Journal of Agriculture and Environmental Sciences
December 2014, Vol. 3, No. 4, pp. 131-149
ISSN: 2334-2404 (Print), 2334-2412 (Online)

Published by American Research Institute for Policy Development
DOI: 10.15640/jaes.v3n4a10
URL: http://dx.doi.org/10.15640/jaes.v3n4a10

Development of Treated Rice Husk as an Alternative Substrate Medium in Cucumber Soilless Culture

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Abstract

The performance and suitability of different substrates for the soilless culture of cucumber plants (*Cucumis sativus* L. cv.Bringy) were studied over a two growing seasons under greenhouse condition employing five different substrates [V:V, 3treated rice husk by composting (TRH): 1 biochar(B) derived from pyrolysis of rice husk, 3 TRH: 1 coir dust (CD), 3TRH: 1 Hundzsoil (HS), 3TRH: 1 fine sand and TRH only]. The results showed that there were significantly differences in fruit yield and growth parameters between the substrates. Media containing 3TRH: 1B led to a significant increase in fruit yield and most of physiochemical characteristics and growth parameters of cucumber plant as compared with the other growth media. It was concluded that the medium containing treated rice husk and Biochar had the best performance for cucumber plant growth as a local growing media due to the superior of its physiochemical characteristics while keeping stability to continue the growth and fruit production for a long season.

Keywords: hydroponic; greenhouse; biochar; hundzsoil; cucumber

Introduction

Increasing difficulties with greenhouse vegetable production is often due to soil borne root diseases. Yields can be limited even in the crop after soil sterilization as the disease organisms are persistent in the soil below the depth reached by normal doses of soil sterilants. This situation is common in old greenhouses. The problem can be solved by changing to soilless grown methods which can protect the crops from soil borne diseases. This can be growing in planter bags full of organic or inorganic substrate. The grower also in that case can make rotation with soilless culture and the original soil with almost the same income.

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Rising costs of conventional soil-less media components have led to a search for other suitable alternative growth medium. These alternatives need to be of high quality and comparative in cost. When choosing a soilless medium, it must first be established what is expected of the medium. The most important functions of the growth media are to serve as a reservoir for plant nutrients, hold water for the plants, gas exchange, and provide anchorage for the plant. Other considerations might be freedom from harmful chemicals and pests. A general greenhouse soilless medium usually contains sphagnum peat moss, vermiculite, coco peat and perlite. These components can be expensive to a grower due to fluctuating costs, shipping cost, and local availability of the product. There has been a great deal of research done on replacing these components with various other materials such as pine bark and saw dust (COTTER 1974 and LAICHE et al. 1990), pecan shells, paper mill sludge, soil, egg shells, sand, rice husk and kenaf fiber core (LAICHE , NEWMAN 1994).

Rice husk (RH), a by-product of the rice milling industry, accounts for about 20 % of the whole rice grains (ESA et al. 2013). The annual yield of rice husks in Egypt is about 960,000 ton (one ton of rice paddy produces 200 Kg of husk). However, the amount of rice husk available is far in excess of any local uses, and, thus, has posed disposal problems. Rice husk was chosen to be applied as a precursor material due to its granular structure, insolubility in water, chemical stability, high mechanical strength and its local availability at almost no cost (AWANG et al. 2009). The advantage in the application of this material is that there is no need to regenerate it because of its low production cost. However, the microanalysis of rice husk shows that C (37 %), ash (20 %) and the main constituents of the ash is SiO_2 (94 %). Thus, this raw material can act as a sorbent for nutrients due to its high content from silica (ALY 1992 and TRAN et al. 1999).

LAICHE (1989) stated that the use of composted rice hulls as an organic amendment for container media compared favorably with media consisting of pine bark alone when growing container-grown woody landscape plants. The composted rice hull medium produced the largest plants and highest rating for shoot quality and highest fresh weight for *Ilex crenata* 'Compacta' and *Ilex vomitoria* Straughn's selection (LAICHE 1989)

These results indicated composted rice hulls as a single-component growing medium can be used successfully (LAICHE 1989). FOSTER and GILLIAM (1989) also stated that rice hull compost may be an alternative to peat moss for at least one growing season.

Other studies conducted by LAICHE and NASH (1990) indicated that a good replacement for pine bark may be composted rice hulls in container media. Media consisting of both 50% and 100% composted rice hulls produced plants with growth that compared favorably with 100% pine bark (LAICHE and NASH 1990). Acceptable growth of three azalea cultivars were obtained by amending media containing pine bark with sand or compos ted rice hulls in comparison to peat moss (LAICHE 1990 and AWANG et al. 2009).

