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THE IMPACT OF RICE HUSK ASH (RHA) AS SOILLESS GROWING MEDIUM ON SAWI CAIXIN GIANT (*Brassica parachinensis*) GROWTH PERFORMANCE

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Abstract:

The Sustainable Development Goal 2 (SDG 2), which aims to end hunger, enhance nutrition, and support sustainable agriculture, places a high priority on food security. The amount of rice husk ash (RHA) produced by the process of burning rice husks has increased over time, causing environmental pollution. In modern soilless agriculture, RHA has a significant potential to be used as a fertile and nutrient-rich medium. The Zero Energy Soilless Agriculture (ZESA) System is a revolutionary concept for horticultural plants that might utilize RHA as a soilless growing medium. The effect of growing medium ratio of cocopeat and RHA on plant growth performance of sawi caixin giant (Brassica Parachinensis) using ZESA system over 35 days was investigated in this study. Three different treatments, T1 (1:0), T2 (1:1), and T3 (3:1), on the growing medium ratio of cocopeat and RHA were carried out. The treatments were set up in four replicates of two individuals each using a randomised full block design. The data of plant Growth parameters such as the number of leaves and plant height were recorded every 7 days, and the fresh weight of the plants was taken on harvesting day. FTIR analysis and an elemental analyzer were used to characterise the chemical analyses of cocopeat, RHA, and fertiliser. As shown by the results, T3 treatment increased all plant growth performance parameters compared to T1 control treatment, with a value of 12.02 cm for plant height, 10 leaves, and 33.75g of fresh weight. The plant growth performance of Brassica parachinensis was improved by using a 3:1 ratio of 25% RHA as a soilless growing medium couple with application of rich nitrogen X and Y fertilisers using the ZESA System. Finally, RHA has the potential to be used as a soilless growing medium for many horticulture plants using the ZESA System.

Keywords:

Soilless Agriculture, ZESA System, Brassica Parachinensis, Sustainable Agriculture, Horticultural Plants

Introduction

According to the prediction of United Nations, the global population is expected to reach 9.7 billion in 2050 and increase further to 11.2 billion by 2100. This rapid population growth, pose to world high demand in food production. To fulfil this needed, agriculture is currently be the dominant channel for food supply (Wang et al., 2022). The increasing global population is related to the issues of decreasing arable land which lead to huge pressure in agriculture production. The worldwide food crisis is worsening, exposing the condition of 113 million people who are in desperate need of food (Adnan & Nordin, 2021). With Asia as the dominant source of population, the global population has grown exponentially to 7.5 billion people. Approximately, 680 million tons of rice is grown yearly which second to wheat for the most produced around the world (Bodie et al., 2019). Therefore, Sustainable Development Goals (SDG) are introduced to fulfil the requirement of world society.

The sustainable development goals are the blueprint to achieve a better and more sustainable for future. Therefore, Malaysia together with other 192 world leaders adopted the 2030 agenda for sustainable development on 25 September 2015. This is a global commitment towards a more sustainable, resilient and inclusive development with 17 sustainable development goals (SDGs). The agenda lays out 17 sustainable development goals (SDGs) to address five critical areas of importance by 2030 which is people, planet, prosperity, peace and partnership. There are goals related towards biomass and agriculture issues; SDG 2 (zero hunger), SDG 13 (climate action) and SDG 15 (life on land).

Goal of zero hunger is the main aim in this study to produce sustainable good quality of foods. The increasing of population is a big challenge to get enough of foods. The limited of farmer's ability to achieved maximum production is the issues to produce good quality product in shorter time (Wongnaa & Awunyo-Vitor, 2018). Therefore, new alternative modern farming method have been studied by many researchers. Zero energy soilless agriculture (ZESA) system is an alternative modern farming in producing sustainable food chain throughout the year.

Land-based biomass that derived from plants is used for fuel, industrial purposes especially in food and feed whereby biomass for food and feed accounted for about 82% due to population growth which threatens food security. Therefore, the application of biochar for food security purposes lead to sustainable agriculture in the long run. Biochar is a form of charcoal with highly stable material, comprised of more than 65% carbon and produced from the biomass through pyrolysis process. Many types of feedstocks are used to produce biochar especially rice husk. Rice husk becomes a popular agro-industrial waste material for production of biochar which is rice husk ash (RHA). This is because RHA has been shown to have a clear effect on

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improving the soil fertility, soil quality, increasing the crop productivity and efficiency as soil amendments.

The aim of this study is to observe the effect of burnt rice husk as soilless amendment and growing medium in sawi caixin giant growth performance using ZESA system. By using this soilless modern agriculture, it can enhance the amount of food supply with high quality, more nutritious and sustainable. In addition, it also can reduce the environment pollution including water and soil due to over use of chemical fertilizers and can contribute to the Sustainable Development Goals (SDG) that ensure zero hunger and having good health among human.

