice husk ash on the growth and yield of rice in the acid lateric soil of India. They showed that the application of the biochar from burnt rice husk improved soil properties by increasing soil pH, organic carbon, available nutrients and help to decrease soil bulk density. Biochars can be used as soil amendments to improve the quality of agricultural soils (Lehmann *et al.* 2003). Instead of burning them for energy, biochar can potentially applied to soil as a conditioner and leads to net removal of carbon from the atmosphere (Lehmann *et al.* 2003). Using as soil additive along with organic and inorganic fertilizer, biochar has shown some effect in increasing nutrient availability, significantly improved soil tilth and increased plant productivity (Glaser *et al.* 2002). Beneficial effects of biochar in term of improvement of soil quality and increasing crop yield also has been reported by Iswaran *et al.* (1980). Biochar application could increase some physical soil properties such as water holding capacity, improved soil aggregation and decreased soil strength (Chan *et al.* 2007). Application of biochar also had improved cation exchange capacity of soil (Liang *et al.* 2006; Yamato *et al.* 2006). The increase in crop yield with biochar application also has been reported elsewhere around the world for different type of crops such as soybean (Tagoe *et al.* 2008), cowpea

(Yamato *et al.* 2006), Maize (Rodriguez *et al.* 2009) and upland rice (Asai *et al.* 2009).

2.3 Coco Peat as Soilless Planting Media

Coconut coir dust or commercially known as coco peat is one of the soilless media widely available in the tropics. It is an agriculture by-product obtained by the extraction of fiber from the coconut husk (Abad *et al.* 2002). Coco peat has been considered as a renewable peat substitute to be used in horticulture (Yau and Murphy 2000; Pickering 1997). Good properties of coco peat are includes high total pore space, low bulk density, low shrinkage and slow biodegradation (Prasad 1997). Coco peat is well known as a good growing media component with acceptable pH, electrical conductivity and other chemical attributes (Abad *et al.* 2002). Known as a good growing medium, coco peat can be used to produce variety of crop species with acceptable quality in the tropics (Yahya *et al.* 2009). There are many experiments that shows coco peat used alone or as a component of soil medium is suitable for many potted plants. The aeration of the coco peat could be improved by addition of coarser materials into the media (Sambo *et al.* 2008). Coarser materials that could be used to improve the air-water relationship of coco peat is such as burnt rice husk, kenaf core fibre and perlite (Sambo *et al.* 2008; Tsakaldimi 2006).

2.4 Sea Water as a Source of Minerals

Castro and Huber (2003) had shown that sea water can be used as source of minerals as it contain elements such as sodium, magnesium, calcium, chloride and potassium that contribute to sea water salinity (Table 2.1). They had found that the highest amount of element in normal sea water is chloride, followed by sodium, sulfate, magnesium, calcium, potassium and other micronutrients.

Table 2.1 Proportions of minerals that are available and contribute to sea water salinity

Chemical Ion Contributing to Seawater Salinity	Concentration in Average Seawater (Part per thousand)	Proportion of Total Salinity
Chloride	19.345	55.03
Sodium	10.752	30.59
Sulfate	2.701	7.68
Magnesium	1.295	3.68
Calcium	0.416	1.18
Potassium	0.390	1.11
Bicaronate	0.145	0.41
Bromide	0.066	0.19
Borate	0.027	0.08
Strontium	0.013	0.04
Flouride	0.001	0.003
Other	Less than 0.001	Less than 0.001

2.5 Nutrient Requirement by Cucurbitaceae

Cucurbitaceae such as Rock Melon, watermelon, pumpkin and squash generally accumulate in vegetation and fruit 145 to 160 lbs nitrogen (N), 30 to 45 lbs phospate (P^2O^5) and 160 to 180 lbs potassium (K^2O) per acre (Warncke 2007). These values can be used as general guides for applying amount of supplemental nutrients as fertilizers. Warncke (2007) also stated that it is important to maintain a soil pH between 6.0 to 6.5 especially for Rock Melon variety. Watermelon can be tolerant to acid soil conditions whereas pumpkin and squash are intermediately tolerant toward acidic conditions. Allowing the pH to decrease below 6.0 will affect the quality and the yield of the crops. When the pH decrease to 5.5 and below, rock melon growth will be reduced and some sign of manganese (Mn) toxicity such as 'black spots' will occur (Warncke 2007). Maintaining soil pH in the range of 6.0 to 6.8 also help to improve the availability of magnesium (Mg) and calcium (Ca) which is important for the development of young fruit. Developing melon have high demand for potassium (K) since it has the highest K concentration among fruits. Previous research has shown that potassium (K) deficiency during fruit development and maturation can be solved by supplemental foliar K application to netted cantaloupe (Lester *et al.* 2005).

2.6 Role of Humic Acid in Increasing Nutrients Uptake

Humic substances are being known throughout the world for their importance in agriculture (Tan 2003). Humic acid preparations were reported to increase the uptake of mineral elements (Mackowiak *et al.* 2001). Enhancement of plant growth using humic acid had been reported due to the increased uptake of nutrients, such as N, Ca, P, K, Mg, Fe, Zn, and Cu, in tomato and binding toxic elements, such as Al^{3+}, in maize plants (Mackowiak *et al.* 2001). Studies have repeatedly shown that humic acid can give positive direct and indirect effect on plant biomass as long as there is sufficient amount of nutrient available and the stimulation of root growth is generally higher than the shoot growth. The uptake of minerals is enhanced by the humic substance through the stimulation of microbial activity (Albuzio *et al.* 1994). Humic substance will coat the mineral surfaces with a bi-layer membrane which helpin the solubilization of insoluble compound by dissolving, complexing and chellating the dissolved nutrients (Mackowiak *et al.* 2001).

2.7 Effects of Salinity on Melon Fruit

Under saline irrigation, the total yield of the Cucurbit species is decreased when the salinity increased (Zhong *et al.* 2009). Mavrogianopoulus *et al.* (1999) also showed that saline irrigation can caused a reduction in the yield of two *Cucumis melo* cultivars, decreased mean fruit weight but not the fruit number. Similar results have been showed for different melon cultivars including Galia and Amarillo Oro reported by Botia *et al.* (2005). They also found that the fruit firmness was increased for Amarillo Oro, but for Galia it reduced significantly after saline irrigation. Shannon and Francois (1978) also have been reported that yield and fruit weight decreased by increasing salinity. El-Doweny *et al.* (1990) reported that yield, number of fruit per plant and mean of fruit weight were affected by salinity and decreased.

