EFFECT OF PARTIALLY BURNT RICE HULL INCORPORATED SOILLESS GROWING MEDIA ON GROWTH AND YIELD OF SALAD CUCUMBER (*Cucumis sativus* cv. Apollo) GROWN UNDER A PROTECTED CULTIVATION SYSTEM

R. M. S. K. Rathnayake[1], H. L. Darshani Weerahewa[1*], R. P. S. S. Rajapakse[2] and H. B. P. Sandani[1]

[1]Department of Botany, The Open University of Sri Lanka, Sri Lanka
[2]United Graduate School of Agricultural Sciences, Kagoshima University, Japan

Salad cucumber (*Cucumis sativus* cv. Apollo) in Sri Lanka are cultivated using soilless methods, preferring cocopeat for drainage. However, cocopeat lacks nutrients and thus requires fertigation. Partially burnt rice hull (PBRH) enhances the media properties and mineral supply. The combination of cocopeat and PBRH, which has the potential to improve cucumber cultivation efficiency and quality, remains underexplored. Therefore, this study investigated the effects of different ratios of cocopeat, sand, and PBRH on the growth, yield, and postharvest quality of salad cucumbers grown in a protected cultivation system. The experiment was conducted in a protected house located at the Open University of Sri Lanka, Nawala, Nugegoda from November 2023 to February 2024. Salad cucumber plants were grown in polybags containing ten different media compositions of PBRH, sand, and cocopeat at various ratios (1:2:1,1:2:0,2:2:1, 2:1:0,1:1:0,1:0:0,0:1:1,1:0:1, and 0:2:1), with four replicates in a completely randomized design (CRD). Growth parameters, including the number of flowers and SPAD index, were measured. Additionally, yield parameters, such as average fruit weight, firmness, length, and circumference, were measured. The mean separation data were analysed using Minitab 19 to determine the significant differences between the treatment groups. The media containing a higher volume of PBRH exhibited the best performance in terms of growth, quality, and yield. The ratios containing cocopeat, PBRH, and sand in the ratio 1:2:1 had a 22.15% higher SPAD index and the 2:2:1 ratio had 33.3% more flowers. There was no significant difference ($P>0.05$) in the average length of cucumbers; however, the mixture of cocopeat:PBRH:sand in a 1:2:1 ratio showed the highest circumference ($P\leq0.05$). The cocopeat:PBRH:Sand 2:2:1 ratio resulted in the highest fruit counts (20-30 Fruits/plant), while the 1:2:1 ratio showed significantly ($P\leq0.05$) higher fruit firmness (8 Nm-2 with peel) than those grown in the 2:0:1 ratio (5.8 Nm^{-2}). Integration of PBRH likely improved media properties, enhancing nutrient availability and water retention, resulting in better growth, higher yields, and increased firmness, thereby advancing sustainable cultivation and food security.

Keywords- Cocopeat, growing media composition, partially burnt rice hulls (PBRH), salad cucumber, soil-less cultivation

[*]Corresponding Author: hlwee@ou.ac.lk

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INTRODUCTION

Food security remains a paramount concern in the agricultural sector of the new millennium. Conventional soil-based crop cultivation faces significant challenges such as land scarcity, pest infestation, chemical interference and soil-borne pathogens. Soil-less agriculture emerges as a promising alternative, offering efficient plant nutrition management and protection against monoculture-related issues. Commercial greenhouse vegetable production has increasingly adopted soilless media to mitigate losses caused by soil-borne infections (Rodriguez et al., 2006).