Literature Review
The Hydroponics system as a method for plantation was discussed intensely to observe the plant growth in a soilless medium. Hydroponics has several techniques such as Hygrowpipe. Hygrowpipe process is suitable for short-term plants and self-watering systems.

Modern Farming
In the past decades, the application of chemical fertilizer in agricultural production causes some problems including over use of fertilizer and serious environment issues (Obaid et al., 2022). Therefore, the researcher began to search more about modern farming methods that give more highly healthy food product. Modern soilless plant growth system is one of the modern agricultural technologies where it refers to any method of growing plants without the usage of soil as a growing medium and fertilizer, in which the element of nutrients is absorbed through water (Pode, 2016). The limitation of space is one of the reasons of application of soilless modern agriculture (Tabassum et al., 2021). Nowadays, use of RHA as fertilizer become popular among world's population live in urban areas. This type of biochar is produced by low temperature pyrolysis with several properties such as large specific surface area (SSA), high cation exchange capacity (CEC), high chemical, and rich of functional groups (Jílková & Angst, 2022).

Hydroponic Agriculture
Hydroponics is an efficient method to grow a large number of plants in a water based enriched with nutrients. The performance of plant in terms of quality, taste and nutritive value through hydroponic system is generally higher that conventional method using soil-based cultivation (Jan et. al, 2020). This method is cost effective, disease free, ecofriendly and is gaining popularity all over the world, in both the developed and the developing countries.

Hygrowpipe system is a new hydroponics technique in cultivation technology and is rarely used in the hydroponic system. This technique enables users to do it yourself because most hydroponics instruments are enormous and difficult to install at home. In addition, the Hygrowpipe system is focused on those who live in areas of limited soil for conventional crops such as apartment areas. At the same time, home Hygrowpipe system gardens can be successful in growing flowers and vegetables in their home. Hygrowpipe technique which is ZESA is mainly soilless cultivation has been studied by Kasim et. al (2022).

Soil contains all of the nutrients essential for optimal plant growth. Hence, the soil is usually the most readily available growing medium for plants. However, soils also pose severe limitations for plant growth. The presence of diseases from soil to the plant called soil-borne diseases is caused by organisms and nematodes. Thus, by introducing the ZESA system to

Volume 5 Issue 13 (June 2023) PP. 49-64
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agriculture, soil consumption will be reduced, and plant diseases will be minimized. On the other hand, the cultivated conventional crop growing in soil needs a large space area. Significantly, some places like apartments have limited areas to practice traditional crops because the soil is not available for crop growing. Horticultural plants are the plants which have shorter growth cycle and widely adaptable. It is significantly considered as global food chain for every population in the world. The faster and high production in shorter time gives benefit to agriculture sector particularly to fulfil high demand with increasing population growth (Adebajo, 2022).

Methodology

Biomass Sample
Biomass used in this study was rice husk ash. The RHA was purchased from Dibuk Sdn Bhd. Cocopeat which used as growing medium was purchased from Abi Agro in Kangar, Perlis along with the fertilizer of X and Y compounds brand "Joe Jalil Concepts".

Chemical Analysis
In this study, the sample was analyzed in different chemical analysis which are moisture content, Fourier-Transform Infrared Spectroscopy (FTIR), Ultra-Violet Visible Spectroscopy (UV-Vis) and Elemental analyzer to obtain their characteristics.

Moisture Content
The moisture content of cocopeat and rice husk ash (RHA) was determined by recording the weight before and weight after. Initial weighed of each sample was recorded. Then, the samples were dried in oven at 105 °C overnight. The final weighed of the sample after dried was recorded to determine the percent moisture. The percentage of moisture content was calculated by using formula weight after minus the weight before multiply by 100.

FTIR Analysis
FTIR-ATR Spectroscopy (Perkin Elmer Spectrum) was used in this study to identify the functional groups present in the samples. The cocopeat and rice husk ash (RHA) using the KBr disc method with 1mg of sample in 80mg of KBr. The samples were scanned in the scanning range of 4000 to 600cm^{-1} at a resolution of 4cm^{-1} to illustrate the consistency of the bands detected. The FTIR spectrum provides the structural and compositional information on the functional groups to evaluate different types of compounds present on the surface area of the sample. The functional groups of samples were identified through the absorption of wavelengths of infrared from the sample.

Ultimate Analysis
Ultimate analysis was measured the elemental composition such as C, H, N and S content in cocopeat, RHA, fertilizer X and Y. The weight fraction of C, H, N and S were determined through PerkinElmer 2400 CHNS Analyser. For oxygen content it was calculated by the difference of C, H, N and S from 100.

Experimental Setup
The experiment was performed in nursery at UiTM Cawangan Perlis with coordination of. Crops was exposed to temperature estimated from 27 °C to 31°C in the nursery. For the

International Journal of Innovation and Industrial Revolution
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Volume 5 Issue 13 (June 2023) PP. 49-64
DOI 10.35631/IJIREV.513006
germination process, the seeds were placed in germination area for two weeks before transplanted.

