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Growth and Yield of White Bok Choy Plants (*Brassica rapa* subsp. *chinensis*) across Various Media Compositions in an Urban Environment

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Abstract: White bok choy is a vegetable from the Brassicaceae family that holds high economic value and is highly sought after by consumers. However, its cultivation is often constrained by the selection of appropriate growing media, especially in limited urban spaces. This study aimed to determine the effect of different growing media compositions on the growth and yield of white bok choy plants. The research was conducted from January to February 2025 in the backyard area of a house located in Ciputat District, South Tangerang City. A Randomized Complete Block Design (RCBD) was used with six treatment levels: soil (control); organic growing media; soil + rice husk charcoal (1:1); soil + organic growing media (1:1); organic growing media + rice husk charcoal (1:1); and soil + rice husk charcoal + organic growing media (1:1:1), each replicated four times. The results showed that the composition of the growing medium had no significant effect on any of the observed variables. Soil alone as the growing medium produced comparable results to other growing media and can be recommended as an efficient growing medium for white bok choy cultivation.

Keywords: Charcoal, organic media, rice husk, vegetable

1. INTRODUCTION

White bok choy plant (*Brassica rapa* subsp. *chinensis*) is a variety of the Brassicaceae family that is quite popularly cultivated in Asia, including Indonesia. Bok choy is believed to have originated from China and has been widely cultivated since the 5th century, particularly in the southern and central regions, as well as Taiwan (Ernanda, 2017). Currently, countries such as Thailand, the Philippines, Malaysia, and Indonesia are major centres for this plant's cultivation. Bok choy's appeal lies in its crisp and refreshing flavour, as well as its distinctive physical appearance: dark green leaves with thick, white stems that contrast and are visually appealing. Furthermore, bok choy is recognised for its high nutritional value due to its rich content of various essential nutrients, including vitamin A, vitamin C, calcium, and iron. These contents make it a popular choice in various healthy dishes because it can provide health benefits and play a role in disease prevention (Nurhasanah et al., 2021).

Demand for bok choy in Indonesia has steadily increased, in line with growing public awareness of the importance of consuming highly nutritious green vegetables. Bok choy's ability to grow well in both lowland and highland areas makes it highly potential for large-scale cultivation to meet growing market demand. Economically and commercially, bok choy cultivation is highly promising. Although market demand for bok choy continues to increase, production data over the past three years show fluctuations. In 2021, total production reached 727,467 tons, then increased to 760,608 tons in 2022. However, this figure declined again to 686,876 tons in 2023. A similar pattern also occurred in productivity per hectare, which was recorded at 10.45 tons ha^{-1} in 2021, increased to 10.65 tons ha^{-1} in 2022, and then dropped again to 9.93 tons ha^{-1} in 2023 (Central Statistics Agency, 2024). The potential for developing bok choy cultivation in Indonesia is significant due to its favourable tropical climate. Furthermore, this plant boasts a fast harvest cycle and potentially profitable yields (Barokah et al., 2017). The ease of cultivation and consistent market demand make bok choy a promising and low-risk vegetable crop for farmers to cultivate.

White bok choy itself is a vegetable of high economic value due to its short harvest time, which is approximately 40–60 days after planting from seed, or 25–30 days if grown from seedlings (Prastio, 2015). Its growth is influenced by two main factors: internal and external. Internal factors include genetics and plant hormones (Putra et al., 2016), while external factors include environmental conditions such as temperature, lighting, and the type of growing medium used (Mariana, 2017).

Research conducted by Nazimah et al. (2024) indicates that selecting the appropriate growing medium can significantly enhance the quality and yield of bok choy. Therefore, a thorough understanding of bok choy's characteristics and the factors that influence its growth is crucial to support the productivity and quality of this vegetable. The growing medium serves as a medium for plant roots to grow, providing water and nutrients (Landis et al., 2014). In addition to providing physical support for plants, the growing medium must also be able to retain water and contain essential nutrients to support plant growth (Radha et al., 2018). Criteria for a good growing medium include being free from weeds, pests, and diseases, having the ability to regulate water levels effectively, a pH between 6 and 6.5, and adequate porosity for optimal root growth (Bui et al., 2016).

In urban areas, including South Tangerang City, the availability of soil for use as a growing medium in plant cultivation is very limited. Therefore, alternative growing media are needed that can be used as a mix-in or as a substitute for soil. Organic growing media, available commercially in agricultural stores, is an ideal and practical solution; however, it is quite expensive for large-scale use. Mixing it with other, more economical materials, such as rice husk charcoal, can reduce production costs.