Most of the previous research involved the use of RH in its original form and mix it with other imported material (peat moss or coco peat) or local organic matter such as compost. Rice husk functions and advantages based not only on the silica content but also depend on the pore number and volume in addition to the acidic groups such as carbonyl, carboxyl and phenolic functional groups. It is likely that these groups are largely responsible for the reaction with nutrient elements. Hastening of RH decomposition using organic matter will formulate all the functions and advantages mentioned above (LAICHE 1989)

An important aspect of media management is obtaining and maintaining the correct pH for specific plants (HIPP et al. 1985). PITTENGER (1986) reported that the container soils should be slightly acidic (pH of 5.0 to 6.5), low in soluble salts, and have the ability to hold essential nutrients for growth of plants. Optimum availability of nutrients is obtained by maintaining the proper pH in the soil (BONAMINIO 1981). The physical and chemical properties determine the performance of a container medium (PITTENGER 1986). The structure of media affects its physical properties. An ideal soil contains 25% air, 25% water, 5% organic matter, and 45% mineral material (SHUMACK 1978) however greenhouse and nursery media often do not fit this standard. Plant growth is influenced by the physical properties of the soil, which include soil moisture, temperature, and air (MILLER, MAZURACK 1958). Physical characteristics of a medium consist of bulk density, total porosity, and particle size distribution, water holding capacity, air space, and hydraulic conductivity (TILT, BILDERBACK 1987). The portion of the media occupied by air and water is the amount of pore space in media particles (BILDERBACK 1982).

Shape, size, and arrangement of solid particles in a medium decide the characteristics of pores through which water and air must flow (NASH, HEGWOOD, 1978).

TILT, BILDERBACK (1987) reported acceptable air space for propagation media to be from 15 to 45% (by volume). Bulk density influences other physical properties (POKORNY 1984). Recommended bulk density values are 0.35 gcm^{-3} to 1.3 g cm^{-1} (NEAL 1983). Due to higher cost and lower availability of the commercial media, alocal alternative was looked into and rice husk could be a viable replacement for peat moss or coco peat in peat-based media. The objectives of this study were:

1. To determine the effect of rice husk as an organic component of container media on the vegetative growth of cucumber (*Cucumis sativus* L. cv) under drip irrigation system with fertigation technique; and
2. To determine the physiochemical characteristics of the media under study.

Material and Method

Plant and Growth Condition

Two experiments were conducted in spring season of 2012 and 2013; in both experiments cucumber seedlings were transplanted in the first half of February at Al Posaly research station, the Central Laboratory for Agriculture Climate (CLAC), Egypt. This study was done over a period of four months in soilless culture in the greenhouse. Each experiment has five greenhouses (9.5 m X 70 m), one greenhouse for each treatment. Five main substrates were used in this study i.e. Treated Rice Husk (TRH), coir dust (CD), HundzSoil, (HS), Biochar (B) perlite (P), fine sand (S). Each material was sieved to provide a coarse (4 mm to 1 cm), medium (1 mm to 4 mm,), and fine fraction; the fine fraction was discarded. The coarse and medium fractions were combined together to form the media. HundzSoil is a growth media of recycled agricultural material which has a density of 230Kg m^{-3}. It is composed of dry compressed granules that vary in diameter from 1.0 mm to 1.5mm with the same physical characteristics and chemical composition as conventional soil (http://www.hundzsoil.com/about.html#composition). It is imported from USA some Egyptian companies.

Biochar has been prepared by the pyrolysis of the rice husk at 350 oC in absence of Oxygen (Lehmann, Joseph 2009). Treated Rice Husk was prepared by decomposing the fresh RH with fresh farm yard manure in the ratio of one ton of RH to 200 Kg fresh manure and blending carefully every two weeks up till a period of eight months when the color of RH changes to dark brown.

Five different growing media were prepared V: V i.e. (1) 3 TRH: 1 HS, (2) 3 TRH: 1 CP, (3) 3TRH: 1B, (4) 3TRH: 1S and (5) TRH. Each medium was prepared by blending carefully to get homogeneous composite. Some physiochemical properties of each medium are presented in Table 3.

. Composite fertilizer of 3Kg NPK (19:19: 19) was blended carefully per cubic meter of media. Each bag (with four holes for aeration) was filled up with 8 L of growth media. Perlite material was added in the bottom of each bag by 5 cm height as shown in figure 1. Each greenhouse had five rows with each row having 224 bags,the spacing between rows was 80cm and it was 0.5 m between each bag. The bags were soaked for two days till the growth media becomes more stabilized. After the bags were fixed in their place drip irrigation was applied.