Germination Process Setup
The seed was sown into sowing tray using soil as germinating medium. The seed was placed in each of the holes on the tray. Germination process to ease the process of transplant later. The sowing tray were then place in the propagation area at the nursery and was covered with the plastic to avoid exposure to sunlight. The medium was kept moist by spraying the medium twice daily during the whole germination process.

Preparation of irrigation nutrient solution
The fertilizer solution was prepared by the combination of fertilizer X and Y with electrical conductivity (EC) 1500-1800 µs/cm which suitable reading for vegetable growth performance. A manual irrigation system was schedule 1 times for 3 days. Each pump was connected to a low- density polyethylene (LDPE) pipe then inserted into a polyvinyl chloride (PVC) grow pipe.

Hygrowpipe Set up
The Hygrowpipe technique using ZESA System for observing plant performance was set up in an open system as schematically shown in Figure 1. The effect of SBE on the plant growth performance is obtained using the Hygrowpipe technique.

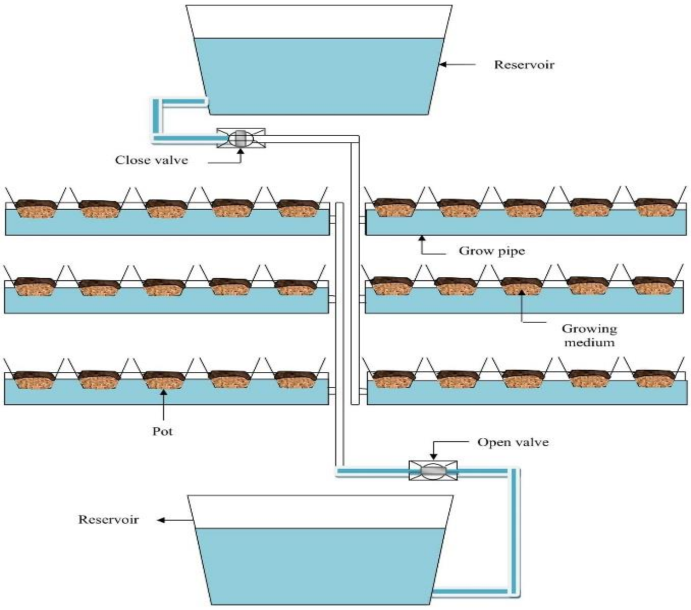

Figure 1: Shows The Schematic Diagram Of The Hygrowpipe Set Up Is Used In This Study To Investigate The Plant Growth Performance

Growth Performance
Sawi caixin giant (*Brassica Parachinensis*) was used in this study for the hygrowpipe technique because of its shorter growth cycle and widely adaptable. Sawi takes about 5-9 days for the seeds to germinate and be transplanted to the pot in the hgrowpipe system for further analysis. The first-time interval is recorded after the plant has been transferred to the pot. The plant growth is observed for 42 days in seven-time intervals, each of which was recorded six times

International Journal of Innovation and Industrial Revolution
IJIREV
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for seven-time intervals. Plant height, number of leaves and fresh weight of sawi after harvest are measured.

Design of Experiment

Design of experiment means designing an experiment for the observation or measurements should be obtained in validly and efficiently way. The experiment was designed correctly, then the data generated is correct and proper analysis of data provides reasonable statistical inferences. Therefore, a completely randomized design (CRD) was used in this study to evaluate the effect of individual and interaction of input parameters on the design. Generally, CRD is the treatments are assigned to experimental units completely at random which every experimental unit has the same chance of receiving any one treatment.

CRD for Hygrowpipe System

The small-scale pot assays of RHA based medium soil-less on plant growth assessment were carried out on sawi. The treatments were arranged in randomized complete block design with four replicates. Total plot used were 4 x 6 = 24 plots. The pot measures were filled up with the treatment to about three-quarters full. A randomized block is designed having three medium soilless treatments which T1 cocopeat alone to act as control, T2 combination of 50% of cocopeat and 50% of rice husk ash (RHA) hence giving ratio of 1:1, and T3 combination of 75% of cocopeat and 25% of rice husk ash (RHA) hence giving ratio 3:1 respectively. There was altogether the ratio for each treatment as shown in Table. Sawi was planted in 4 rows per bed and seeds were planted directly into the medium. Parameters observed are the average number of leaves, the average height of sawi, and the fresh weight of sawi. Harvesting is 42 days after sowing.

Rice husk ash (RHA) was almost containing the entire nutrient for the plant growth. Thus, RHA is containing moderately quantity of NPK compared to the agricultural waste such as cocopeat that require in any medium or fertilizer production. The nutrient was observed based on the three-medium of treatment and commercial fertilizer use in the hygrowpipe technique. The nutrient observed is nitrogen, phosphorus, potassium, organic matter and moisture.