3.2 Seedling and Medium Preparation

About 300 seeds of rock melon from Glamour variety had been selected to be germinated. The seeds were dipped inside the solution of Thiram fungicide to prevent infection during germination process. The seeds then were planted inside the germinations trays filled with coco peat as the planting media. The seeds in the trays were left to germinate for two weeks inside the netted house at temperature of 25°C and 95% humidity. After two weeks, 250 of germinated seeds were selected to be transferred into the polybags. Medium size poly bags (16 cm x 16 cm) filled with coco peat as the planting media were used in this experiment. The plant were placed inside the rain protection house (RPH) equipped with the tank and pipelines for the irrigation. Total of 140 poly bags were labeled based on treatment and replications.

3.3 Treatment and Medium Preparation

Four types of media were prepared to be used in this experiment. They are consist of 100% coco peat; coco peat + biochar; coco peat + humic acid; and coco peat + biochar + humic acid. Each media was treated with seven different level concentration of sea water which is 0, 1000, 1500, 2000, 2500 and 3000 ppm and there were five replications for each set of treatments. The composition of the media and concentration of sea water used was shown in Table 3.1.

Table 3.1 Type of media and treatments used during the experiment

Media	Treatments of Sea Water (ppm)					
100% Coco peat (CP) (M1)	0	1000	1500	2000	2500	3000
Coco peat + biochar (3:1) (CPB) (M2)	0	1000	1500	2000	2500	3000
100% Coco peat + humic acid (CPH) (M3)	0	1000	1500	2000	2500	3000
Coco peat + biochar (3:1) + humic acid (CPBH) (M4)	0	1000	1500	2000	2500	3000

3.4 Parameters Taken

3.4.1 Fruit Weight and Brix Level

The fruits were harvested at the optimum ripening stage. The weight of each fruit was determined to evaluate the mean fruit weight. Fruits were selected from each treatment in the harvest period to measure fruit shape index, fresh weight, and total soluble solid. The equatorial and longitudinal diameters of the fruit were measured and their ratio was defined. Sugar level of the fruits were measured with a digital refractometer and express as ^{o}Brix.

3.4.2 Total Mineral Content of the Fruit and Media

A fruit was selected randomly from each treatment plot and weighed before and after drying in an oven at 65 ^{o}C, until they reached constant weight, to determine the fruit water content. The dried fruit material was milled to a find powder and retained for ion analysis. The random sample from the media were also taken once a week to determine the soil pH and electro conductivity. At the end of the harvesting period, samples from the media is also taken to measure the total nutrient content inside the media and the root development for the rock melon plants is also recorded.

3.5 Experimental Design and Data Analysis

The design that had been used for this experiment is the split plot design. The main factor is the type of media and the sub factor is the concentration level of sea water. Data were analyzed with Statistical Analysis System software (SAS 9.1). Analysis of variance (ANOVA) was performed to determine the treatment effects. When significant treatment effects ($P \leq 0.05$) were found, the treatment means were separated by the Duncan's New Multiple Range Test (DNMRT). The layout of the experiment in split plot design is shown in Figure 3.2.

CHAPTER 3

MATERIALS AND METHOD

3.1 Location of the Experiment

The research was carried out at fertigation site of Universiti Putra Malaysia Bintulu Sarawak Campus. The coordinates for the place is latitude 3°12'28.13' N and longitude 113°4'41.93"E. The figure 3.1 shows the photo of exact location for the experiment site taken from the satellite.

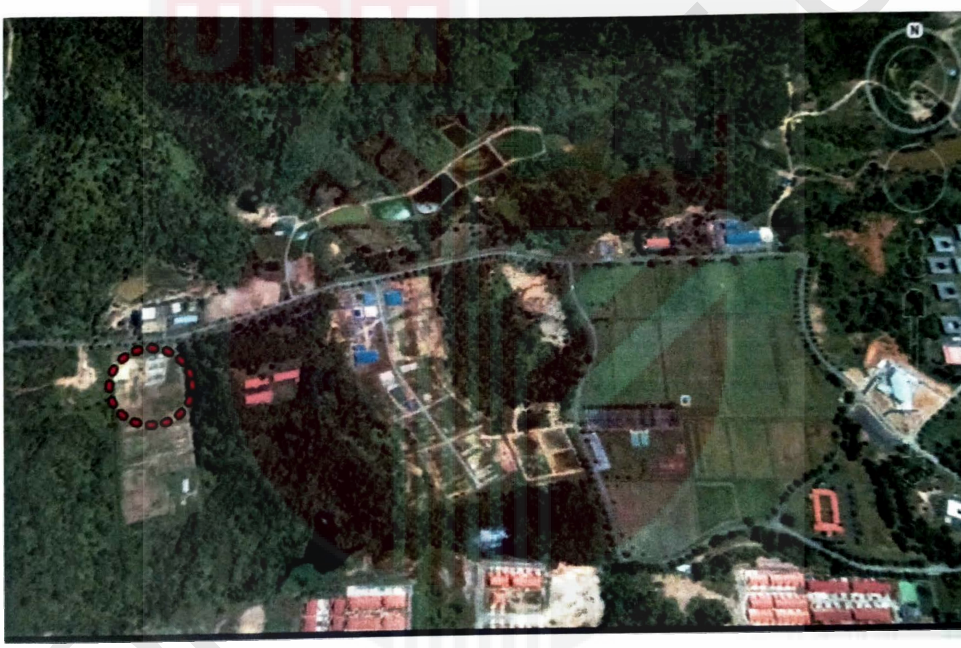

Figure 3.1 The marked sign shows the location of fertigation site located at Universiti Putra Malaysia Bintulu Sarawak Campus

