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Response on growth and production of cayenne pepper (*Capsicum frutescens* L.) due to application of bio-slurry and biochar

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Abstract. This study aims to determine the best concentration of bioslurry and type of biochar for cayenne pepper growth and production. The research was conducted from March to June 2022 located in Sompe Village, Sabbangparu District, Wajo Regency. The research was carried out in the form of 2-factor factorial experiment using a randomized block design. Four concentration of bio-slurry, used as the first factor, were 0, 125, 250, and 250 cc per plot. The second factor was types of biochar consisted of control, rice husk biochar, corn cob biochar, and coconut shell biochar with a dosage of 4.4 kg per plot. Research results show no significant interaction occurred between the bioslurry and biochar treatments that affect the growth and production of cayenne pepper. Use of coconut shell biochar treatment resulted in the highest plant (36.31 cm) while application of rice husk biochar resulted in the highest number of fruits per plant (30.27), weight per fruit (4 g), fruit weight per plant (34.88 g), and fruit weight per plot (139.54 g). Treatment of rice husk biochar is the most optimal treatment in upgrading the production of cayenne pepper plant.

1. Introduction

Cayenne pepper is an important type of vegetable that has high economic value and is suitable to be developed in the tropical regions such as Indonesia. The cayenne pepper is one of vegetable commodities that is needed in everyday life. This plant can be grown in the lowlands and highlands and it is relatively resistant to disease [1].

According to Indonesian Central Bureau of Statistics (CBS) [2], the national productivity of the cayenne pepper during the year of 2015 to 2019 has increased by 6.90 percent per year. The highest increase in productivity occurred in 2018, which was 8.47 quintals per hectare (12.31 percent) compared to 2017. In 2019, the productivity level of national cayenne pepper reached 82.32 quintals per hectare, or an increase of 5.05 quintals per hectare of productivity on 2018. However, based on data from BPS (2019) production in South Sulawesi has decreased in the last five years, in 2017 production reached 45,770 tons while in 2019 cayenne pepper production only reached 26,115 tons.

Cayenne pepper cultivation among farmers generally uses high doses of inorganic fertilizers and synthetic pesticides. Higher input applied by farmers is due to the hope that cayenne pepper production will increase. If these practices are carried out continuously for a long time, it will have an impact on soil fertility both physically, chemically, and biologically. Excessive use of inorganic



fertilizers will threaten the survival of microorganisms in the soil, for this reason it needs to be balanced with organic fertilizers. Efendi [3] stated that the use of chemical fertilizers (inorganic fertilizers) is not only harmful to the soil but also to living things, hence it is necessary to substitute it with organic fertilizers to improve soil structure and increase plant growth.

Bioslurry is the end product of liquid waste treatment which is very useful as a source of nutrition for plants. In addition, Bioslurry is a high-quality organic material rich in humus [4]. Not only contains a lot of nutrients, Bioslurry fertilizer also contains useful microbes to increase the fertility and health of agricultural land. Therefore, it can increase harvest quality and quantity. As a quality organic fertilizer, Bioslurry is safe for use by humans for fertilizing various food crops, vegetables, flowers, fruit, and plantation crops.

Biochar is an organic carbon buffer because it has a high organic acid content, just as biochar organic matter is able to maintain the pH at any change in soil condition [5]. Soil pH conditions can affect soil respiration. Measurement of soil respiration is well correlated with soil fertility variables related to the microbial activity such as organic matter content, the intermediate result of pH, and the average number of soil microorganisms [6].

Making Biochar and its application to the soil will provide benefits through increased soil fertility and hence, the crop production. In the process of making biochar approximately 50% of the initial C will be contained in the biochar, whereas in combustion only 3%, and biological decomposition is usually <20% after 5–10 years. The efficiency of C conversion from biomass to biochar is highly dependent on the type of base material [7]. The combination of the use of compost and biochar in the planting medium can increase the growth and production of cayenne pepper, where the compost provides the needed nutrients and the biochar retains the nutrients and improves soil conditions.

This study aims to increase plant growth and production through fertilizer management and addition of soil amendment, namely by combining bioslurry and biochar. Information and results study this expected could become the solution for cayenne chili farmer in repairing the cultivation system, especially on stage of land preparation for planting.