According to the Centre for Agriculture, Food, and the Environment (2020), ideal planting media should consist of various components that provide water, air, nutrients, and physical support for plants. Generally, planting media are divided into two types: inorganic (such as sand, clay, and rockwool) and organic (such as cocopeat, compost, and rice husk charcoal). Some organic materials, such as manure and rice husks, are often combined with soil to increase nutrient availability and porosity. Studies by Zulkarnain et al. (2013) and Surya et

al. (2017) demonstrate that the use of organic materials can enhance soil structure, organic carbon content, and the soil's ability to store water and nutrients. Meanwhile, Pratiwi et al. (2017) found that the addition of burnt rice husks in a 2:1 ratio can provide the best nutrient supply for strawberry plants (*Fragaria vesca* L.).

Organic-based growing media have several advantages over soil-based media, such as being lighter in weight, free from pathogens, and more hygienic. Organic matter also contains relatively high levels of nutrients. Furthermore, the balance between macro- and micro-pores in organic matter supports good air circulation and high water absorption capacity (Dalimoenthe, 2013). Therefore, selecting the right growing medium is crucial for optimal plant growth. A good medium should have adequate aeration, good permeability, and an appropriate pH. These conditions allow for proper root growth and prevent waterlogging, which can potentially inhibit growth (Sugianto & Jayanti, 2021).

The use of a combination of organic materials, such as rice husk charcoal and manure, has also been shown to improve the quality of the growing medium. In addition to improving the medium's structure, this combination also provides the necessary nutrients for plants (Syahputra et al., 2014). Research by Hartatik and Widowati (2015) demonstrated that a suitable growing medium can significantly enhance plant height and leaf number. Therefore, studying the composition of growing media is crucial for determining the best formulation to support optimal growth of white bok choy. This study aimed to determine the effect of different growing media compositions on the growth and production of white bok choy.

2. METHOD

The research was conducted from January to February 2025 in the backyard of a house located in Ciputat District, South Tangerang City. The research location is at an altitude of ± 44 meters above sea level (masl). The tools used were hoes, scales, buckets, stationery, watering cans, seedling trays, organic pesticides, pH meters, plastic cups, and tarpaulins. The materials used in the research included 30 cm x 30 cm polybags, White Pakcoy variety bok choy seeds, organic planting media (comprising topsoil, burnt rice husks, manure, and fertiliser bacteria), soil, rice husk charcoal, and water.

The study was conducted using a Randomized Complete Block Design (RCBD) method with six levels of planting media composition treatment, namely: Soil (control); organic planting media; soil + rice husk charcoal (1:1); soil + organic planting media (1:1); organic planting media + rice husk charcoal (1:1); and soil + rice husk charcoal + organic planting media (1:1:1) (Jayanti, 2020). Each treatment was repeated four times, resulting in 24 experimental units. Each experimental unit consisted of three plants, resulting in a total of 72 plants studied. The observation data were analysed using the F-test, and further tests were conducted using the BNJ test at the 5% significance level if the F-test results indicated a significant effect.

Land preparation was carried out prior to the research by clearing the area of plant debris and weeds. The land was then prepared for planting polybags. Seeds were sown using seed trays filled with organic growing media. One bok choy seed was sown per hole in the seed

tray containing the prepared media. The seedling media were watered with a hand sprayer every morning and evening. The seed trays were placed in a shaded area, out of direct sunlight.

Planting media preparation is carried out one week before transplanting. The planting media to be used are first prepared, and then each medium is mixed. The planting media is filled to a depth of 5 kg per polybag. The media is mixed in proportions according to each treatment. The composition of the planting media mixture is based on a volume ratio. Planting is carried out by transplanting bok choy seedlings that are 14 days after sowing (DAS), with the criteria being that the plants have three to four leaves, upright stems, and are free from pests and diseases. The bok choy seedlings are transferred into polybags containing the planting media according to the treatment.

White bok choy plants were given NPK fertiliser at planting. Each NPK fertiliser dose was 0.75 g per plant (Sintia & Sa'diyah, 2024). Watering was carried out regularly in the morning and/or evening (depending on conditions), while still paying attention to soil moisture. Pest and disease control was carried out manually by directly removing pests that attacked the plants, setting yellow traps around the plants, and spraying the botanical pesticide Neem Oil Spray. Pesticide was applied by spraying all parts of the plant three times: at 7, 14, and 21 days after planting (DAP) (Nalu et al., 2021).