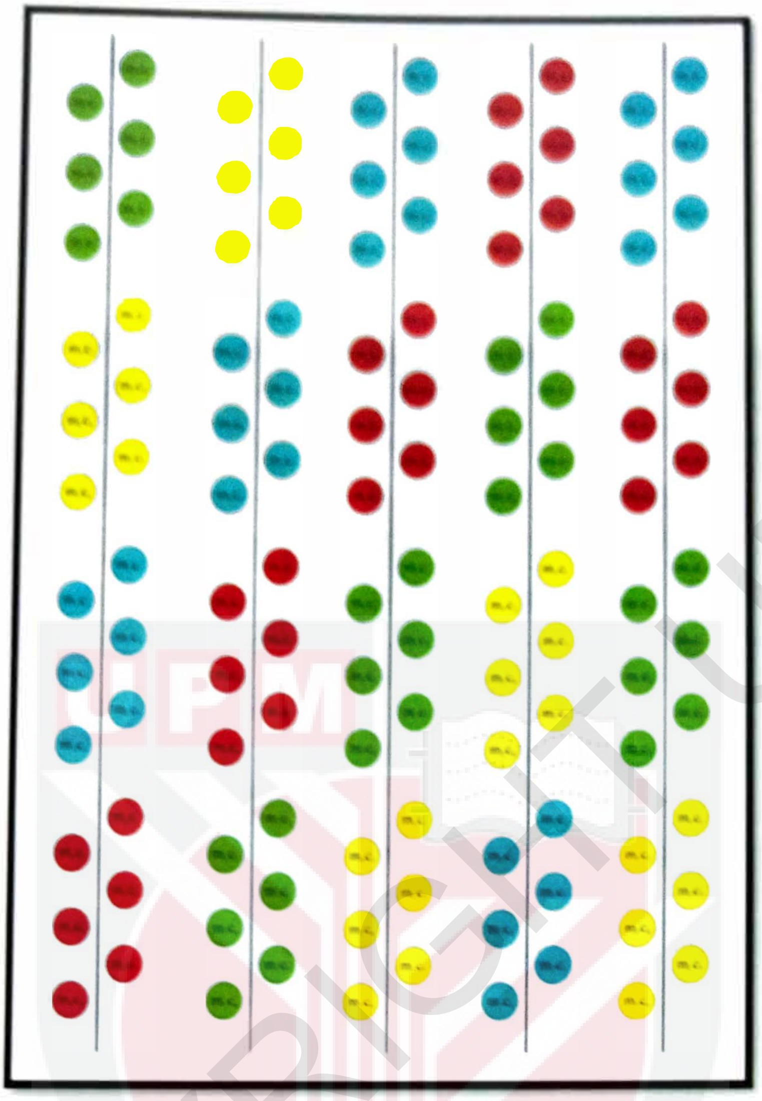

Figure 3.2 Layout of the experiment in split plot design

CHAPTER 4

RESULTS

4.1 Root Biomass

The results of the main factor (Figure 4.1) of the first parameter after statistical analysis indicate that, the mediums have no effect on the root biomass.

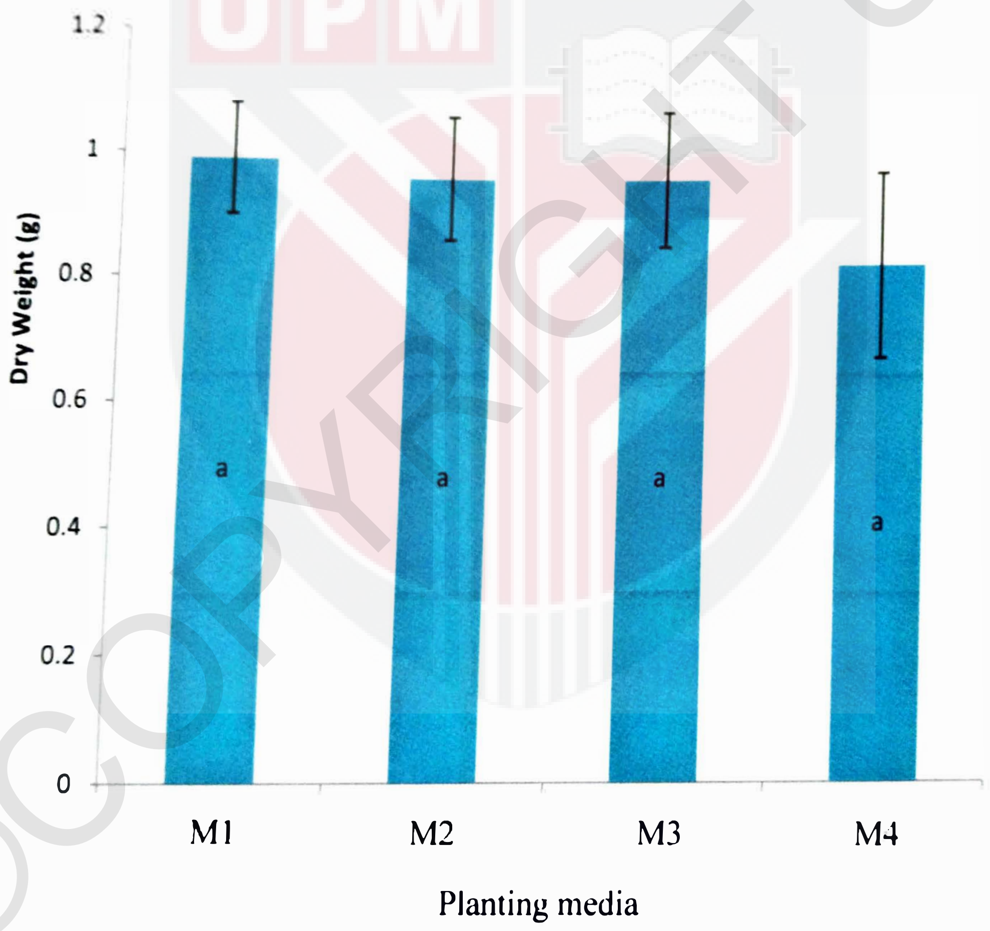

Figure 4.1 Effect of planting media on root biomass. Same alphabets on bar indicate there is no significance difference between means at P≤0.05 Duncan's New Multiple Range Test (DNMRT)

The root biomass of the Rock Melon plant decreased as the concentration level of sea water increased. The various concentration of sea water used as a sub-factor with the medium on the melon indicate that, concentration 4, 5, and 6 have the same effect on the root biomass but statistically different from concentration 1, 2, and 3. Concentration 1, 2, and 3 are statistically different from each other with concentration 1 having the highest weight on the root biomass of the melon (Figure 4.2).

