



## **Vegetative Growth Response of Chili Pepper Plants (*Capsicum frutescens* L.) Absolut 69 Variety to Rice Husk Biochar Application**

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**Abstract.** Chili pepper (*Capsicum frutescens* L.) is one of the raw material crops with high economic value in Indonesia. This research aims to determine the effect of rice husk biochar on the vegetative growth of cayenne pepper plants (*Capsicum frutescens* L.) Absolute 69 variety. This research was conducted from June to August 2024 in Kertasura Village, Kapetakan District, Cirebon Regency. The technique used in this research was a randomized block design (RAK) with six treatments. The rice husk biochar treatments tested consisted of B0 (0 t/ha control), B1 (2.5 t/ha), B2 (5 t/ha), B3 (7.5 t/ha), and B4 (10 t/ha) and B5 (12.5 t/ha) and each treatment was repeated four times so that resulting in 24 trials. The parameters observed were plant height, number of leaves, stem diameter, root length, root volume, and plant dry weight. The results showed that applying rice husk biochar affected all parameters except root volume. Providing 10 tons of rice husk biochar per hectare is most effective for the vegetative growth of chili peppers.

**Keywords:** *vegetative, cayenne pepper (Capsicum frutescens L.), biochar*

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### **INTRODUCTION**

Chile pepper is a vegetable crop cultivated in Indonesia. Indonesians commonly use chili pepper in a variety of culinary preparations (Amalia et al., 2018). The Central Statistics Agency (CSA) reports that chili pepper production in Indonesia has declined by 8.09% throughout the past five years. The production of chili peppers in 2020 amounted to 1.5 million tons, while the figure declined to 1.39 million tons in 2021. Typically, inadequate plant growth marks the initial stage of a decrease in chili plant yield caused by poor soil fertility. Optimizing cultivation techniques and incorporating soil amendments can significantly improve plant growth and soil fertility. Manure, charcoal, dolomite, and guano are soil amendment materials designed for amelioration purposes.

A frequently employed amendment is biochar, which functions to enhance or function as a soil amendment. The moisture retention properties of biochar can benefit plants in drought conditions. Biochar and fertilizers are essential techniques for improving soil fertility, hydrological efficiency, and agricultural productivity in regions with limited water resources by reducing the adverse effects of drought (Faloye et al., 2019). Furthermore, applying biochar improves soil's physical characteristics, including its ability to retain water, structure, porosity, bulk density, and fertility (Azeem et al., 2019; Baiamonte et al., 2021). Through the modification of soil structure and enhancement of water retention capacity, biochar indirectly augments groundwater supplies (Zhang et al., 2023). Research by Andreas et al. (2022) indicates that biochar can expedite plant growth and preserve nutrients in the soil, therefore reducing the risk of their loss through leaching. This has the potential to enhance plants' vegetative growth, productivity, and water use efficiency. Usman and colleagues (2016). Biochar exhibits a significant cation exchange capacity (CEC), efficiently adsorbing water and nutrients. This can facilitate the augmentation of the nitrogen (N) concentration in the soil (Maghdalena et al., 2016).

## **LITERATURE**

In order to enhance soil quality and serve as an alternative soil management technique, biochar is a porous charcoal generated by carbonization pyrolysis (Jindo et al., 2014). The rice husk biochar contains organic carbon (20.93%), nitrogen (0.71%), phosphorus (0.06%), and potassium (0.14%). When applied to the soil in its ideal form, it will yield the best possible outcomes for plant growth (Tiara et al., 2019). Research conducted by Johnson et al. (2018) indicates that using biochar enhances soil fertility by augmenting the soil's nutritional composition and organic carbon levels. This study's findings demonstrate that biochar utilization promotes enhanced growth and productivity of chili plants. Experimental evidence has demonstrated that biochar enhances chili plants' development, productivity, and nutrient uptake (Al-Harbia et al., 2020). A high carbon content (C-organic) and a good nutrient retention capacity characterize biochar produced from rice straw. The elevated C-organic content is attributed to 36.5% cellulose and 33.8% hemicellulose (Purwaningsih et al., 2012). Based on the findings of Lukmana et al. (2023), the application of 250 grams of rice husk charcoal per polybag containing 3 kilograms of soil has been shown to enhance the quantity of chili fruit and roots per plant.