2. Method

2.1. Location and experimental design

This recent study was carried out in the Village Sompe, Sabbangparu District, Wajo District, South Sulawesi, Indonesia from March to June 2022. The equipment used in this research is paranet, wood, treatment boards, buckets, calipers, markers, rulers, scales, label paper, cameras, hoes, scales analytics, drums, stoves, *miniature leaf spectrometer*, *chlorophyll content meter* (CCM-200 plus) and other writing instruments. The materials used in this study were cayenne pepper seeds (variety Dewata 43 F1), rice husk biochar, corn cob biochar, coconut shell biochar, and bio-slurry. The experiment was set using split-plot design (SPD) with Bioslurry (M) as the main plot (MP) which consisted of 4 levels, without bioslurry as control (P0), 125 cc bio-slurry fertilizer (P1), 250 cc bio-slurry fertilizer (P2), 375 cc bio-slurry fertilizer (P3), type of Biochar (P) was used as the sub plot (SP) consisted of 4 types, namely without biochar (M0), rice husk biochar 8 ton/ha (M1), corn cob biochar 8 ton/ha (M2), coconut shell biochar 8 ton/ha (M3). All treatments were repeated 3 times resulted in total of 48 experimental units.

2.2. Preparation of biochar

Biochar was produced with combustion method and carried out using a drum for 4 – 6 hours. The combustion was conducted using a gas stove [8] with temperature ranged from 300 – 400 °C following the method of Hossein et al. [9]. A bimetal thermometer attached on the top of drum was used to help control the temperature during combustion. Bio slurry and biochar were mixed with the dosage of bio slurry and type of biochar according to the treatment and allowed to stand for one week before being applied to the beds.

2.3. Observation parameters and data analysis

Observation parameters in research this as follows: *Plant height (cm)*. Observations were made by measuring the height of the plant from the ground surface to the point where the highest stem grows. Measurements are made every 2 weeks when the plants are 4 weeks after planting (WAP), 6 MST, 8 WAP, and 10 MST. *A number of fruits per plant (fruit)*. Observations were made by counting the number of fruits per harvest that were physiologically ripe. *Fruit weight per plot (gram)*. Observations were made by weighing all the fruit per plot of plants at each harvest. Data was analysed using analysis of variance (ANOVA). If there is an effect of the treatment, a further test is carried out to distinguish the average between treatments using the Least Significant Difference (LSD) Test at the 95% level of confidence.

3. Results and discussion

3.1 Results

3.1.1. Plant Height. Analysis results show that the use of different types of biochar significantly affected the plant height of the cayenne pepper which varied between types of biochar (Table 1). The highest cayenne pepper plant, at 8 weeks after planting (WAP), resulted from coconut shell biochar treatment (36.31 cm) compared to control plants.

Table 1. Average plant height (cm) of cayenne pepper at 8 WAP on different concentration of bio slurry and biochar types.

Bio slurry (M)	Biochar (P)			
	Control (p0)	Rice husk (p2)	Corn cob (p2)	Coconut shell (p3)
Control (m0)	28.98	37.62	32.11	38.50
125 cc (m1)	31.87	38.17	32.02	38.18
250 cc (m2)	34.24	31.38	32.00	34.57
375 cc (m3)	36.60	35.15	32.28	33.99
Average	32.87 ^b	35.58 ^a	32.10 ^b	36.31^a
LSD _{0.05}	3.31			

Number followed by different letters in row (a, b) means significantly different based on LSD test at the 95% level of confidence.

3.1.2. Number of fruits per plant

Analysis results show that the biochar treatment had a highly significant effect on the number of fruits formed per plant. Average fruit numbers per plant were higher in the biochar treatments compared to control (Table 2). The highest number of fruits per plant obtained by the use of rice husk biochar i.e. 30.27.

Table 2. Average number of fruits per plant (fruits) of cayenne pepper at different concentration of bioslurry and biochar types.

Bio slurry (M)	Biochar (P)			
	Control (p0)	Rice husk (p2)	Corn cob (p2)	Coconut shell (p3)
Control (m0)	21.76	28.68	29.92	28.07
125 cc (m1)	23.56	30.39	28.09	27.01
250 cc (m2)	24.64	30.70	29.30	28.89
375 cc (m3)	25.27	31.33	30.05	27.62
Average	23.81 ^c	30.27^a	29.34 ^a	27.90 ^b
LSD _{0.05}	1.66			

Number followed by different letters in row (a, b) means significantly different based on LSD test at the 95% level of confidence.