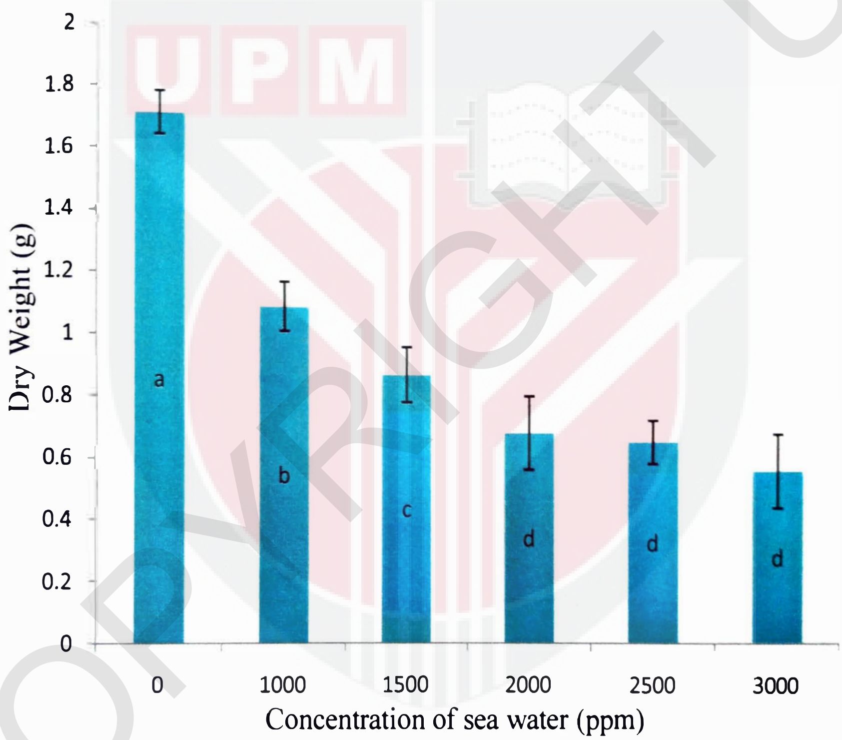

Figure 4.2 Effect of concentration on root biomass. Different alphabets on bars indicate significance difference between means at P≤0.05 Duncan's New Multiple Range Test (DNMRT)

The results in Figure 4.3 indicates that, there was interaction effect of medium and the concentration on the root biomass. The effect of concentration 6 with the mediums were statistically different from the rest of concentration accept concentration 5 with medium 1 and 2. The effect of concentration 1, 2, and 3 on medium 1, 2, 3, and 4 are not statistically different from each other (Figure 4.3).

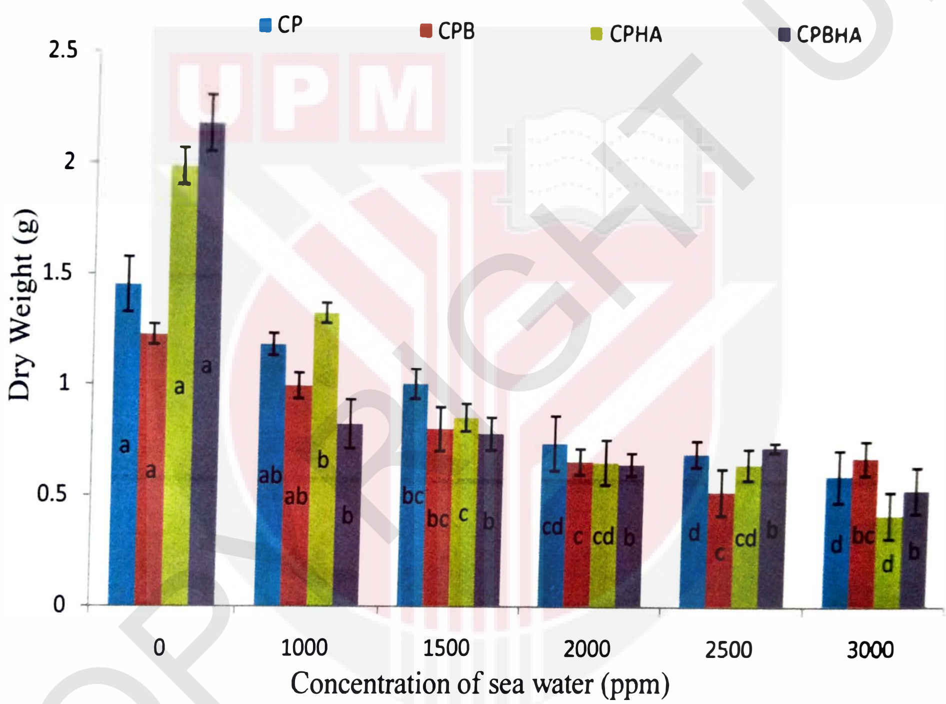

Figure 4.3 Effect of concentration and planting media on root biomass. Different alphabets on bars indicate significance difference between means at P≤0.05 Duncan's New Multiple Range Test (DNMRT)

4.2 Brix Level in Fresh Fruit

Brix level of the melon fruit that was measured using refractometer showed that there is no significant different for the sucrose level in Medium 1, 2, 3 and 4 (Figure 4.4).