## **METHODS**

This study was conducted at Kertasura Village in the Kapetakan District of Cirebon Regency. The study site is situated at an elevation of 20 meters above sea level, with an average air temperature of 32<sup>0</sup>C to 34<sup>0</sup>C and a soil pH 6.8. It falls under climatic classification C. This study was carried out during June and August 2024. The equipment utilized in this investigation included seedling trays, shovels, sprayers, buckets, meters, cameras, nameplates, stationery, and calipers. The materials utilized were Absolute 69 cayenne pepper seeds, seedling planting medium, water, rice husk charcoal, organic compost, and pearl NPK fertilizer type 16-16-16. The present work employed a Randomized Block Design (RBD) with a single factor, precisely the dosage of biochar, which was divided into six levels: B0 (equivalent to 0 tons/ha control), B1 (2.5 tons/ha), B2 (5 tons/ha), B3 (7.5 tons/ha), B4 (10 tons/ha), and B5 (12.5 tons/ha). Each treatment was replicated four times, resulting in 24 experimental units. The experimental plot had dimensions of 1.2 m × 2 m.

Production of rice husk biochar by biomass pyrolysis involves the thermal decomposition of organic material from rice husks in the absence or with little presence of air. This process takes place at elevated temperatures ranging from 400<sup>0</sup>C to 700<sup>0</sup>C Celsius. The furnace containing dehydrated rice husks is subjected to a combustion process lasting 4-5 hours. Biochar is administered during the second stage of land processing at a dosage determined by the specific treatment. The initial planting spacing for seedlings is 40 cm by 50 cm. The measured characteristics encompass plant height, leaf count, stem diameter, root length, root volume, and plant dry weight. Once the data processing results from variance analysis indicate a significant effect, the Scott-Knott Cluster Test is conducted at a significance level of 5%.

## **DISCUSSION**

### **Plant Height**

Based on the results of the analysis, the treatment of rice husk biochar significantly impacts the height of chili plants at 7, 21, and 35 DAP after planting (Table 1).

Applying rice husk biochar treatments B0, B1, and B2 did not significantly change plant height seven days after planting (DAP). This phenomenon is believed to arise due to the inadequate dosage of rice husk biochar to fulfill the nutritional requirements of plants and its slow decomposition process. The extended longevity of biochar in the soil can be attributed to its slow disintegration process and resistance to microorganisms (Bagus et al.,

2023). Concurrently, treatments B3, B4, and B5 have exhibited a notable disparity in the vertical stature of cayenne pepper plants. At 21 days after planting (DAP), only treatments B2, B3, B4, and B5 exhibited a statistically significant variation in the height of cayenne pepper plants. Significant differences in plant height were observed in treatments B2, B3, B4, and B5 at 35 days after planting (DAP). Among these treatments, treatment B5 demonstrated the most favorable outcomes and substantially impacted plant height. Adequate nutrient content in the soil available for absorption by chili pepper plants promotes robust growth.

**Table 1. Effect of Rice Husk Biochar on Chili Plant Height at Age 7, 21 and 35 Day After Planting (DAP)**

Treatments	Plant Height (cm) at Age (DAP)		
	7 DAP	21 DAP	35 DAP
B0 (control/ha)	10,40a	14,61a	22,94a
B1 (2,5 ton/ha)	10,80a	17,32a	24,47a
B2 (5 ton/ha)	11,30a	20,87b	27,08b
B3 (7,5 ton/ha)	13,30b	23,57c	26,84b
B4 (10 ton/ha)	13,80b	22,53b	28,51b
B5 (12,5 ton/ha)	15,00c	23,41b	29,14c

Description: The average figures accompanied by the same letter in the same column show no significant difference based on the Scoot-Knott Cluster Test at a 5% significance level.

Applying biochar can increase soil nitrogen levels (Abel et al., 2021). An advantage of nitrogen components in the soil is their potential to promote the growth of vegetative plants (Patti et al., 2013). These findings align with the study undertaken by Maghfira et al. (2024), which showed that the application of rice husk biochar can impact the height of plants.

**Number of Leaves**

The number of plant leaves is the number of leaves that grow on a plant at a certain time. The number of leaves reflects the condition of plant productivity. Based on the analysis results, the treatment of rice husk biochar only significantly affected the number of cayenne pepper leaves at the age of 35 DAP (Table 2).

Applying rice husk biochar with treatments B0, B1, B2, B3, B4, and B5 did not have a notable impact on the leaf count of cayenne plants 7 and 21 days after planting (DAP). This phenomenon is believed to occur since cayenne pepper plants need a more significant amount of nutrients in order to sustain branch development. A positive correlation exists between the dosage of rice husk biochar and the quantity of leaves (Musnoi et al., 2017).