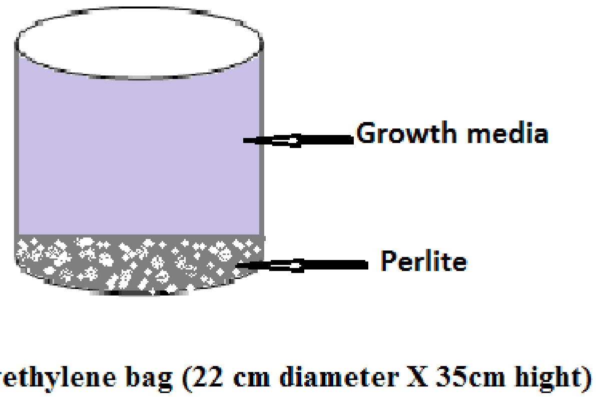

Fig. 1

Cucumber (cv. Bringy) seeds were sown in a box of peat moss with vermiculite and young plants at three leaf stages were transferred in 8 liter plastic bag filled with culture media. One cucumber plant was cultivated per pot. The fertilizer was formulated based on the needs of the plant. All the fertilizer components were water soluble. The fertilizer stocks were prepared according to Yaseer et al. (2011).

The macro and micro nutrients were prepared separately as A and B stock solutions respectively, at 100x dilution. Solution A contained calcium nitrate and iron, while solution B contained all other components. All components were added one by one to ensure that they dissolved completely in the water.

In preparing stock A solution, calcium nitrate was added into the container containing tap water (pH 5.5 – 6.5) and stirred until it dissolved, then the solution was poured into a 100-litre vessel. Iron powder was added into another container that contained tap water, stirred until it dissolved completely, and then added into the vessel. The same procedure was applied in preparing stock B solution. The irrigation solutions were prepared in a 1,500-litre tank. Stock A and stock B were added into the tank at 1:1 ratio until the needed electric conductivity (EC) was achieved. The EC of the fertigation solution was between 1.5 mS cm-1 and 2.5 mS cm-1. The duration of irrigation was 3 min and an identical amount of fertilizer solution was applied to all polyethylene bags. Plants were watered as needed usually every three to four days for the first seven weeks of the study. After seven weeks, it became necessary to water every three days. Plants were fertilized once weekly using the fertilizer as mentioned above. Routine horticultural practices for pest and disease control were followed for fungicide (rizolex) and applied once every 2 weeks.

Physio-chemical characteristics

Some physiochemical characteristics of the culture media including media temperature, air filled porosity (AFP), bulk density (Barua, Barthakur1998), organic carbon (% OC) (Walkley, Black 1934), total porosity (Baruah, Barthakur 1998) and water holding capacity (WHC) (Verdonck, Gabriels 1992), cation exchange capacity (CEC) (RHOADES 1982) were measured. Growth media temperature at 10 -15 cm deep from the above service media was measured with a soil thermometer throughout the season

Growth Parameter

Six cucumber plants were randomly selected from each greenhouse (each treatment) and the measuring growth parameters began 15 days after transplantation

. The fresh yield of cucumber was measured immediately after harvest to prevent desiccation and water loss from the rhizomes. Plant root was separated from the growth media carefully and then both shoot and root mass were dried in a 70 °C oven for 72 hours. Shoot dry weight (SDW) (g plant-1) and root dry weight (g plant-1).

Other growth parameters such as plant length (PL) (cm) and, number of plant internodes and crop growth rate (CGR). Crop growth rate (g plant-1day-1) = W2- W1/ P (t2 – t1); where W1 and W2 are the total plant dry weight at time t1 and t2, respectively and P is the land area.

Root volume (cm3 plant^{-1}), leaves area (cm2 plant-1), stem diameter (mm) as well as yield (kg ha^{-1}) for each harvesting time were determined. Realizing the importance of dry matter accumulation in seedling health and shot dry weight plant – main plant length ratio (DW/PL) as an indication of plant vigour and uniform plant rate. CGR at 15 days intervals was also compared. CGR was computed for different growth intervals for each treatment using the formula of RADFORD (1967). Roots were washed using water free of soil before root measurements. Root volume was determined using measuring flask filled with water. .

Statistical Analysis

Plant growth parameters of cucumber including shoot and root parameters and fruit weight were analyzed under factorial completely randomized design. Analysis of variance and LSD tests were carried out using the CoStat Statistical Package software (CoHort Software, 2002) at $P \leq 0.01$.