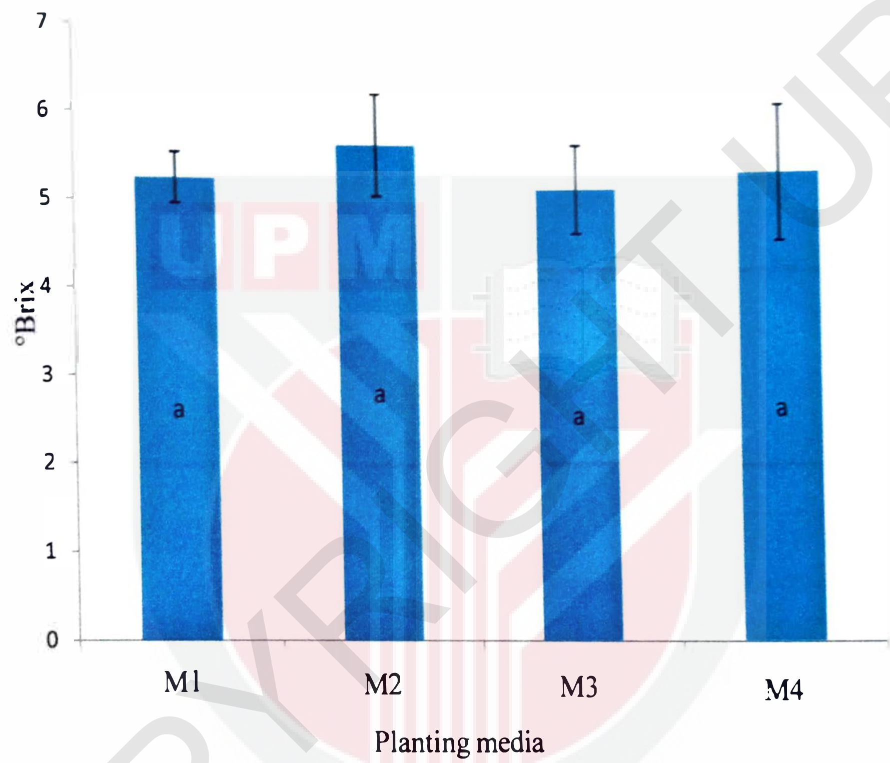

Figure 4.4 Effect of planting media on brix level in fresh fruit. Same alphabets on bar indicate there is no significance difference between means at P≤0.05 Duncan's New Multiple Range Test (DNMRT)

The various concentration of sea water used as a sub-factor with the medium on the melon indicate that, concentration 1, 2, and 3 have the same effect on the brix level of melon fruit but statistically different from concentration 4, 5, and 6. For the concentration 4 and 5, they have same effect on the brix level but are statistically different from concentration 6 which shows the highest effect on the brix level of the melon (Figure 4.5).

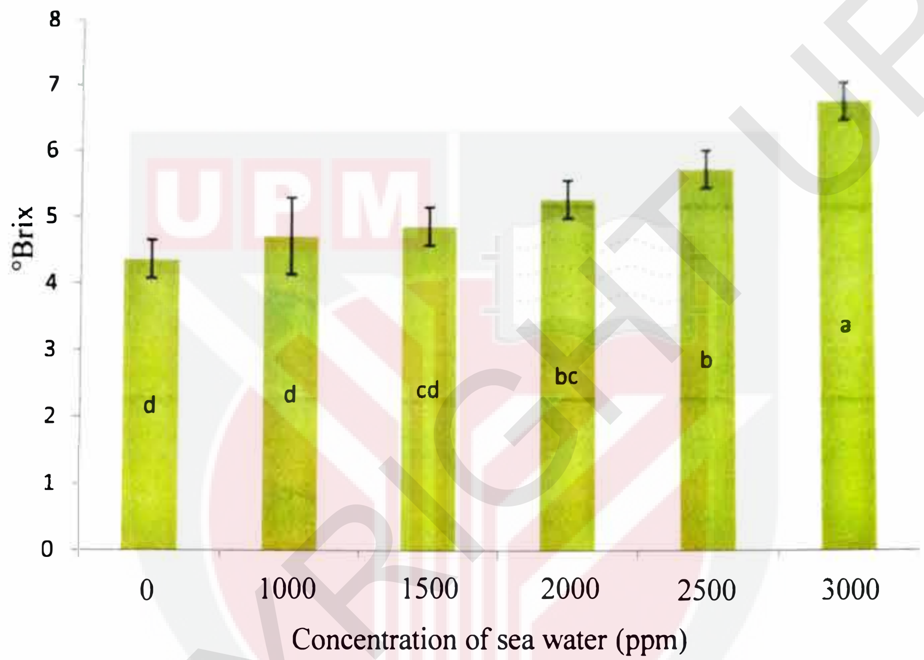

Figure 4.5 Effect of concentration on brix level in fresh fruit. Different alphabets on bars indicate significance difference between means at P≤0.05 Duncan's New Multiple Range Test (DNMRT)

The results in Figure 4.6 indicates that, there was interaction effect of medium and the concentration on the brix level. The effect of concentration 6 with the mediums were statistically different from the rest of concentration except concentration 5. The effect of concentration 1, 2, and 3 on medium 1, 2, 3, and 4 are not statistically different from each other (Figure 4.6).

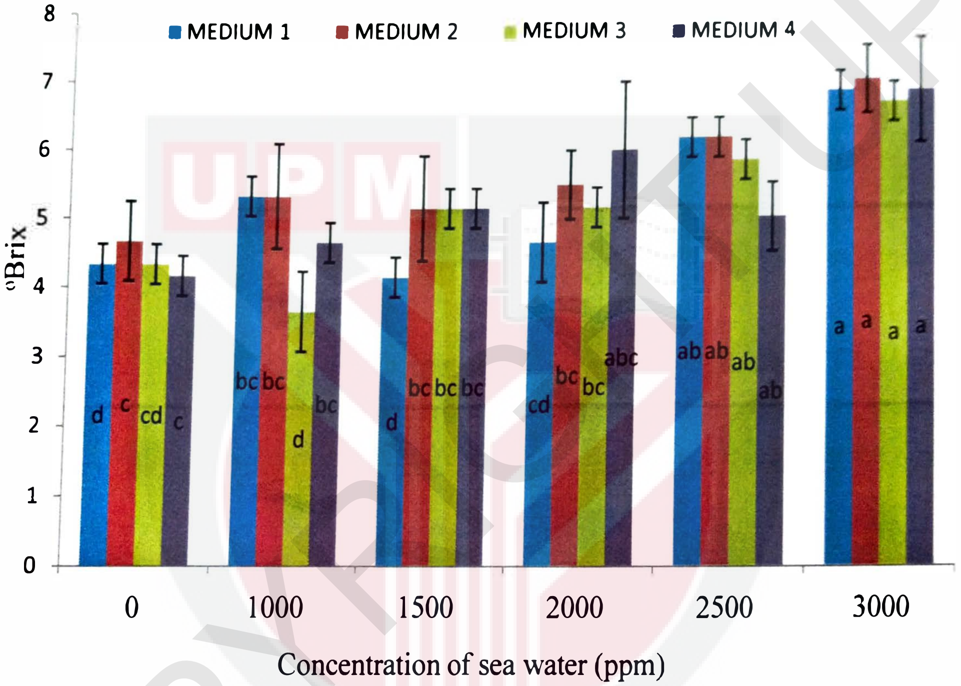

Figure 4.6 Effect of concentration and planting media on brix level in fresh fruit. Different alphabets on bars indicate significance difference between means at P≤0.05 Duncan's New Multiple Range Test (DNMRT)

4.3 Fruit Weight

The results of the main factor (Figure 4.7) of the first parameter after statistical analysis indicate that, the mediums have no effect on the weight of the Rock Melon fruit.