Table 1: List of Treatments

Treatment no.	Cocopeat (%)	RHA (%)
1	100	0
2	50	50
3	75	25

In the hygrowpipe system, twenty-four experiments were required for the CRD. Single-factor analysis of variance (ANOVA) is used to estimate the significance of treatment. The effect of the plant growth performance of each factor on the RHA properties is analyzed from the variance of experimental results using the method of One-way analysis of variance (ANOVA). The optimization use for this design of experiment is statistical package for the social sciences (SPSS). This is because ANOVA method used to estimate the effect of the plant growth performance of each factor. This optimization is a user-friendly software package for the manipulation and statistical analysis of data. The function of this application is to analyze scientific data related with the social science.

International Journal of Innovation and Industrial Revolution IJIREV
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Plot Treatment Design

This study was prepared in randomized block design for plot treatment that consist of ratio cocopeat and RHA which includes three treatments. Each treatment has four replications with two individuals was used. Thus, total of 24 plants were observed with three treatments applied. Figure 2 shows the position of each treatment in the randomized block design.

T1R1I1	T1R2I1	T1R3I1	T1R4I1
T2R1I1	T2R2I1	T2R3I1	T2R4I1
T3R1I1	T3R2I1	T3R3I1	T3R4I1
T1R1I2	T1R2I2	T1R3I2	T1R4I2
T2R1I2	T2R2I2	T2R3I1	T2R4I2
T3R1I2	T3R2I2	T3R3I2	T3R4I2

Figure 2: Randomized Block Design for Each Treatment

Statistical Analysis

Daa were displayed and tabulated in proper form that derived from four replicates. Standard deviation, r^2 value and p value analysis of variance (ANOVA) was done for completely randomized design by using Statistical Package of the Social Science (SPSS) software.

Experimental Set Up

Three PVC pipe, 24 pots, and 48 screws were used to build the hygrowpipe. Ten holes was drilled on one side of the PVC pipe where each of these holes were placed with single pots except for one of them. The hole that did not fit with the pot was used to measure the water level inside the PVC. Its surface then was closed with tape to avoid any contamination and impurities. Each pot was screwed to maintain its placement, and each was labelled according to the treatments, replicate and individual. At the end of the PVC head, a small hole was made to insert a small pipe which connect the PVC pipe with fertilizer container. Once all the components were attached, the three different mediums were placed inside the pots following their label.

Experimental Design

This study used three different treatments: T1 is cocopeat solely which act as a control, T2 with 50% eggshells and 50% cocopeat and T3 with 20% eggshells and 80% cocopeat. Each of this treatment was replicated 4 times and each replication was divided into two individuals.

Plant Growth Performance

The seed of the red spinach was first germinated in the tray with peatmoss medium. After 7 days germination in the propagation area, the plants were moved into the medium treatment under an open area. Performance of the plant growth was measured a day after the plantation in the medium treatment. Heights and number of leaves were observed in each plant. The observation was from 22nd April until 27th May, where the data was recorded every 5 days.

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Results and Disscussion

Moisture Content

From Table 2, shows cocopeat has high moisture content compared to RHA which is 76.68% that able to retain a large amount of water. This is because cocopeat mixture absorb water over time which results in a relatively high wettability of the mixture. Therefore, crop grown on cocopeat medium can be efficiently irrigated using sub-irrigation methods such as such as aggregate hydroponic system. These methods when employed can increase water use efficiency. Excessive water loss in the media during plant growth can be easily remedied. Hence, irreversible drying can be avoided. For RHA, the moisture content obtained are 0.68%. This indicates that the RHA neither able to retain nor absorb water as good as cocopeat. However, RHA has small pores which is good water holding capacity for a longer period of time.

Table 2: Moisture Content of Cocopeat and RHA

Sample	Weight Loss(g)	Moisture Content (%)
Cocopeat	11.5187	76.68
RHA	0.1026	0.68

FTIR Analysis

Agricultural residues commonly contain functional groups as phenol, aldehydes, alcohols, ether, ketones, and carboxyl groups, which can bind pollutants to some extent. As illustrated in Figure 3, the common FTIR spectrum of cocopeat samples at wavelength 3308.83 cm^{-1} indicates caused by surface O-H vibration of bonded hydroxyl groups. The hydroxyl group present in cellulose was reflected in the peak. The peak at 2922.4 cm^{-1} is due to the present of C-H stretch that causes vibrations of CH, CH_2 and CH_3 functional groups. This peak shows the weak band that cause the C-H stretching mode which is reflect the aliphatic nature of cocopeat. The absorption bands at wavelength around 1609.59 cm^{-1} and 1534.3 cm^{-1} shows the characteristic of C=C bonds in aromatic rings. The stretching of C=C in the aromatic compounds reflects the lignin.