3. Results and Discussion

1- Substrate Temperatures

The least difference between maximum and minimum temperatures during the study was for both 3TRH: 1 HS and 3TRH: 1B treatments compared to other media in both seasons (Tables 1, 2). It is known that optimal range of growth media temperature for vegetables growth is within (20-24º C) (JARQUIN et al. 2005), and temperature stress (hot or cold) affects plants grown in soil as well as soilless culture (WOITKE, SCHITZLER 2005). The optimum temperature of the nutrient solution (25º C), significantly increases plant growth due to the increased upward flux of nutrients and water (ECONOMAKOIS, KRULJI 2001). Generally roots in soilless culture are usually exposed daily to large variations in temperature while deep penetrating roots of soil grown plants can escape

Table 1. Temperature of Growth Media (2012)

Growth media	Temperature(°C)		Differences(°C)
	Day	night	(day - night)
3TRH: 1 HS	26.3	22.0	4.3
3TRH:1 CD	27.2	21.5	5.7
3TRH: 1B	26.6	22.4	4.2
3TRH: 1S	27.0	21.2	5.8
TRH	27.8	20.5	7.3
$LSD_{0.05}$			0.09

TRH= Treated rice husk; HS= Hundzsoil; CD= coir dust; B = Biochar; S= sand soil

Table 2: Temperature of Growth Media (2013)

Growth media	Temperature(°C)		Differences(°C)
	Day	night	(day - night)
3TRH: 1 HS	28.5	22.9	5.6
3TRH:1 CD	28.4	22.4	6.0
3TRH: 1B	27.8	23.3	4.5
3TRH: 1S	28.2	22.1	6.1
TRH	29	21.4	7.6
$LSD_{0.05}$			0.10

TRH= Treated rice husk; HS= Hundzsoil; CD= coir dust; B = Biochar; S= sand soil

Extreme hot and cold root temperatures (KAFKAFI 2001). Large differences in day and night temperatures may affect several aspects of plant growth, and yield (HUREWITZ, JANES 1983 and PAPADOPOULOS 1991). Thus maintaining of optimum root temperature is the main factor in plant production under soilless culture conditions, and the least difference of temperature in both 3TRH: 1 HS and 3TRH: 1B substrates in both seasons (4.30º C and 4.2 º C; 5.6 and 4.5 respectively) may reduce the negative effects on vegetative growth and plant yield.

2-Physiochemical Characteristics of Media

The growing substrates under study can differ remarkably in their physiochemical properties. These properties affect the air content and retained volume of available water as well as nutrient retention in the substrate (DUEITT 1994 and (BILDERBACK 1982). These differences need to be taken into consideration when growing greenhouse crops with varying demands for water and oxygen in the root zone of cucumber. There was a great difference in the most physiochemical properties of the studied growing media as shown in Table 3. The water holding capacity, air filled porosity, bulk density and total porosity are vastly different. Bulk densities of media ranged between 0.15 and 0.25 g cm^{-3} depending on the composition. Bulk densities values between 0.1 and 0.3 g cm^{-3} are considered acceptable for hydroponic seedlings and crops (KAMPF et al. 1999). The highest total porosity was recorded with 3TRH: 1 B (78%) followed by 3TRH: 1 HS (70%) substrates, but TRH medium recorded the lowest value of total porosity (59%). Container

Table 3: Some Physiochemical Properties of Culture Media

Growth media	Water holding capacity (% vol.)	Air filled porosity (%)	Bulk density (g cm^{-3})	Total porosity (%)	CEC (Cmol kg^{-1})	OC (%)
3TRH: 1 HS	33	37	0.17	70	108	90
3TRH:1 CD	30	35	0.16	65	98	82
3TRH: 1B	35	43	0.15	78	112	94
3TRH: 1S	24	40	0.25	64	62	68
TRH	23	36	0.19	59	72	74
$LSD_{(0.05)}$	3.0	2.4	0.03	8.2	5.8	2.5

TRH= Treated rice husk; HS= Hundzsoil; CD= coir dust; B = Biochar; S= sand soil

Media should contain 50 to 85% pore space. Total porosity of the media is important, but probably more crucial than this is the portion that is air filled porosity versus water holding capacity. Some plants prefer wet soils while others prefer dry soils. On average, 10 to 30% of the container volume should be composed of air space while 45 to 65% should be water (ALTLAND 2006).

The highest amount of WHC was obtained with 3TRH: 1 HS (39 %). Data in Table 3 showed that also a negative significant relationship was found between air filled porosity and water holding capacity for different substrate under study. There was a trend of decreasing AFP and increasing WHC by adding coir dust and HundzSoil. Bulk density of 3TRH:1S was higher than the other media cultures. But the lowest bulk density (0.15) and highest porosity was related to 3TRH:1B (69%), therefore root media aeration in this treatment was better than the other media. When root media aeration is sufficient , water and nutrient elements supplying for plants is better. The CEC of the culture media varied between 62 and 112 Cmol kg^{-1}. Minimum and maximum values of CEC were related to sand and Biochar content respectively, therefore media contained Biochar had more capacity to supply nutrient elements for plant. High level of organic carbon present in TRH mixed with Biochar helps to maintain a stable soil structure and improves the water-holding capacity of the media compared with other growth media under study. High content of organic carbone reduced the release of ammonia and other toxic substances, and it also helped to retain the soil nutrients and increase the soil with beneficial organisms (CHAN et al. 2008).