**Table 2. Effect of Rice Husk Biochar on the Number of Leaves of Cayenne Pepper Plants at Age 7, 21 and 35 Day After Planting (DAP)**

Treatments	Number of Leaves (strand)		
	7 DAP	21 DAP	35 DAP
B0 (control/ha)	7,60a	16,10a	21,35a
B1 (2,5 ton/ha)	9,10a	17,20a	24,95a
B2 (5 ton/ha)	9,35a	19,00a	28,00a
B3 (7,5 ton/ha)	10,30a	19,35a	28,85a
B4 (10 ton/ha)	10,55a	21,00a	32,10b
B5 (12,5 ton/ha)	10,05a	19,80a	38,30c

Description: The average figures accompanied by the same letter in the same column show no significant difference based on the Scoot-Knott Cluster Test at a 5% significance level.

At 35 days after planting (DAP), the use of rice husk biochar in treatments B4 (10 tons/ha) and B5 (12.5 tons/ha) resulted in a notable variation in leaf biomass compared to treatments B0 (control/ha), B1 (2.5 tons/ha), B2 (5 tons/ha), and B3 (7.5 tons/ha). This occurs because the inherent characteristics of rice husk charcoal necessitate a prolonged delay in its decomposition process. This supports the assertion stated by Lingga and Marsono in Malik et al. (2022) that the prolonged availability of plant nutrients resulting from regular application of biochar in the soil will impact the absorption of nutrients, namely nitrogen, by plants. Generally, nitrogen nutrients can expedite the vegetative development of plants, particularly in the stems and leaves.

**Stem Diameter**

The diameter of the plant stem is a measure of the width or thickness of a plant stem, which reflects an indicator of plant growth. Based on the analysis's results, the rice husk biochar treatment had a significant effect on the stem diameter of cayenne pepper plants aged 7, 21, and 35 DAP (Table 3).

**Table 3. Effect of Rice Husk Biochar on Stem Diameter of Cayenne Pepper Plants at Age 7, 21 and 35 Day After Planting (DAP)**

Treatments	Stem Diameter (mm)		
	7 DAP	21 DAP	35 DAP
B0 (control/ha)	2,22a	2,60a	2,95a
B1 (2,5 ton/ha)	2,12a	2,71a	3,31a
B2 (5 ton/ha)	2,40a	3,05a	3,75b
B3 (7,5 ton/ha)	2,53a	3,05b	3,73b
B4 (10 ton/ha)	2,53b	3,33c	4,14c
B5 (12,5 ton/ha)	2,56c	3,22b	3,91b

Description: The average figures accompanied by the same letter in the same column show no significant difference based on the Scoot-Knott Cluster Test at a 5% significance level.

At seven days after planting (DAP), the application of rice husk biochar treatments B0, B1, B2, and B3 did not result in any notable variation in stem diameter. Applying a low dosage of rice husk charcoal resulted in a reduction in stem diameter. This phenomenon is associated with the restricted accessibility of essential nutrients required by plants, leading to disturbances in the plant metabolic process and reduced production of assimilates, thereby causing compromised plant growth (Beatrix et al., 2021). Furthermore, treatments B3, B4, and B5 have exhibited notable variations in the vertical stature of cayenne pepper plants. Significant variations in stem diameter of cayenne pepper plants were seen only in treatments B3, B4, and B5 at 21 days after planting (DAP). Significant variations in plant height were observed in treatments B2, B3, B4, and B5 at 35 days after planting (DAP). It is hypothesised that biochar, when used as a soil conditioner, can effectively address soil issues, so promoting enhanced growth and development. Because of its elevated CEC and macropore values, biochar enhances the soil's capacity to assimilate nitrogen, phosphorus, and water nutrients (Kevin et al., 2024).

**Root Length**

The length of a plant's roots is the total measurement from the tip of the longest root to its base, including the main root and root branches. Root length reflects how deep and wide the plant's roots spread into the soil to obtain water and nutrients. Based on the analysis results, the dose of rice husk biochar significantly affected the number of leaves of cayenne pepper plants at the age of 35 DAP (Table 4).

**Table 4. Effect of Rice Husk Biochar on the Root Length of Cayenne Pepper Plants at Age 7 and 35 Days After Planting (DAP)**

Treatments	Root Length (cm)	
	7 DAP	35 DAP
B0 (kontrol/ha)	5,85a	19,00a
B1 (2,5 ton/ha)	6,63a	22,25b
B2 (5 ton/ha)	4,08a	18,25a
B3 (7,5 ton/ha)	5,88a	18,25a
B4 (10 ton/ha)	8,25a	21,50b
B5 (12,5 ton/ha)	7,35a	24,50c

Description: The average figures accompanied by the same letter in the same column show no significant difference based on the Scoot-Knott Cluster Test at a 5% significance level.

The treatments B0, B2, and B3 had the shortest root length at 35 days after planting (DAP). At 7 days after planting (DAP), the addition of rice husk biochar had no significant impact on the root length of cayenne pepper plants. This is because the incorporation of rice

husk biochar requires a longer duration to engage with the soil and microaerobic organisms. Moreover, the current physical and chemical characteristics of rice husk biochar are insufficient to facilitate the uptake of nutrients by plants in their initial growth phases, leading to less than-ideal development of root length.

This aligns with the study undertaken by Lakitan (2013), which suggests that plant genetic characteristics can influence plant roots, but additional factors such as soil conditions or growing media can also impact roots. The result of this investigation revealed that the soil temperature varied between 35°C and 35°C. Chili plants growing at a soil temperature of 35°C may encounter stress that hinders plant roots' uptake of water and nutrients.

**Root Volume**

Plant root volume is a measure of the space occupied by a plant's root system in the soil, which reflects the total number of roots, including the primary root and its roots. Based on the analysis's results, the rice husk biochar treatment did not significantly affect the root volume of cayenne pepper plants (Table 5).

**Table 5. Effect of Rice Husk Biochar on Root Volume of Cayenne Pepper Plants at Age 7 and 35 Days After Planting (DAP)**

Treatments	Root Volume (ml)	
	7 DAP	35 DAP
B0 (control/ha)	0,13a	0,32a
B1 (2,5 ton/ha)	0,18a	0,35a
B2 (5 ton/ha)	0,20a	0,45a
B3 (7,5 ton/ha)	0,13a	0,60a
B4 (10 ton/ha)	0,25a	0,52a
B5 (12,5 ton/ha)	0,70a	0,47a

Description: The average figures accompanied by the same letter in the same column show no significant difference based on the Scoot-Knott Cluster Test at a 5% significance level.

This phenomenon is believed to be caused by insufficient phosphorus elements and elevated temperatures in the soil, leading to the underdevelopment and restriction of the root system. This is consistent with the results of Raisa's study (2016), which demonstrates that phosphorus (P) and potassium (K) nutrients play a crucial role in the processes of root development, fruit set, and fruit maturation. Phosphorus nutrients impact the development of juvenile plant seed roots (Purwati, 2013). Due to its crucial nature as a nutrient, phosphorus significantly promotes root growth and development (Lakitan, 2011). Optimal nutrient absorption in plants will positively impact the root system of long plants, resulting in an expansion in root volume (Siregar et al., 2015).

**Dry Weight**

Plant dry weight refers to the net mass of a plant once all water content has been extracted. A plant's dry weight refers to its mass after all hydrological water has been removed. This measure represents the content of organic matter retained in plants unaffected by variations in moisture levels. Upon research, it was determined that the rice husk biochar treatment had no significant impact on the dry weight of cayenne pepper plants seven days after planting (DAP), but had a significant impact at 35 DAP (Table 6).

**Table 6. Effect of Rice Husk Biochar on Dry Weight of Cayenne Pepper Plants at Age 7 and 35 Days After Planting (DAP)**

Treatments	Dry Weight (g)	
	7 DAP	35 DAP
B0 (control/ha)	0,38a	5,63a
B1 (2,5 ton/ha)	0,38a	5,80a
B2 (5 ton/ha)	0,40a	5,98a
B3 (7,5 ton/ha)	0,28a	6,18a
B4 (10 ton/ha)	0,43a	7,18c
B5 (12,5 ton/ha)	0,35a	7,08b

Description: The average figures accompanied by the same letter in the same column show no significant difference based on the Scoot-Knott Cluster Test at a 5% significance level.

Biochar is believed to have a prolonged lifespan in the soil due to its inherently slow disintegration process. By 35 days after planting (DAP), the treatments B4 (10 tons/ha) and B5 (12.5 tons/ha) exhibited a notable disparity in plant dry weight. This hypothesis is based on the observation that the presence of carbon, silica, minerals, and other components in rice husk biochar, together with its ameliorating characteristics, have a beneficial impact on soil conditions and the development of cayenne pepper plants. The study conducted by Kurniawan et al. (2016) found that plant weight is directly affected by plant height and leaf area. Specifically, as the plant height and leaf area increase, so does the plant weight. A study undertaken by Safitri et al. (2018) demonstrates that biochar can potentially enhance plants' dry weight.

**CONCLUSION**

The research findings and subsequent debate led to the conclusion that rice husk biochar substantially impacts the vegetative growth of chili plants. This effect was observed in the stem height and diameter parameters at 7, 21, and 21 days after planting (DAP), leaf count, root length, and plant dry weight at 35 DAP. Nevertheless, there was no apparent

impact on the volume of the roots. The application of 10 tons per hectare of rice husk biochar has a beneficial effect on the vegetative development of chili plants.

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