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IJIREV
Volume 5 Issue 13 (June 2023) PP. 49-64
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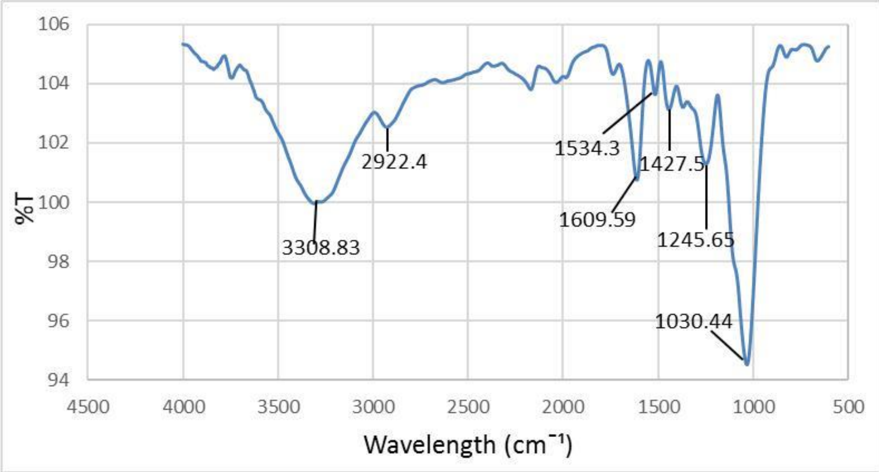

Figure 3: FTIR Spectrum of Cocopeat Sample

Therefore, Krishnapillai et al., (2020) stated that cocopeat has high content of lignin which is can result in immobilization of plant nutrients. For the peak 1245.65 cm^{-1} are recognized as Si-O stretching and bending which indicate the presence of silica. Moreover, the peak at 1030.44 cm^{-1} can be related to the C-N stretch of amine functional group. Based on Lazim & Hadibarata (2015), the peaks present was obvious that cocopeat indicates as adsorbent which displayed the number of adsorption peaks to reduce nutrient leaching and help conserve water.

Figure 4 shows the FTIR spectrum that present rice husk ash (RHA) used in this study. The spectrums indicate that the broad peak at wavelength 3668 cm^{-1} is caused by O-H stretch from alcohol functional groups. However, the broad peak of O-H stretching bands unclearly seen in the spectrum. This is because the strength of the silanol bond is decreasing as the temperature of incineration increased due to dihydroxylation in which the bandwidth is shifted to lower number. The silanol groups (SiO-H) and the HO-H vibration of the absorbed water molecules bound to the silica surface. The surface silanol groups are responsible for physically adsorbing water molecules and hydrogen attaching them to the surface. The weak absorption peak between 2046.9 to 1987.8 cm^{-1} is contributed to the presence of C-H bending for aromatic compound. The strong sharp peak at 1059.71 cm^{-1} is the vibration frequency of the Si-O-Si bond due to the structural siloxane. The peak at 789.83 cm^{-1} was correspond with the symmetric Si-O-Si stretching vibration. This peak at the lower wavenumber due to the higher temperature of incineration of RHA.

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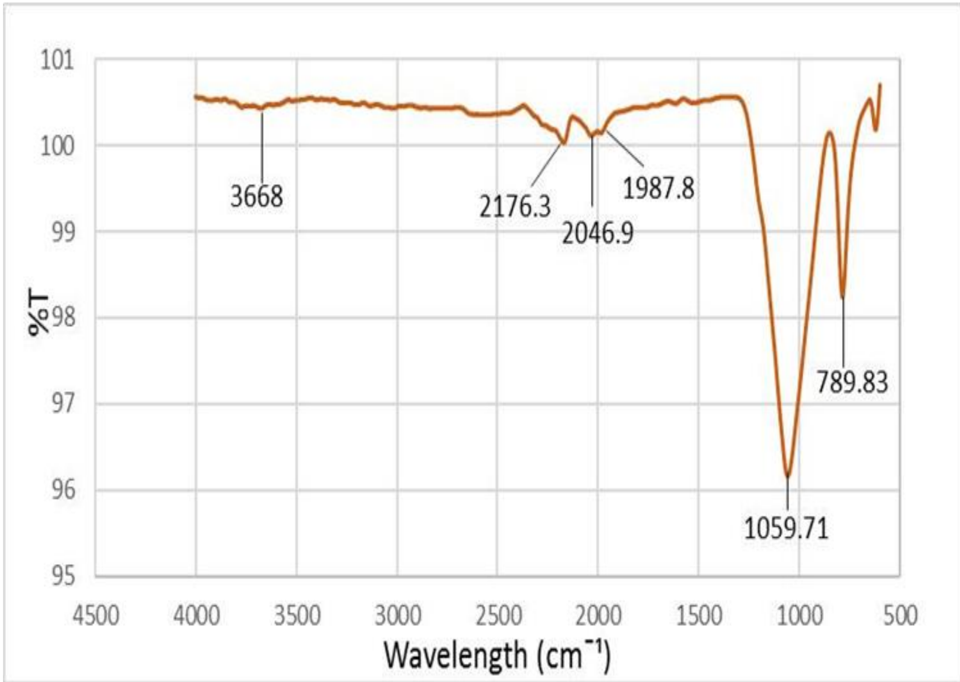