Harvesting is carried out when the plants are 4 weeks after planting (WAP) or 28 DAP, characterised by bright green and fresh leaves, healthy leaf bases, and even and consistent height (Rahmadhani et al., 2020). Harvesting is done by dismantling the polybag and then carefully removing the soil attached to the roots, ensuring that the roots are not broken. The variables observed are growth and yield variables, consisting of crop height, number of leaves, leaf width, leaf length, root length, root weight, gross plant weight, plant consumption weight, and production conversion per hectare, all of which were observed once at harvest time.

3. RESULT AND DISCUSSION

Based on climate data obtained from the Meteorology, Climatology, and Geophysics Agency for the South Tangerang region (BMKG, 2025), the average air temperature in January is approximately 27 °C, with an air humidity of 85% and a total rainfall of 400 mm per month. The average air temperature in February is 27.9 °C, with air humidity of 80%, and total rainfall of 350 mm per month.

According to Liferdi and Saprianto (2016), bok choy has optimal growth conditions at temperatures of 16-30 ºC, an air humidity of 80-90%, and rainfall ranging from 1,000 to 1,500 mm/year, or equivalent to 83.33-125.00 mm per month. Bok choy can be planted throughout the season with suitable rainfall of 200 mm per month. Bok choy requires sufficient water for growth and is intolerant of waterlogging, as it can cause rot and increase the risk of pest and disease attacks. Gustia (2013) added that plants grown in environments with above-average temperatures will affect their growth so that the resulting production will ultimately be low. This is due to the imbalance between the amount of photosynthesis produced and the reduction in carbohydrates resulting from respiration. As a result, the

respiration process occurs more frequently than photosynthesis, leading to a decrease in temperature, which in turn reduces production (Wuryan, 2008). Climate data showed that during the study, climatic conditions were inconsistent with the growing requirements for bok choy, particularly during the relatively high rainfall. This was addressed by watering less frequently than usual to prevent water pooling around the plants.

The growth and yield of bok choy plants can be influenced by the growing medium. The growing medium plays a crucial role in providing nutrients, supporting root development, and maintaining the availability of water and oxygen for the plant. Generally, the characteristics of the growing medium, such as texture, porosity, and water retention capacity, can also influence plant growth. A good growing medium should support root development and facilitate optimal nutrient absorption.

Based on the results of soil analysis at the research location, it was found that the soil has a good level of fertility and a pH close to neutral, namely ±7. This condition is highly supportive of plant growth because a neutral pH allows for the availability of macro- and micro-nutrients in a form that is easily absorbed by plants (Nurlaeny, 2015). At a pH range of around 6.5 to 7.5, most essential nutrients, including nitrogen (N), phosphorus (P), and potassium (K), are in an optimal condition for absorption by plant roots, thereby supporting maximum plant growth and development (Juliansyah et al., 2022).