Cucumis sativus, commonly known as cucumber, holds historical significance as one of the earliest cultivated vegetables, dating back 5,000 years (Eifediyi et al., 2010). In Sri Lanka, the cultivation of salad cucumbers employs both traditional soil-based and soil-less methods, with a growing emphasis on food security and the exploration of alternative cultivation techniques. Soil-less agriculture, owing to its efficient drainage capabilities, presents a promising avenue for cultivation, particularly for cucumbers soilless culture, utilizing inert substrates and nutrient solutions present an intensive and effective approach to greenhouse vegetable production (Rodriguez et al., 2006). In Sri Lanka, growers commonly employ compost, cocopeat and sand for soilless cultivation, facilitating optimal plant growth conditions and minimizing chemical and pest-related risks (Sharkawi et al., 2014). The choice of substrate significantly impacts crop yield and quality with organic substrates like cocopeat favourably influencing tomato fruit yield and quality (Jilani, 2009). Rice hull, a by-product of rice milling, emerges as a valuable substrate for soilless culture due to its microporous nature and nutrient content, particularly silicon (Oshio et al., 1981). Various studies demonstrate the beneficial effects of incorporating rice hulls, either partially burnt or carbonized, into soil media for enhancing crop growth and yield (Weerahewa & Somapala, 2016). Silicon supplementation, derived from rice hulls, improves firmness and quality in strawberries, tomatoes, leeks and pineapple (Munaretto et al., 2018; Weerahewa & Wicramasinghe, 2017).

This study aims to assess the efficiency of different ratios of media mixture including cocopeat, partially burnt rice hull and sand used for soilless cultivation methods in enhancing the growth quality and yield of salad cucumber.

METHODOLOGY

This study was conducted in a protected house with an insect-proof, UV-protected net, located in the Open University of Sri Lanka. Salad cucumber seeds were sown in grow bags ((30cm×12cm×30cm) containing different ratios of coco peat, partially burnt rice hull (PBRH) and sand. Ten different treatments with different ratios (V:V:V) of partially burnt rice hull (PBRH), sand and cocopeat (1:2:1,1:2:0,2:2:1,2:1:0,1:1:0,1:0:0,0:1:1,1:0:1,0:2:1 and 2:0:1) were used for this study. substrates were mixed carefully to get a homogeneous mixture. Seeds were directly planted in grow bags. A drip line irrigation system was used for fertigation. Fertigation was employed at various stages of plant growth based on the recommended dosage by the Department of Agriculture reference. Growth parameters (leaves SPAD index and number of flowers) and yield parameters (including fruit weight, fruit firmness, fruit circumference and fruit length) were measured. Treatments were arranged in a

completely randomized design (CRD) with four replicates and the mean separation data were analysed using (ANOVA) Minitab® 19 to determine significant differences between treatment groups.

RESULTS AND DISCUSSION

Number of flowers

Based on the flower count, the cocopeat: sand: PBRH 1:2:0 ratio yielded the highest number of blooms (160 flowers per growth season). In contrast, the plants grown in cocopeat: PBRH: sand 1:2:1 ratio resulted in the least number of flowers (100 flowers per growth season). Flowers are crucial for attracting pollen to plants, which is essential for seed production and plant reproduction. Kumari et al. (2023) indicated that silicon sources can influence and enhance flowering. Partially burnt rice hull (PBRH) is a good source of silicon and may contribute to the increased number of flowers. However, some related research suggests that rice hull substrates do not show a significant difference in flowering for Petunia and sunflowers in soil-less agricultural practices (Boldt et al., 2018). The influence of PBRH on cucumber plant flowering, however, has not been clearly identified. Based on our flowering data, no significant difference was found between the different growing media treatments. This suggests that other factors, beyond substrate composition, may significantly influence the flowering outcomes for cucumber plants.

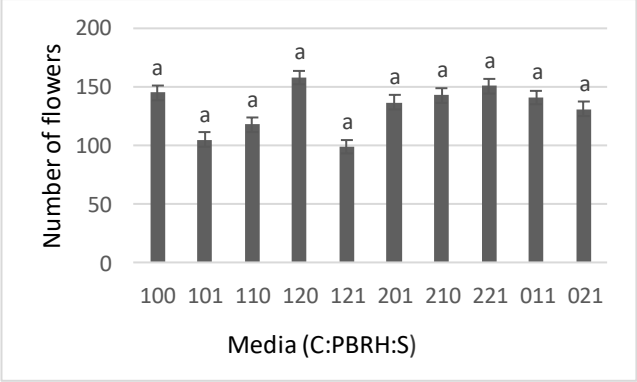

Figure 1. Total number of flowers of salad cucumber grown in different media compositions

SPAD index

Salad cucumber grown in high PBRH incorporated media (cocopeat: PBRH: sand 0:2:1 ratio) exhibited the highest SPAD index. The increase of 22.15% of SPAD value compared to the plants grown in cocopeat: PBRH: sand 1:0:0 ratio. However, no significant difference was observed in both treatments. However, some studies conclude that Si can increase the chlorophyll content. According to Kumari et al. (2023), the chlorophyll content significantly increased in rose plants when silicon was added to cocopeat-based media.