Figure 4: FTIR Spectrum of RHA Sample

Ultimate Analysis

Ultimate analysis is particularly important in evaluating the fertilizer and biomass feedstock as soil amendment for quality control purposes in agronomy. The experimental results of ultimate analysis of cocopeat, rice husk ash (RHA), fertilizer X and fertilizer Y were listed in Table 3. The result revealed that percentage of carbon in cocopeat (42.48%) was higher than RHA (1.7%), fertilizer X (0.64%) and fertilizer Y (1.08%). For oxygen content, it showed that oxygen in RHA (97.26%) was higher compared than cocopeat (46.67%), fertilizer X (69.95%) and fertilizer (63.05%). Other than that, hydrogen content for each sample were approximately 0.10-6.5%. Besides, the percentage of nitrogen for cocopeat and RHA below than 1.5%. Meanwhile, nitrogen content of fertilizer X and Fertilizer Y higher than cocopeat and RHA which are 22.45% and 24.27%. The percentage of sulfur for all samples has low concentration of sulfur at approximately 0-8%. Therefore, growth performance of vegetable is negatively affected.

Table 3: Ultimate Analysis of Cocopeat, RHA, Fertilizer X and Y

Sample	Carbon	Hydrogen	Nitrogen	Sulfur	Oxygen
CP	42.48	6.42	1.46	2.97	46.67
RHA	1.7	0.13	1.01	-0.1	97.26
Fertilizer X	0.64	4.82	22.45	2.14	69.95
Fertilizer Y	1.08	3.97	24.27	7.63	63.05

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Plant Growth Performance

The effect of different treatment on the plant growth performance of sawi caixin giant *(Brassica* Parachinensis*)* was studied following the pots experiment. The number of leaves, height of plant and fresh weight of plant were measured for sawi treated with different treatment. SPSS analysis was performed to determine the statistically significant difference between the treatment used.

Effect of Treatment on Plant Height

The height of plant is observed and based on Figure 5 show that sawi caixin giant planted in T3 grows taller than in T2 and T1. Sawi caixin giant that grown with T3 which the combination of cocopeat and rice husk ash (RHA) had given better performance than other treatment tested. Based on elemental analysis, the cocopeat and RHA contain nitrogen element which are at 1.46% and 1.01%. The presence of nitrogen in cocopeat and RHA improve the growth performance of sawi caixin gaint which results in taller plants. Current study was strongly agreed with the finding of Leghari et al., (2016) which stated that nitrogen is play a key role in agriculture for enhancing of crop yield and produce rapid early growth. The clear difference of the treatments can be seen on 1 and 2 reading at early growth stage.

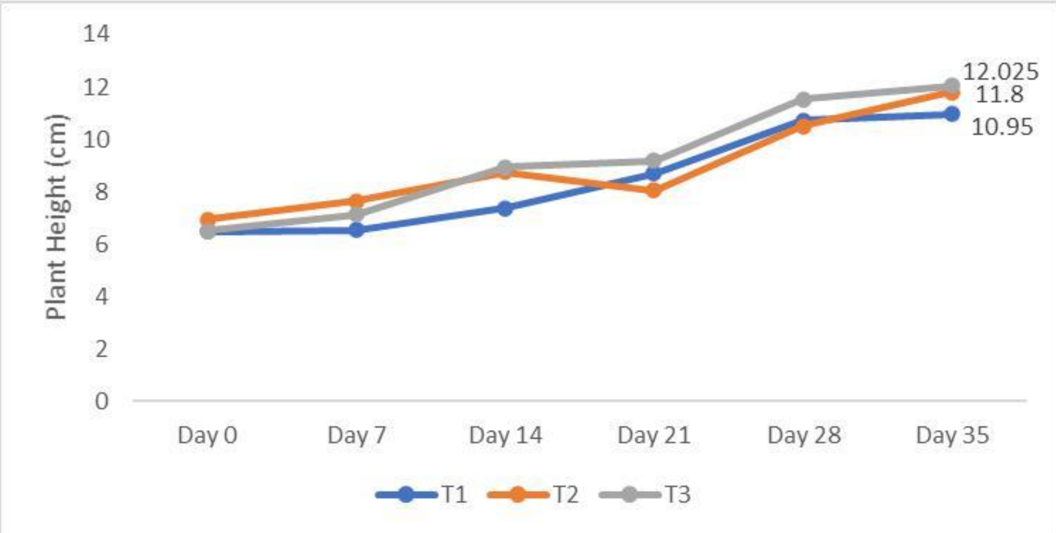

Figure 5: Plant Height (cm) for Different Treatment

T1 shows the shortest height of sawi caixin giant with a height of 10.95 cm with treatment that consist of 100% of cocopeat. This finding clearly demonstrates that high moisture content in cocopeat related to the poor root aeration. According to Krishnapillai et al., (2020), high water retention ability will weaken the air-water connection which resulting in poor medium aeration. This can obstruct oxygen diffusion to the roots, causing the roots to decay since they are unable to absorb oxygen.