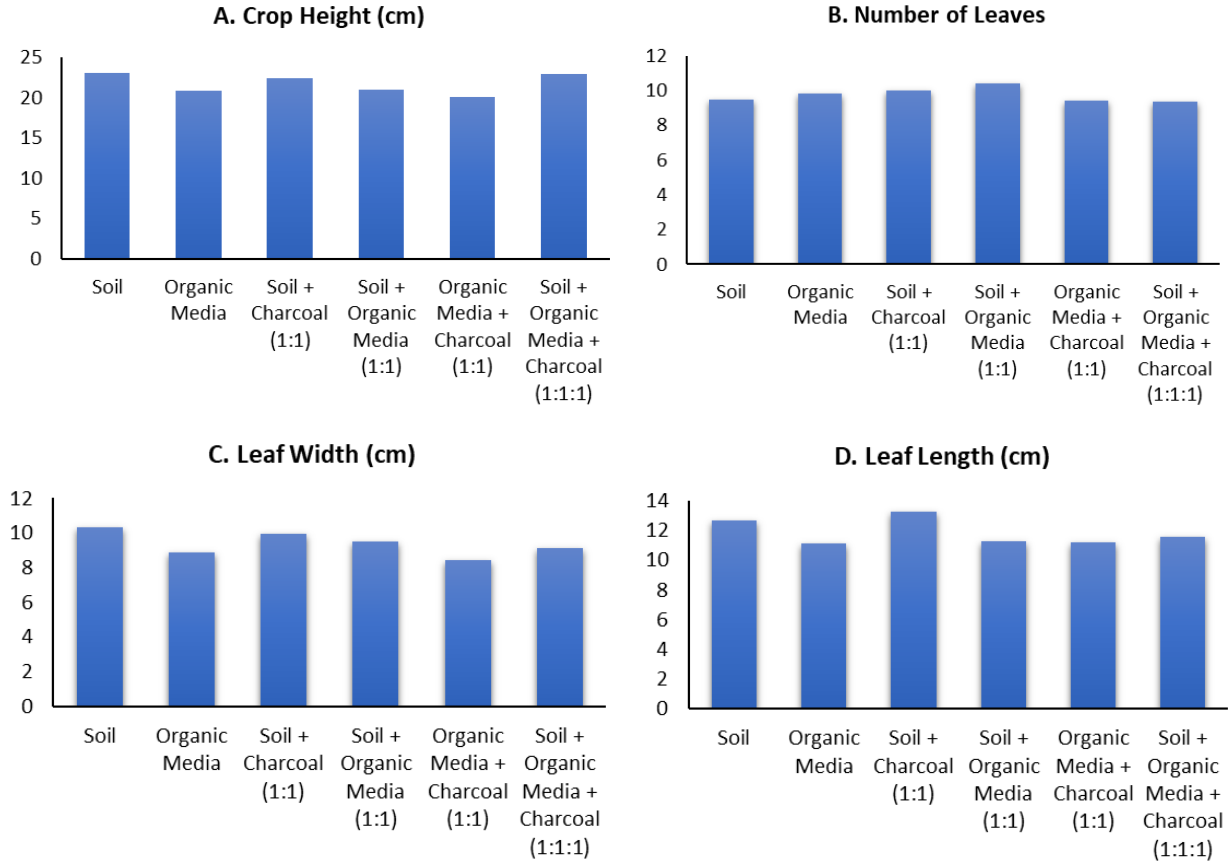

Figure 1: A. Crop height; B. Number of leaves; C. Leaf width; and D. Leaf length of white bok choy plants in different growing media compositions

The results of the analysis of variance showed that the use of various planting media compositions did not significantly affect the variables of crop height, leaf number, leaf width, and leaf length of the white bok choy. The height of the canopy of the white bok choy

plants ranged from 20.06 to 23.12 cm, the number of leaves ranged from 9.33 to 10.41, the width of the leaves ranged from 8.45 to 10.29 cm, and the length of the leaves ranged from 11.13 to 13.26 cm (Figure 1). These insignificantly different results are presumably due to the fact that the study used the recommended dose of inorganic fertiliser (0.75 g per polybag) for all plants, so the availability of nutrients and the structure of the planting media used supported plant growth relatively similarly (Damayanti et al., 2019). According to Septian et al. (2024), the use of various planting media, including soil, rice husk charcoal, and organic media, can enhance plant growth. However, it often does not provide a significant difference if environmental factors and nutrient availability are still optimal.

Other factors such as nutrition, genetics, and environmental conditions can influence plant development, including crop height. Environmental conditions vary from place to place, and the specific environmental needs of plants result in diverse growth patterns (Novitasari, 2022). Nutrients, especially nitrogen, play a crucial role in plant vegetative growth. Much of the nitrogen absorbed by plant roots rises to the leaves, combining with carbohydrates to form proteins for leaf formation (Aisyah et al., 2024).

All treatments, whether single or combined, involving two or three planting media compositions, showed no significant differences in root growth. Based on the results of the analysis of variance, the composition of the planting media had no significant effect on the root length and root weight of white bok choy plants. White bok choy plants had root lengths ranging from 9.41 to 11.37 cm and root weights ranging from 6.08 to 8.62 g (Figure 3). Soil, as the sole planting medium (control), showed root weight and root length that tended to be higher, but not significantly different from those of the other treatments. This is suspected because the nutrient content of the fertilisation applied was sufficient to support growth similar to that of other mixed media. The soil media used is also suspected to have good physical properties, thus supporting plant root growth. The more porous the soil, the easier it is for roots to penetrate, and the easier it is for water and air to circulate (Hanafiah, 2014).