3.1.3. Fruit Weight per plot

Analysis results show that the biochar type treatments had a highly significant effect on the fruit weight per plot of cayenne pepper. Average fruit weight per plot were higher in the biochar treatments compared to control. The highest fruit weight per plot obtained by the use of rice husk biochar 4.33 kg.

Table 3. Weight average fruit per plot (gr) per plant at concentration treatment bioslurry and biochar types.

Bio slurry (M)	Biochar (P)			
	Control (p0)	Rice husk (p2)	Corn cob (p2)	Coconut shell (p3)
Control (m0)	3.39	3.78	2.85	4.37
125 cc (m1)	3.73	4.43	3.61	3.70
250 cc (m2)	2.32	4.54	3.86	4.35
375 cc (m3)	4.40	4.58	3.99	4.40
Average	3.46 ^b	4.33 ^a	3.58 ^{ab}	4.18 ^{ab}
LSD _{0.05}	7.59			

Number followed by different letters in row (a, b) means significantly different based on LSD test at the 95% level of confidence.

3.2. Discussion

Application of biochar to the soil has been demonstrated in this recent study can improve the growth and production of cayenne pepper. Despite this, the responses varied with the types of biochar used. Based on the growth and production parameters, coconut shell biochar showed best effect on the plant height, while in production parameter, biochar made from rice husk gave the best result based on number of fruits per plant and total fruit weight per plot. Biochar is known as soil amendment that contained nutrient needed for plant growth and production. [10] stated that coconut shell biochar contained the highest P. The P nutrient is very helpful in the process of plant root growth and also has a role in distribution of energy throughout part plant [11]. Better plant root growth can impact on the nutrient absorption and distribution to plant parts which in turn resulted in higher plant cell division shown by taller plants.

Application of coconut shell biochar can increase the effectivity of fertilization in plants, besides can be used as a nutrient binder in nutrient deficient plants to help plant growth. Biochar becomes valuable because it made from organic matter with many benefits, namely (1) its high stability against overhaul; (2) the ability to retain nutrients land; and (3) reduce environmental pollution [12]. Previous studies had reported increasing land fertility. The addition of biochar is strongly influenced by the characteristics of the biochar. Each biochar has a character and different chemistry, depending on the ingredients and raw materials used, and the chemical properties of biochar is one possible factor influence its role in improving soil fertility [13].

Rice husk biochar treatment significantly affected parameter of number of fruits per plant and fruit weight per plot. This might be caused by the role of rice husk biochar applied to increase the availability of P and K nutrients for nutrient uptake of the cayenne pepper, hence, can produce more fruits. Fruit production was determined by the availability of nutrients and waters that control the photosynthesis rate. During the reproductive phase, plant use the resulting photosynthate that are distributed to plant part including fruits. Biochar has capacity high water resistance, therefore adding the biochar to the growth media can maintain the Nitrogen and make it more available for plants by avoiding nutrient loss caused by leaching. Addition of biochar can increase moisture and soil pH, and stimulates the process of N mineralization and nitrification that causes the plant uptake to increase [14]. Rice husk biochar contains nutrients of 2% N, 15% P₂O₅, 31% K₂O and some elements with a pH of 6.8. This type of biochar can improve soil porosity making the land becomes loose and also increase land ability to absorb water. Abrishamkesh et al. [15] reported that rice husk biochar application can significantly upgrade land organic carbon, cation exchange capacity, availability of potassium and degrade heavy metal content.

4. Conclusion

Based on the results of the recent study, it can be concluded that there is no significant effect of bioslurry except on the parameter of fruit weight per plot. Types of biochar applied to the cayenne pepper plant significantly affected the plant height, number of fruits per plant formed, and in turn fruit weight per plot. Application of coconut shell biochar 4.4 kg per plot resulted in the highest plant height (36.31 cm) while the use of rice husk biochar 4.4 kg per plot resulted in the highest number of fruits per plant (30.27) fruits and total fruit weight per plot (4.33 kg).

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