T2 treatment with average height of plant 11.80 cm appeared to be in between the tallest and shortest represent by T3 and T1 respectively. The difference in height may be due to the ratio of the medium used which is 1:1 of cocopeat and RHA as compared to T1 which used 100% of cocopeat. This can be proven that the present of RHA influenced the growth of sawi caixin giant as can be seen in the Figure 5.

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Effect of Treatment on Number of Leaves

Figure 6 shows the number of leaves for each treatment with 6 reading measures. From the graph, the number of leaves appeared to be high at 10.125 in the T3 with the ratio 3:1 of cocopeat and rice husk ash (RHA) while T1 and T2 with 9.375 and 9.125, respectively. After 14 days of growing process, T3 was observed increase drastically. Meanwhile, number of leaves of T2 and T1 were decreased. As we can say from the FTIR results in RHA spectrum, it demonstrates that RHA has silanol group which is able to improve photosynthesis process in plant as it can help to mobilize the calcium hydroxide in the soil for the formation of cementitious compounds.

T2 medium treatment demonstrates of the least number of leaves with average of 9.13. Through observation conducted, the 50% of the RHA used in the growing medium resulted in small leaves. Furthermore, the quantity of leaves produced is also influenced by the plants' position. This is because, despite the presence of excess nutrients, if enough sunlight is present, growth improves. During the growing stage, insects, snails and even parasites attacked most of the plant. Many holes were found on the leaves and some lost due to infection. The leaves of the plants appear like they were scorched and the infected leave might infect the foliage around it. Compared to the T1, growth performance of sawi caixin giant displays a result in the middle of the scale with 9.38. The graph reveals that, the reducing percent of cocopeat the number of leaves rate decreases.

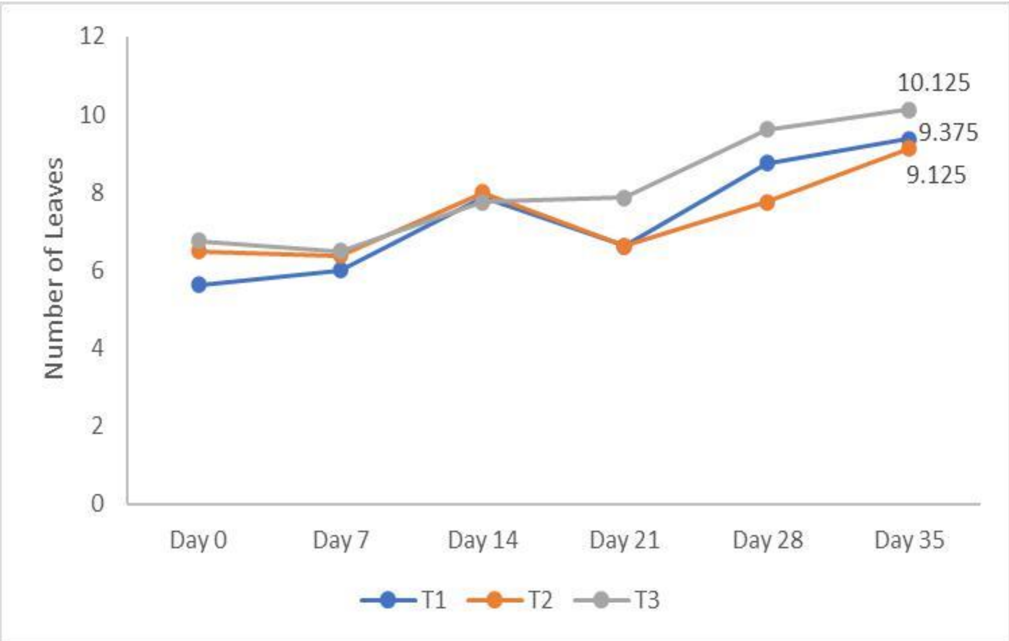

Figure 6: Number of Leaves for Different Treatment

Effect of Treatment on Plant Fresh Weight

The fresh weight of the sawi caixin giant was recorded after harvested. The bar chart in Figure 7 shows the fresh weight of the three treatment which are T1, T2 and T3. It is evident from the chart that T3 has the highest value of fresh weight followed by T1 and T2. The fresh weight for T1, T2 and T3 are 31.13, 32.13 and 33.75g, respectively. The high weight of sawi caixin giant in T3, depicts that addition of RHA in growing medium able to enhance the plant growth performance. However, the fresh weight determination used for plant growth promotion is less

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Volume 5 Issue 13 (June 2023) PP. 49-64
DOI 10.35631/IJIREV.513006
effective compared to the dry weight determination. This is because plant has high water content in plant tissues and the quantity of water in plant depend on the amount of water in its environment. Huang et al., (2017) stated that the fresh weight of plant may be affected by environmental and technical factors such as humidity, temperature, air currents and excess moisture during harvest. Therefore, it is recommended that observation of plant growth performance using dry weight determination rather than fresh weight determination.