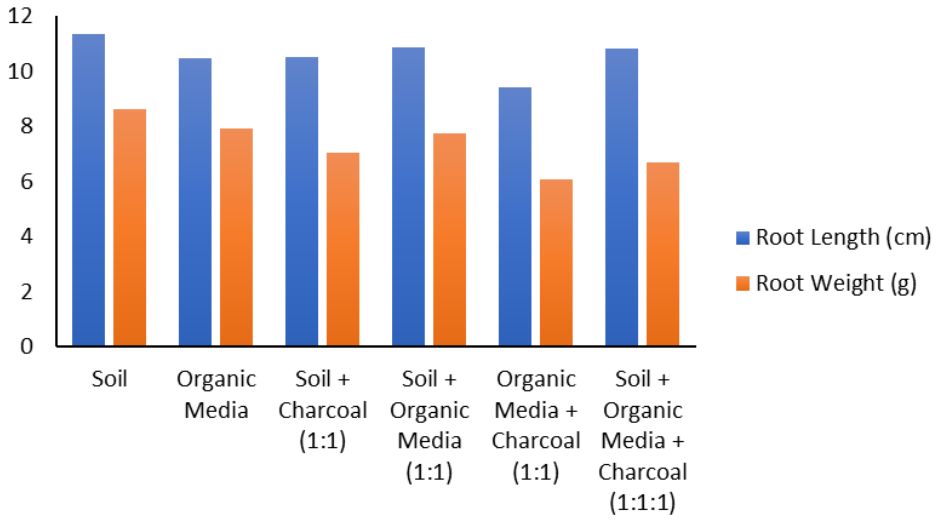

Figure 3. Root length and weight of white bok choy plants in different growing media compositions

Similar results were also observed for white bok choy yield variables. Based on the analysis of the various growing media compositions, there was no significant effect on the gross weight and consumption weight of white bok choy plants. White bok choy plants produced gross plant weights ranging from 35.46-44.86 g, plant consumption weights ranging from 26.17-36.00 g, and production conversion per hectare ranging from 3.94-4.98 tons ha^{-1} (Table 1). The results also confirmed that with the same dose of fertiliser, soil planting media was able to produce the same plant weight as mixed planting media and pure organic planting media.

Herawati et al. (2023) found that the use of soil-based growing media tends to result in higher consumption weight compared to pure organic growing media. In a study by Agfharinda (2023), it was reported that the use of soil-based growing media, rice husk charcoal, and organic media had varying effects on bok choy growth. However, it showed no significant differences in harvest weight. Research by Ndiwa et al. (2022) also demonstrated that a combination of growing media with rice husk charcoal can enhance soil aeration, which in turn impacts the growth of bok choy. However, the harvest yield in gross weight did not show significant differences, which is also suspected to be influenced by environmental and plant genetic factors.

Table 1. Gross height, consumption weight, and conversion yield per hectare of white bok choy in different growing media compositions

Growing Media Compositions	Gross Weight (g)	Consumption Weight (g)	Conversion of Yield per Hectare (ton ha^{-1})
Soil	44.52	32.30	4.95
Organic Media	39.50	27.52	4.39
Soil + Charcoal (1:1)	44.86	36.00	4.98
Soil + Organic Media (1:1)	44.10	33.28	4.00
Organic Media + Charcoal (1:1)	35.46	26.17	3.94
Soil + Organic Media + Charcoal (1:1:1)	40.91	29.80	4.55

The conversion results of production per hectare, based on a planting distance of 30 x 30 cm, showed the highest yield in the soil + rice husk charcoal (1:1) treatment, namely 4.98 tons ha^{-1}. This yield is lower than the description of the White Pakchoy variety of bok choy, which is around 45 tons/ha. This can be caused by several factors, including unsuitable growing conditions, especially the altitude and duration of sunlight. Although white bok choy plants can grow in places with low to high altitudes, according to Susilo (2016), the growth and yield of bok choy plants will be better in the highlands. In this study, the location was at an altitude of ±44 masl, resulting in suboptimal growth of white bok choy plants.

Furthermore, during the study, rainfall was very high, suggesting that sunlight was not optimal due to the frequent occurrence of overcast clouds, which resulted in suboptimal duration and intensity of sunlight. Plants can grow optimally when they receive sufficient sunlight (Mahardika et al., 2023). Sunlight is the primary source of energy for photosynthesis in leaves. If light intensity is too low, the rate of photosynthesis will decrease

due to a lack of energy (Zannah et al., 2023). Plants that are not exposed to light cannot produce chlorophyll, resulting in pale leaves. However, if the amount of light is too high, chlorophyll can be damaged (Pramadana et al., 2021).

Although there was variation in the results, no statistically significant difference was found. This suggests that the growing medium is not the sole factor influencing the growth and yield of white bok choy. These results indicate that cultivating white bok choy requires sufficient fertile soil as the growing medium.

4. CONCLUSIONS

The use of various growing media compositions did not significantly affect all observed variables for white bok choy growth and yield. The soil media (control) with the recommended dose of inorganic fertiliser use showed comparable results to the other treatments in white bok choy cultivation. In urban farming practices with limited land availability, the use of ready-to-use organic growing media or its combination with charcoal can be an alternative solution to replace soil when soil availability is minimal. However, based on these results, for resource-constrained urban farmers, native soil supplemented with NPK is sufficient, reducing the need to purchase expensive specialised media. It is suggested that future research should test these media without NPK to determine the true "bio-potential" of the organic components.

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