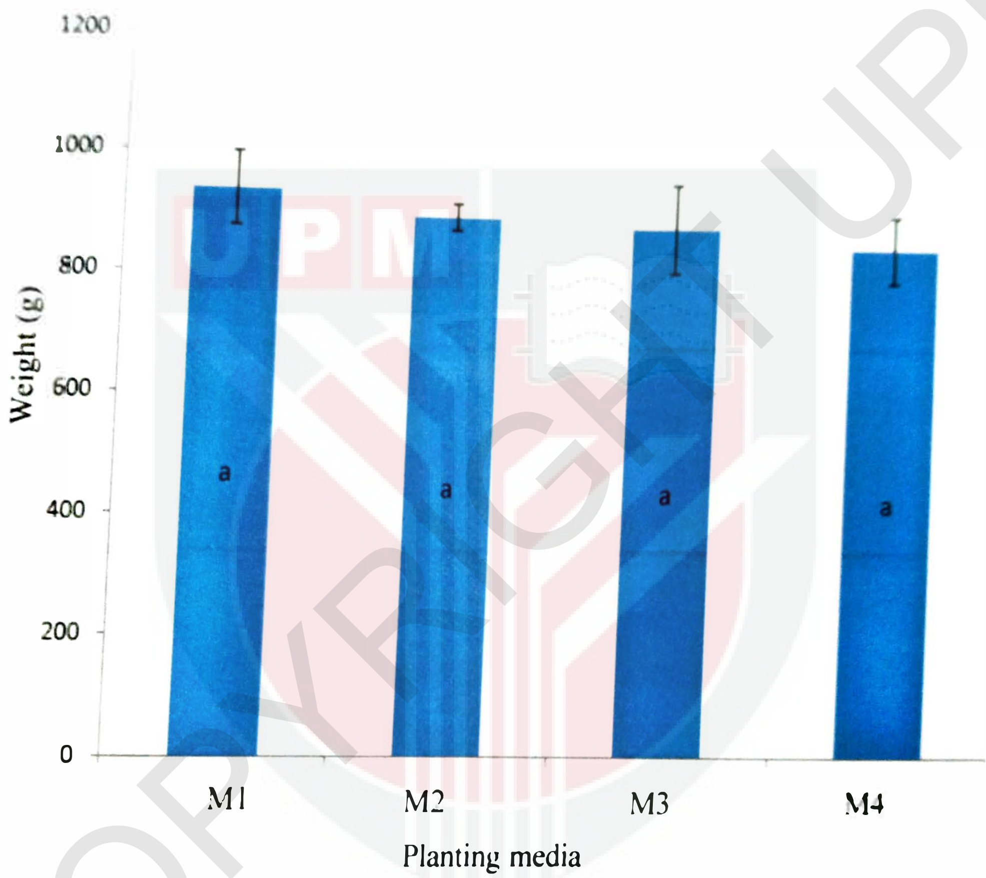

Figure 4.7 Effect of planting media on fruit weight. Same alphabets on bar indicate there is no significance difference between means at $P \leq 0.05$ Duncan's New Multiple Range Test (DNMRT)

The various concentration of sea water used as a sub-factor with the medium on the melon indicate that there is significant different for the weight of Rock Melon for the concentration 1, 2, 3, 4, 5 and 6 (Figure 4.8).

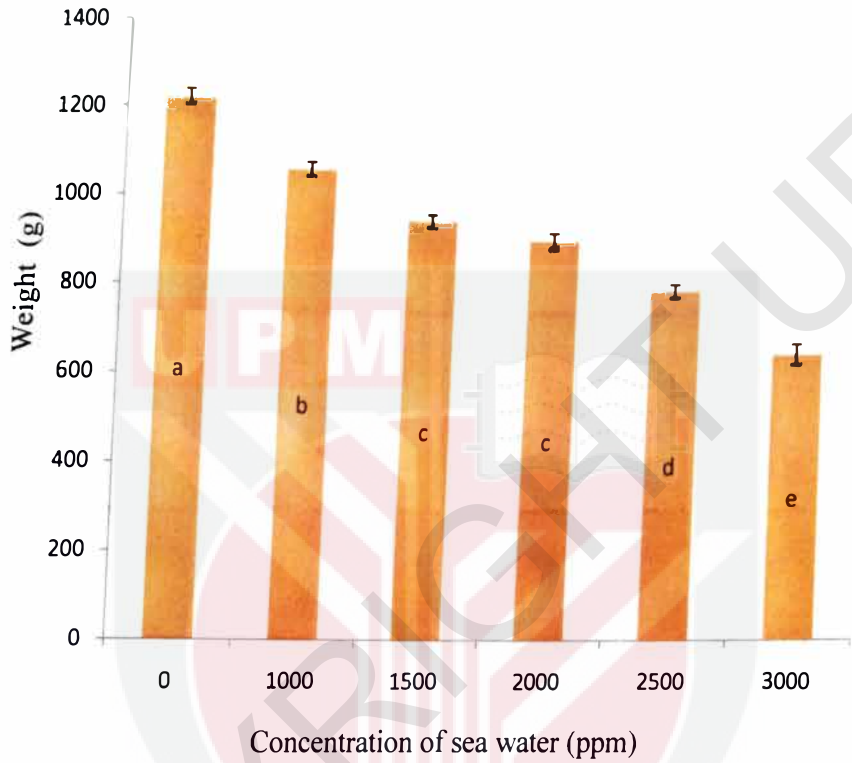

Figure 4.8 Effect of concentration on fruit weight. Different alphabets on bars indicate significance difference between means at P≤0.05 Duncan's New Multiple Range Test (DNMRT)

The results in Figure 4.9 indicates that, there was interaction effect of medium and the concentration on the brix level. The effect of concentration 6 with the mediums were statistically different from the rest of concentration except concentration 5. The effect of concentration 1, 2, and 3 on medium 1, 2, 3, and 4 are not statistically different from each other (Figure 4.9).