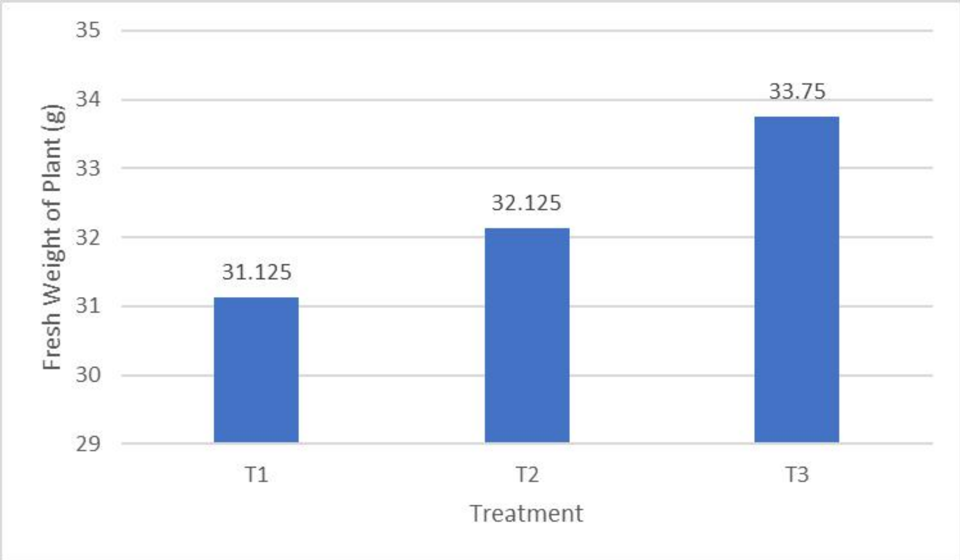

Figure 7: Plant Fresh Weight for Different Treatment

Statistical Analysis

In the results of analysis of variance (ANOVA), height of plants, number of leaves and fresh weight of plant revealed that there were significantly effects for the different treatment. Besides, the mean of the analysis was different to each other. Therefore, the null hypothesis of the three analyses can be rejected. Table 4 shows the p-value obtain for the number of leaves, height of plants and fresh weight of plants. The p-value of the analysis less than alpha significance level 0.05 which are 0.022, 0.017 and 0.025, respectively.

R-squared value is measuring the strength of the relationship between the response and model. The convenient scale of R^2 is in between 0-100%. In R^2, the higher the value, the better fit of the observation data. However, the low value of R^2 can be perfectly good model if the independent variables are significant. This is because statistically significant represent the different of mean in the response. Table 5 illustrated the value of R^2 in the dependent variable of the analysis.

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DOI 10.35631/IJIREV.513006

Table 4: The p-value of Number of Leaves, Height of Plants and Fresh Weight of Plants

		Sum of Squares	df	Mean Square	F	Sig.
Number of Leaves	Between Groups	9.146	2	4.573	4.607	0.022
	Within Groups	20.844	21	0.993		
	Total	29.990	23			
Height of plant	Between Groups	19.273	2	9.637	4.941	0.017
	Within Groups	40.961	21	1.951		
	Total	60.234	23			
Fresh weight of plant	Between Groups	1222.333	2	611.167	4.419	0.025
	Within Groups	2904.625	21	138.315		
	Total	4126.958	23			

Table 5: Model Summary of Number of Leaves, Height of Plants and Fresh Weight of Plants

Model	R^2	R^2 (%)	Adjusted R Square	Std. Error of the Estimate
Number of Leaves	0.169	16.9	0.131	0.777
Height of plants	0.251	25.1	0.217	0.738
Fresh weight of plants	0.211	21.1	0.175	0.758

a. Predictors: (Constant), Number of leaves, Height of plants, Fresh weight of plant

Conclusion

In conclusion, the effect of different ratio of rice husk ash (RHA) as growing medium was successfully observed on the growth performance of sawi caixin giant (Brassica Parachinensis) in terms of number of leaves, height and weight of plants. Based on the results of plant growth performance, the growth of sawi caixin giant on T1 treatment with 100% cocopeat was found to be poor among T3 and T2. The higher percent of cocopeat can reduce the plant growth due to reduce in the moisture content of medium. Therefore, the addition of RHA in T2 and T3 to the soilless growing medium enhance the plant growth performance. Sawi caixin giant with 25% of RHA addition shows the great growth performance of number of leaves, height and weight of plants. With the sufficient amount of nutrients from the combination of cocopeat and RHA, the plant able to grow to the height of 15 cm with 12 leaves and 64g fresh weight. In addition, the ZESA system used in this study can be implemented to ease the cultivation process. From this study, rice husk ash (RHA) can be utilized in environmentally friendly products such as cement application, soil amendment, an additive in steel and soil stabilization. Rice husk ash has a high potential to be used as soilless amendment. This is because the RHA contains vary amount of potassium which is macronutrient that required for plant growth and reproduction.

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Volume 5 Issue 13 (June 2023) PP. 49-64
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