Number of fruits

Salad cucumber grown in PBRH-treated media exhibited a higher number of fruits. The highest yield was obtained from the plants grown in Cocopeat: PBRH: Sand 2:2:1 and 1:2:0 ratios. There were no significant effects of PBRH-treated and untreated media on fruit yield. When plants have sufficient nutrients, it is possible to achieve high yield. Additionally, silicon has been proven to improve the photosynthetic activities in plants, resulting in increased crop yield(Chan-In *et al.*, 2023). According

to (Li *et al.*, 2024), similar studies show that the application of biochar from rice hulls did not significantly impact the fruit number, vegetative growth or fruit yield in greenhouse tomatoes.

Fruit circumference and fruit length

The fruit circumference was highest in plants grown in cocopeat: PBRH: sand 1:2:1 ratio. The increase in fruit circumference is 14%, compared to the PBRH untreated 1:0:0 ratio. However, there was no significant difference in the length of cucumber fruit when PBRH was applied. The highest fruit length was observed in the cocopeat: PBRH: sand 2:0:1 ratio, and the lowest fruit length was observed in the 1:2:1 ratio (P≥0.05).

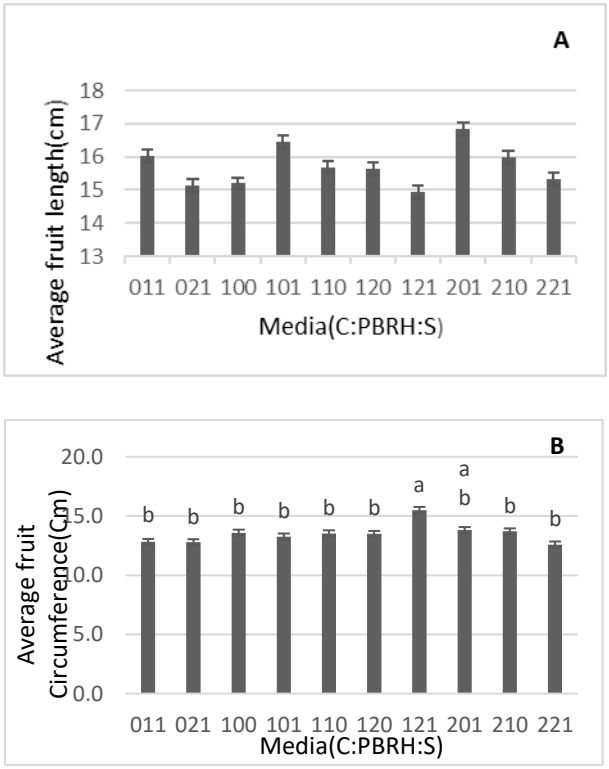

Figure 2A. Effect of different substrate ratios on salad cucumber fruit length. 2B. Effect of different substrate ratios on salad cucumber fruit circumference

Fruit weight

The highest fruit weight was obtained for the plants grown in Cocopeat: PBRH: Sand ratio 1:2:1(202.0 g) and the lowest was obtained from plants grown in Cocopeat: PBRH: Sand ratio 0:2:1(134.4g). While there was a significant difference ($p<0.05$) among the ten treatments, the variation in fruit weights was slight between the PBRH-treated and untreated groups, PBRH serves as a good source of Si (Sharkawi et al., 2014). According to a study by (Chan-In *et al*.,2023), treatments incorporated silicon (Si) have shown a significant increase in both fruit number and fruit quality, including the weight of individual fruits. Specifically, higher doses of PBRH treatments resulted in the highest fruit weights.

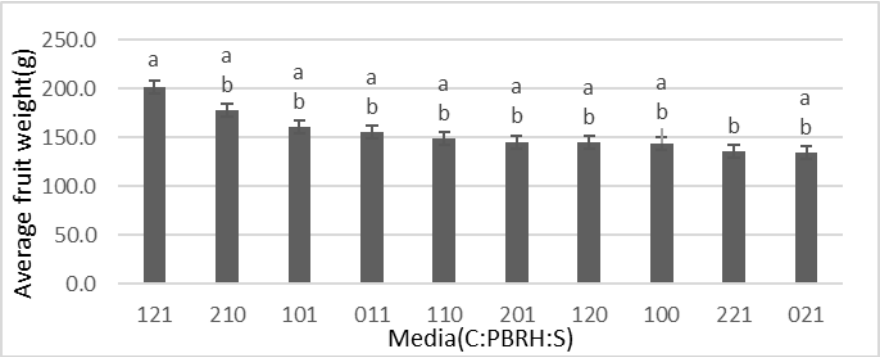

Figure 3. Effect of different substrate ratios on fruit weight

Firmness

The mixture containing cocopeat:PBRH:sand in a 1:2:1 ratio resulted in the highest firmness (8.0 Nm^{-2}). However, the plants grown in a 2:0:1 ratio (cocopeat:PBRH:sand) displayed the lowest firmness of 5.8 Nm^{-2}. This discrepancy in firmness is attributed to silicon (Si) enrichment in the rice hull media. Si leached through PBRH, can deposit under the cuticle of cucumbers (Sharkawi et al., 2014) and in leeks (Weerahewa & Rajapakse, 2020). This Si deposition is believed to enhance firmness and strengthen the cell wall structure of salad cucumber. The study conducted by Emad et al. (2017) also indicated that silicon treatment has increased the firmness of salad cucumber. Figure 4 illustrates the differences in firmness (with peel) in fruits obtained from plants grown in different media compositions.

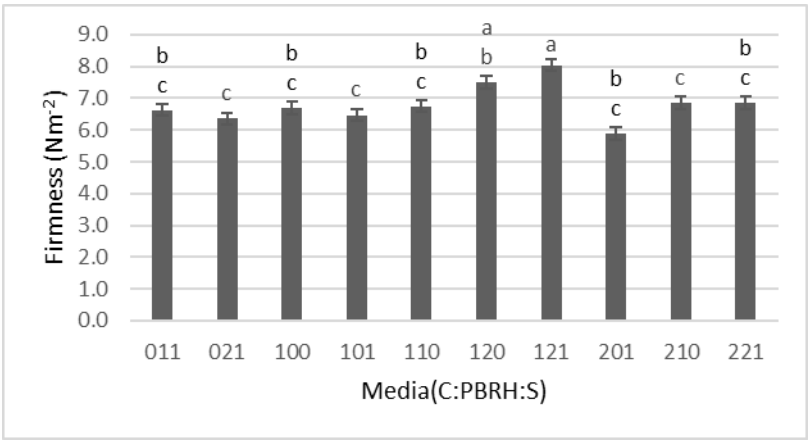

Figure 4. Mean firmness (with peel) difference between different media treatments

CONCLUSION

This study revealed that there is an impact on the growth, yield and firmness of salad cucumbers grown in different media compositions. The salad cucumber grown in media containing higher proportions of partially burnt rice hulls (PBRH) showed higher performance. Plants grown in the cocopeat:PBRH:sand ratio of 1:2:1 demonstrated significant improvements in growth parameters and yield, including enhanced fruit weight, fruit circumference and fruit firmness. Additionally, the 2:2:1 ratio exhibited the highest blooming and yield. Overall, these findings highlighted the potential of PBRH-enriched soil-less media in enhancing the efficiency and quality of salad cucumber production. By promoting sustainable horticultural practices, particularly in protected cultivation systems, this research contributes to advancing food security and agricultural productivity.

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