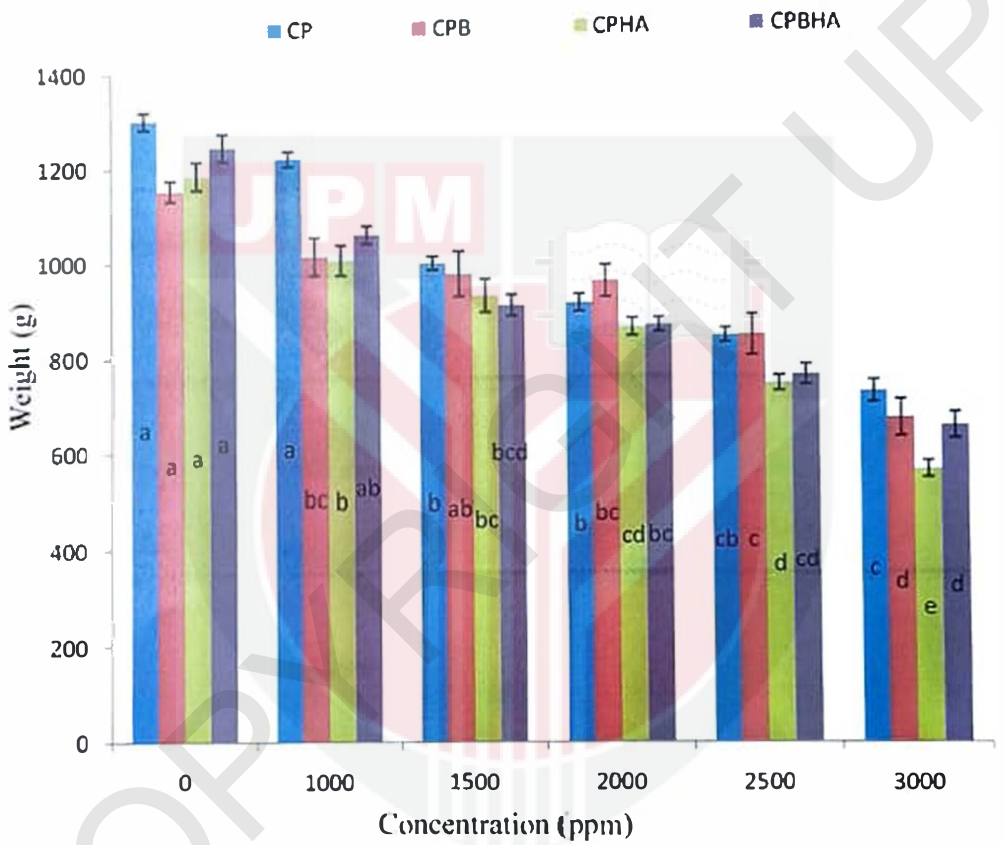

Figure 4.9 Effect of concentration and planting media on fruit weight. Different alphabets on bars indicate significance difference between means at P≤0.05 Duncan's New Multiple Range Test (DNMRT)

4.4 Mineral Uptake in Fruit

4.4.1 K and Ca Level in Rock Melon Fruit

From the result obtained, it showed that there was significant different in K and Ca level for each medium in different concentration of sea water. For the coco peat (CP), 0 ppm of sea water showed the highest value of K (48000 mg/kg) followed by 1000 ppm (46918 mg/kg), 1500 ppm (42478 mg/kg), 2000 ppm (38973 mg/kg) and 2500 ppm (34986 mg/kg). The lowest level of K in the fruit for coco peat was in 3000 ppm (28053 mg/kg). Ca level also decreased as the concentration of sea water increased. For the coco peat media, 0 ppm of sea water showed the highest value of Ca (6241 mg/kg) followed by 1000 ppm (6089 mg/kg), 1500 ppm (5411 mg/kg), 2000 ppm (4984 mg/kg), 2500 ppm (4412 mg/kg) and the lowest was 3000 ppm (3991 mg/kg). Others media which is CPB, CPHA, and CPBHA also showed the same trend which was decreasing in level of K and Ca as the concentration of the sea water used increased. The accumulation of potassium and calcium (mg/kg) in Rock Melon fruits under different salinity level was shown on Table 4.1.

Table 4.1 Accumulation of potassium and calcium (mg/kg) in Rock Melon fruits under different salinity level

Minerals		**K**				**Ca**		
Concentration (ppm)	**CP**	**CPB**	**CPHA**	**CPBHA**	**CP**	**CPB**	**CPHA**	**CPBHA**
0	4800[f]	48126[f]	47895[f]	48121[f]	6421[f]	6482[f]	6510[f]	6494[f]
1000	4691[e]	4721[e]	46552[e]	46846[e]	608[e]	623[e]	6097[e]	6103[e]
1500	4247[d]	4633[d]	42342[d]	43172[d]	541[d]	551[d]	5432[d]	5531[d]
2000	3897[c]	4224[c]	39654[c]	40116[c]	489[c]	503[c]	4976[c]	5126[c]
2500	3498[b]	3976[b]	3542[b]	38654[b]	441[b]	452[b]	4423[b]	4435[b]
3000	2805[a]	3698[a]	29341[a]	33497[a]	3991[a]	4007[a]	3996[a]	4021[a]

*means with different alphabets within same column are significantly different at P≤0.05 (Duncan's New Multiple Range Test (DNMRT).

CP = 100% Coco peat
CPB = Coco peat + Biochar (3:1)
CPHA = 100% Coco peat + Humic Acid
CPBHA = Coco peat + Biochar (3:1) + Humic Acid

4.4.2 Mg and Na Level in Rock Melon Fruit

Besides that, the results also showed that there was significant different in Mg and Na level for each medium in different concentration of sea water. For the coco peat (CP), 0 ppm of sea water showed the highest value of Mg (4177 mg/kg) followed by 1000 ppm (3615 mg/kg), 1500 ppm (3089 mg/kg), 2000 ppm (2447 mg/kg) and 2500 ppm (2089 mg/kg). The lowest level of Mg in the fruit for coco peat was in 3000 ppm (1672 mg/kg). Na level increased as the concentration of sea water increased. For the coco peat media, 0 ppm of sea water showed the lowest value of Na (2371 mg/kg) were increasing followed by 1000 ppm (2809 mg/kg), 1500 ppm (3204 mg/kg), 2000 ppm (3701 mg/kg), 2500 ppm (4068 mg/kg) and the highest was 3000 ppm (4457 mg/kg). Others media which is CPB, CPHA, and CPBHA also showed the same trend which was decreasing in level of Mg and increasing level of Na as the concentration of the sea water used increased. Data of accumulation of magnesium and sodium (mg/kg) in Rock Melon fruit under different salinity level was shown on Table 4.2.