Biochar can alter physiochemical properties of the growth media such as structure, pore size distribution and density, with implications for soil aeration, water holding capacity, plant growth, and soil workability. Consequently this may improve substrate water and nutrient retention due to increase the CEC of media (Downie et al. 2009). Biochar may increase and reduce soil bulk density as shown in Table 3 which is desirable for most plant growth (BRADY, WEIL 2002).

Due to increase of total porosity of treatment mixed with Biochar, higher surface area and greater Greater porosity therefore improves soil texture and aggregation, which improves water retention in media. Biochar has a higher sorption affinity for a range of organic and inorganic compounds, and higher nutrient retention ability compared to other forms of soil organic matter (Bucheli, Gustafsson 2003; Allen-King et al. 2002; Kleineidam et al. 2002 and Nguyen et al. 2008).

3-Plant Growth Parameters

Some growing indices of cucumber plant of both seasons are presented in Table 4, 5. Amount of cucumber yield in different culture media had significant difference at 5% level as compared with other treatments.

Highest and lowest amount of fruit yield was related to TRH mixed with Biochar followed by THR mixed with HS treatments respectively in both seasons. Also most of growth parameters such as main stem length, stem diameter, number of plant internodes, shoot dry weight, root-shoot ratio, root volume, root dry weight were related to mixture of TRH with Biochar that had significant differences at 5% level as compared with other treatments. Amount of bulk density, Porosity, OC, WHC and CEC in growth media of 3TRH:1B were at optimum values as compared with other growth media and these physiochemical properties were affected on plant growth indices and fruit yield. Sufficient conditions in the TRH with Biochar media provide good support to water and nutrient elements leading to good growth of plants (OLYMPIOUS 1992 and KUMAR 1999). Results showed that there was no significant different between 3TRH:1HS and 3TRH:1CD media in stem diameter, plant length and number of plant internodes in both seasons, and results showed also there was no significant different between 3TRH:1B and 3TRH:1HS in root volume in both seasons at 5% level of

Table 4. Some Growth Parameters as Affected by the Growth Media (2012)

Growth media	Stem diameter (mm)	Main stem length (cm)	Number plant internodes	Leave area (cm^2 $plant^{-1}$)	Root volume (cm^3 $plant^{-1}$)	Shoot dry weight (g $plant^{-1}$)	Root dry weight (g $plant^{-1}$)	Root shoot ratio	Fruit yield (Kg ha^{-1})
3TRH: 1 HS	11.7	189.9	31.0	6072.6	54.3	360.9	55.5	0.15	56.2
3TRH:1 CD	11.7	190.7	31.4	5918.7	53.5	349.7	47.7	0.13	53.28
3TRH: 1B	11.9	191.3	32.3	6086.6	54.6	370.8	60.5	0.16	67.2
3TRH: 1S	11.5	193.2	30.8	5713.4	50.6	336.0	41.5	0.12	48.96
TRH	10.8	192.1	28.9	4518.8	50.0	320.0	34.0	0.10	39.12
$LSD_{(0.05)}$	0.2	1.5	1.4	18.7	0.8	16.1	5.3	0.02	17.28

TRH= Treated rice husk; HS= Hundzsoil; CD= coir dust; B = Biochar; S= sand soil

Table 5: Some Growth Parameters as Affected by the Growth Media (2013)

Growth media	Stem diameter (mm)	Main stem length (cm)	Number plant internodes	Leave area (cm^2 $plant^{-1}$)	Root volume (cm^3 $plant^{-1}$)	Shoot dry weight (g $plant^{-1}$)	Root dry weight (g $plant^{-1}$)	Root shoot ratio	Fruit yield (Kg ha^{-1})
3TRH: 1 HS	12.0	186.9	32.5	6100.6	56.7	361.9	57.3	0.16	61.44
3TRH:1 CD	12.0	187.7	32.9	5964.7	55.9	350.7	49.5	0.14	56.16
3TRH: 1B	12.2	188.3	33.8	6114.6	57.0	376.8	62.3	0.16	75.84
3TRH: 1S	11.8	183.2	29.8	5741.5	51.7	347.0	43.3	0.12	50.40
TRH	11.1	177.2	27.9	4546.8	47.0	331.0	35.8	0.11	42.96
$LSD_{(0.05)}$	0.2	2.5	1.5	12.6	1.7	11.5	5.2	0.01	15.6

TRH= Treated rice husk; HS= Hundzsoil; CD= coir dust; B = Biochar; S= sand soil

significance as compared with other treatments. The roots of cucumber plant had higher growth in the media with Biochar and HS treatment due to improved porosity and lower bulk density compared with other treatments, thus reducing the root resistance to growth in this cultures media. (ALTLAND 2006 and CHAN et al. 2008) A good growing media would provide sufficient anchorage to the plant, serves as reservoir for nutrients and water, allow oxygen diffusion to the roots and permit gaseous exchange between the roots and atmosphere outside the root substrate (BUNT 1988). As a result of root growth in the substrates with Biochar and HS treatments was higher than other treatments (DOWNIE et al. 2009).

Few researchers have studied the relationship between number of node and cucumber yield i.e. CRAMER, WEHNER (1998) found that there strong relationship between number of nodes and fruit yield in the spring season (WEHNER, CRAMER 1996 and GHEHSAREH 2013). On the other hand, healthy cucumber plant should be more stem thick (CRAMER 1997; GHEHSAREH 2013 and RAHIMI et al. 2013) and this characteristic could be expressed numerically as a ratio of shoot dry weight to the plant height. In the present study, the DW/PL in TRH with Biochar was significantly higher than other growth media under study in both seasons through the growth period (Figures 2, 3). Wang et al., 2004 reported that the higher DW/PL is the indicator of the qualities of substrate as shown in 3TRH:1B treatment. Tillering of cucumber plant after that will be affected by DW/PL which will result in more fruit yield.

According to CLAWSON et al. (1986), CGR measures the accumulation of dry matter per unit area and is a reasonable approximation of canopy photosynthetic rate per unit ground area. Although CGR rose to a maximum for 3TRH :1 B, it started to declined at week 5 for all growth media under study in both seasons (Figures 4,5). Generally, cucumber planted in 3TRH:1B media recorded higher values of CGR than other growth media under study as shown in figures 4& 5.

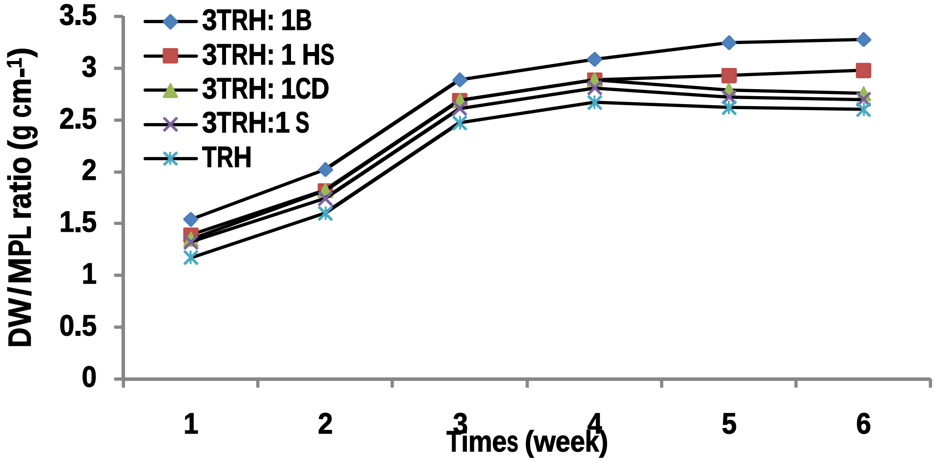

Fig. 2: Dry Weight- Main Plant Length Ratio of Cucumber Plants During the Growing Season of 2012

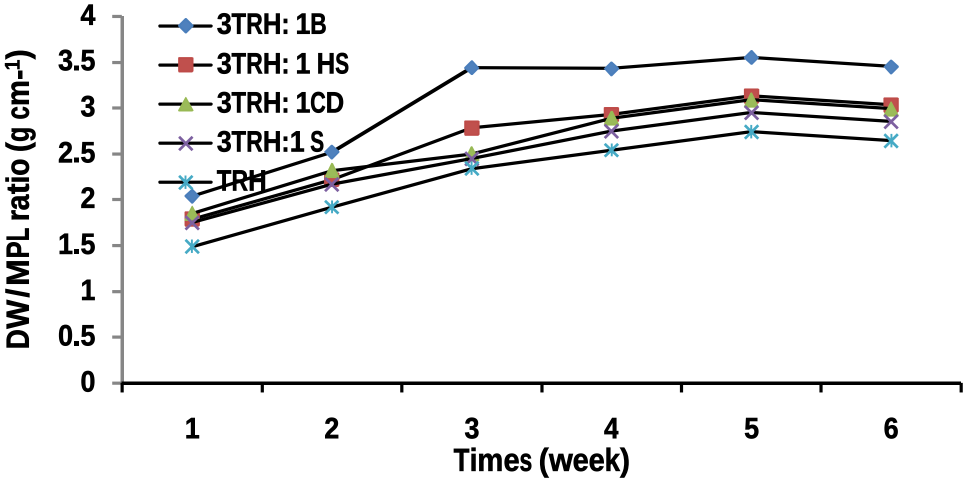

Fig. 3: Dry Weight- Main Plant Length Ratio of Cucumber Plants During the Growing Season of 2013

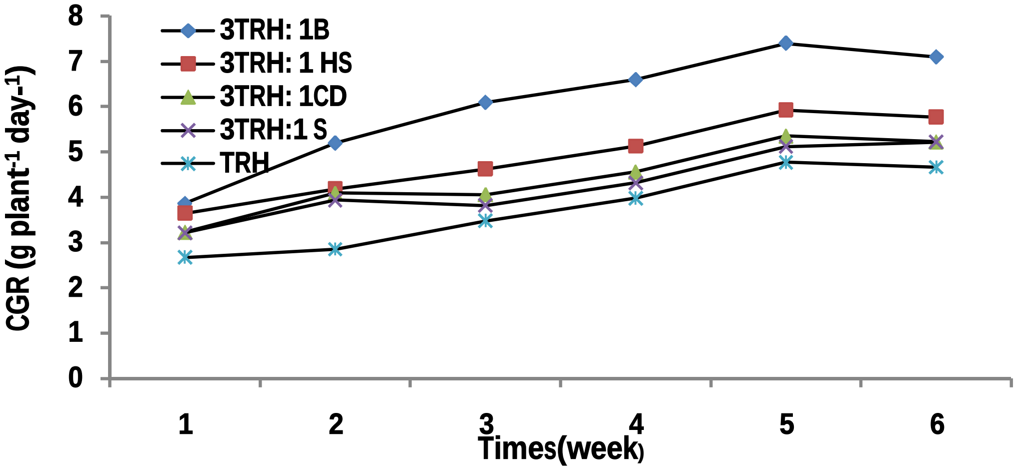

Fig. 4: Crop Growth Rate of Cucumber Plants During the Growing Season of 2012

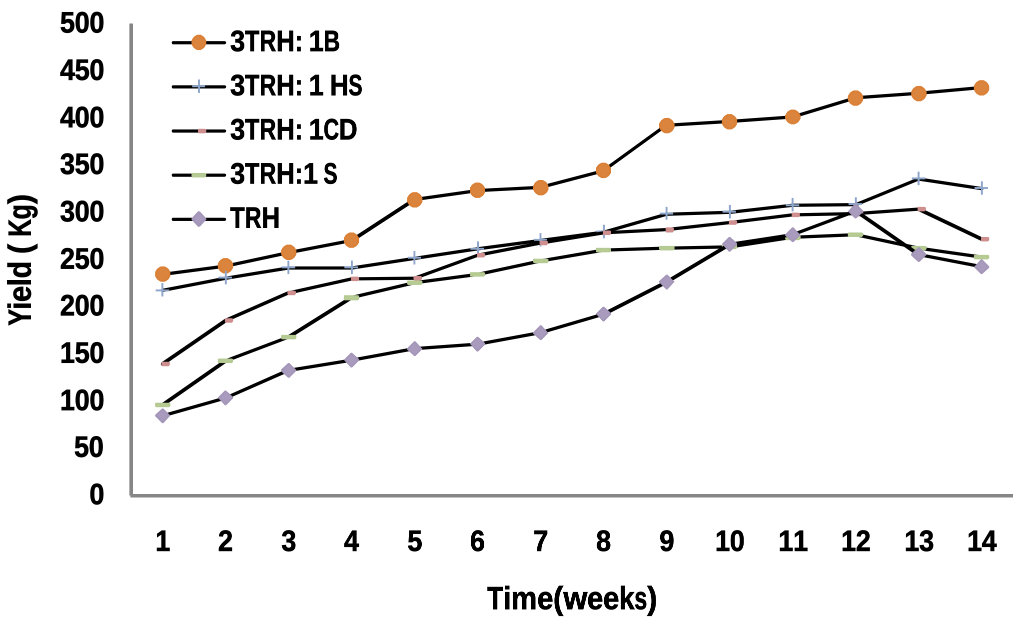

Fig. 5: Crop Growth Rate of Cucumber Plants During the Growing Season of 2013

Results in Figures 6&7 illustrated that media containing TRH and Biochar brought about an increase in mean fruit yield and most growth parameters of cucumber as compared with media consisting of Coir dust, sand and Hundzsoil substrates. The highest accumulated fruit weight in both seasons was obtained with a growth media of 3TRH:1B followed by the media of 3TRH:1HS. Figures 6&7 showed also development of fruit yield throughout the season which was markedly incraesed gradually after 30 and 60 days of transplanting, but after 90 day all growth media under were sharply decreased except the media of TRH with Biochar. This means that the medium's structure have stability for supporting the cucumber plant for long period than other growth media under study. The very good performance of cucumber plants grown on media consisting of 3TRH:1Biochar presumably be attributed to optimum characteristics derived from hasting of treated rice husk and the pyrolysis (Biochar) processing of the rice husk. These materials affect the physical properties, especially the air/water relationships. The aeration porosity, defined by the large pores, under warmer greenhouse conditions where there is increased demand for oxygen by roots, as well as an increased production of carbon dioxide (SPOMER 1979). Accordingly, the superior performance of plants grown on media containing TRH with Biochar as compared to other growth media could be ascribed to their good physiochemical characteristics which rendering the plants able to continue grow and fruit production for a long season.

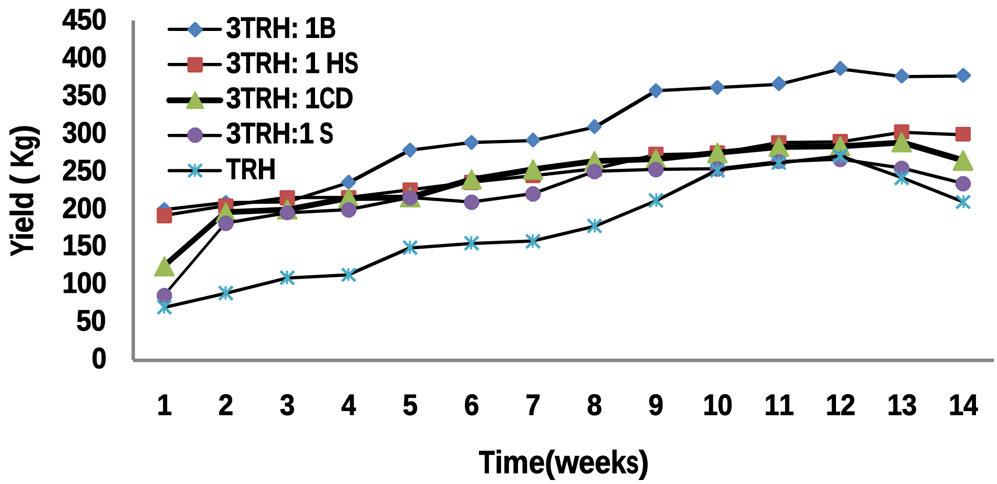

Fig. 6. Fruit Yield Development of Cucumber Plants During the Growing Season of 2012

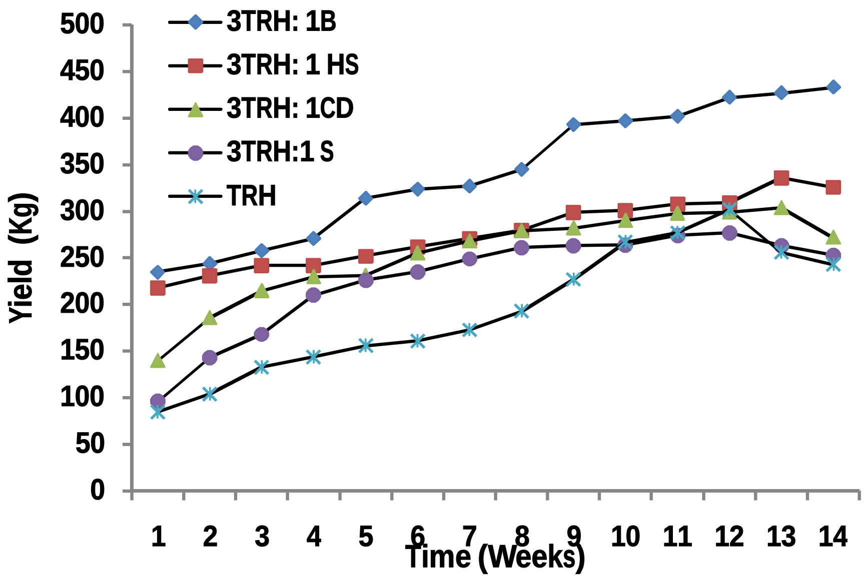

Fig. 7: Fruit Yield Development of Cucumber Plants During the Growing Season of 2013

Conclusion

In conclusion, this study is clearly showed that the 3TRH:1B compared with the other media under study has no inferiority with the growth and yield of cucumber plant. It was found that also there were significant differences in yield and plant growth parameters (including mean fruit weight, shoot and root parameters) with respect to growing media 3TRH:1B, 3TRH:1HS, and TRH: 1 CP. The incorporation of Biochar into treated rice husk brought about a significant increase in plant growth parameters and yield. It was found that also the medium of 3TRH:1B had the excellent performance for cucumber plant growth. With regard to future investigation of rice husk compost mixed with Biochar, it is important to make additional research to study the stability for how many times this media can be cultivated, with the objective of building further confidence in the advantages of this type of growth media.

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