Table 4.2 Accumulation of magnesium and sodium (mg/kg) in Rock Melon fruit under different salinity level

Minerals	Mg				Na			
Concentration (ppm)	CP	CPB	CPHA	CPBHA	CP	CPB	CPHA	CPBHA
0	4177[f]	4213f	4489[f]	4121[f]	2371[f]	2349[f]	2297[f]	2343[f]
1000	3615[e]	3721[e]	3855[e]	3646[e]	2809[e]	2786[e]	2683[e]	2847[e]
1500	3089[d]	3201[d]	3323[d]	3372[d]	3204[d]	3084[d]	3054[d]	3261[d]
2000	2447[c]	2524[c]	2965[c]	3016[c]	3701[c]	3532[c]	3489[c]	3698[c]
2500	2089[b]	2043[b]	2548[b]	2264[b]	4068[b]	4051[b]	4026[b]	4092[b]
3000	1672[a]	1573[a]	1941[a]	1947[a]	4457[a]	4412[a]	4513[a]	4486[a]

*means with different alphabets within same column are significantly different at P≤0.05 (Duncan's New Multiple Range Test (DNMRT).

CP = 100% Coco peat
CPB = Coco peat + Biochar (3:1)
CPHA = 100% Coco peat + Humic Acid
CPBHA = Coco peat + Biochar (3:1) + Humic Acid

CHAPTER 5

DISCUSSION

5.1 Fruit Weight

The decline in fruit fresh weight is consistent with results reported by various authors in similar experiments. For the result in this experiment, the decline in fruit fresh weight is not significantly different compared to previous report but it still showed that the weight of the fresh fruits were affected by salinity. The different is not significant due to the level of sea water concentration used in this experiment is low which is the highest value is 3000 ppm. Mavrogianopoulos *et al.* (1999) showed that saline water treatment caused a reduction in the total yield of two *Cucumis melo* cultivars decreased mean fruit weight but not the fruit number. Shannon and Francois (1978) also have been reported that yield and fruit weight decreased by increasing salinity. El-Doweny *et al.* (1990) reported that yield, number of fruit per plant and mean of fruit weight were affected by salinity and decreased. Seilsepour *et al.* (2008) also showed that salinity had negative effects on number of fruits in plant and average weight of fruit. Their results showed that mean of fruit weight is the best criteria for salt tolerance in muskmelon.

5.2 Brix Level

In this experiment, it showed that there was no significant different for the brix level between the different type of media but for the different concentration of sea water treatment, it shows that the different was significant. Salinity improved fruit quality by increasing the concentrations of sugar content. This had been proved other investigations (Mendlinger and Pasternak 1992a; Shannon and Francois 1978). Gillete (1985) also indicate that NaCl improved the taste of food by enhancing the flavour balance. The accumulation of sugars and other organic compounds in various compartments are an important strategy for the plant to cope with osmotic challenges posed by drought or salt stresses (Serrano *et al.* 1999; Zhu 2001). Yin *et al.* (2009) showed that salinity stress enhanced carbohydrate accumulation as starch during the early development stages and it is responsible for the increase in soluble sugars in ripe fruit. Ullah *et al.* (1993) also found that salinity increased the contents of sugars and acids (ascorbic and citric acid) of the tomato fruits thus improved the fruit quality.

5.3 Root Biomass

The decline in root biomass is consistent with results reported by various authors in similar experiments. Neumann (1997) found that the hardening of the cell wall in the elongating root tips is an important component of root growth inhibition induced by the salinity. The plant length, shoot and root dry weight of watermelon plants significantly decreased as salinity stress increased (Yetisir and Uygur 2010). The decreased in root biomass also caused by the decreased of water potential. According to Sharp *et al.* 2002, root elongation rate decreased and root diameters were reduced in maize plant exposed to low water potential.

5.4 Minerals Uptake by Rock Melon Fruit

Salinity stress disturbs the uptake and accumulation of essential nutrients (Shannon and Grive 1999). Ca^{2+}, K^{+} and Mg contain in Rock Melon fruit decreased with increased salinity levels (0 to 3000 ppm). Essa (2002) showed that the main response of the plant to salt stress is a change in Ca^{2+} homeotasis and attributed that the salt tolerance of plants is their ability to avoid Na^{+} toxicity and to maintained Ca^{2+} and K^{+} concentrations. According to Loneva (1988), increase in Na+ contents, decrease in K^{+} contents and K^{+}/Na^{+} ratios in the plant can be related to the effect of competition between Na^{+} and K^{+} ions on the absorptive sites of the plant roots. Jindal *et al.* (1976) found that Na reduced the uptake of Mg and caused deficiency in fruits and leaves of salinized plants. Mg salts were found to reduce root growth more than Na salts (Marcar and Termaat 1990) and the effect was associated with low concentration of calcium in the root. At a high concentration, Na+ replaced Ca^{2+} from the plasma membrane and caused change in plasma membrane permeability. Na^{+} and Cl^{-} ions can enter the cells and have direct toxic effect on the cell membranes. These primary effects causes some secondary effect like reduced cell expansion and assimilate production (Hasegawa *et al.* 2000). As a result, in extreme cases, the plants could die causes by the salt stress. This study confirms previous reports which suggested that salt stress reduced the root biomass of *Cucumis melo* (Kaya *et al.* 2007).

CHAPTER 6

CONCLUSION

For the conclusion, results of the present study showed that there was no significant different between the various medium used but significant different in fruit weight, root biomass and the sugar content of the fruits due to the different concentrations of the sea water used. The different concentration decreased the fruits size, mineral uptake and the root biomass, but increased the sugar content as the concentration increased. Thus this study revealed that sea water has the potential to be used in fertigation system and should be balance with nitrogen source or good organic growth medium.

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PUBLICATION OF THE PROJECT UNDERTAKING

This is to certify that I have no objection to publish the project entitled "Potential of Using Sea Water in Fertigation System for Rock Melon Cultivation" by the supervisor in a joint authorship. However, it has to be evaluated by the Faculty of Agriculture and Food Sciences, Universiti Putra Malaysia Bintulu Sarawak Campus and published in the form approved by the Faculty.

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Muhammad Haziq Bin Azmi

Date: