



Effectiveness of Biochar and Organic Fertilizer on Growth of Maize in Kayu Putih Agroforestry

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Abstract. The availability of marginal land that is still wide is an opportunity to be exploited. Forest Management Resort in Gunung Kidul is one of the dry lands that can be used for maize cultivation based on Kayu Putih Agroforestry. Biochar as a soil enhancer and organic fertilizer can increase soil fertility in marginal lands. The study aims to obtain the best effect of organic fertilizer and biochar on maize growth. The study was conducted in Playen using 2-factor CRBD. The first factor is the type of biochar (control, rice husk, and coconut shell biochar) and the second factor is the type of organic fertilizer (control, organic cow, organic goat, and organic chicken). Treatment was repeated 3 times. The data obtained were analyzed by Annova and continued with the DMRT. The results showed that coconut shell biochar gave the highest yield on plant height, stem diameter, and several leaves at 7 WAP. Rice husk gave the best yield on leaf area and dry weight at 3 WAP. Chicken organic gave the highest yield on plant height, stem diameter, and several leaves at 7 WAP. Cow organic showed the best leaf area and dry weight at 3 WAP.

Keywords: Agroforestry · marginal land · maize · biochar · organic fertilizer

1 Introduction

Marginal land is characterized by a low level of fertility. This land has a variety of limiting factors ranging from nutrients, temperature, water, humidity, and others [1]. Marginal land is divided into two groups based on water availability, namely *wetlands* and *uplands*. Examples of dry land are yards, fields, and moorlands that have not been optimally utilized [2]. Marginal land use has challenges in the form of low fertility. Marginal land has a low nutrient content so its productivity is low [3]. Marginal land can be used as agricultural land by fertilizing soil and crops by providing microorganisms and sustainable agricultural patterns, namely agroforestry systems [4]. Improvement and improvement of soil fertility are carried out by applying biochar and organic fertilizers. Improving soil fertility and soil health can be done by applying biochar [5]. Soil fertility

chemically, physically, or biologically as well as soil organic matter can be increased by the application of organic fertilizers [6].

The availability of marginal land in Indonesia has a potential area of 157 million hectares. However, the utilization is only 91 million hectares or only about 58%. The use of marginal land can be used as a means of increasing the need for food self-sufficiency, one of which is maize commodities. The need for corn in the world is increasing every year along with the need for corn utilization that is getting higher. Maize is widely used for various needs such as foodstuffs, feed, seeds, and processed industrial materials [7]. The increasing needs certainly need to be balanced with high production. Maize production according to FAO in Indonesia from 2010 to 2018 continued to rise with peak production in 2018 of 30.1 million tons. This production figure continues to rise with the year and the needs are increasing so there is a need to increase maize production. Efforts to increase maize can be done by increasing the planting area or it can be called extensification [8]. Gunung Kidul has a Forest Management Resort with eucalyptus commodities with a passage system so that in between eucalyptus plants can be used for cultivated land such as corn plants, so it is expected to support the provision of corn for the needs of the community. This study aims to examine the growth response of corn by applying biochar and organic fertilizers.

2 Materials and Methods

The research was conducted at the Forest Management Resort, Bleberan, Gunung Kidul Yogyakarta from March to June 2022. The great seed used is the seed of the Pertiwi variety hybrid maize 3. This study used a two-factor Complete Randomized Block Design (CRBD). The first factor, namely biochar consists of 3 kinds, without biochar (control), coconut rice husk, and coconut shell biochar. The second factor, namely organic fertilizer consists of 4 kinds, namely without organic fertilizer (control), chicken organic fertilizer, cow organic fertilizer, and goat organic fertilizer. From these factors, 12 treatment combinations were obtained, and the entire experiment was repeated 3 times so that 36 experimental units were obtained. The observation variables made include plant height, stem diameter, number of leaves, leaf area, and dry weight of the plant.

3 Results and Discussion

3.1 Plant Height

Based on the results of the DMRT test analysis in (Table 1) shows that the application of organic fertilizers and biochar has no interaction with maize plant height at 7 WAP. The results of the various analysis show that organic fertilizers have a significant effect on plant height. The treatment of chicken organic fertilizer is significantly different from other treatments, this is evidenced by the highest plant height measurement results of 192.10 cm. The height of the maize crop is influenced by the nutrients absorbed by the plant [9]. The nutrient content in chicken organic fertilizer can influence maize growth. The application of chicken organic fertilizer has a significant effect on the height of maize plants with nitrogen content that can stimulate plant growth [10]. The element nitrogen is

Table 1. Average plant height with the application of organic fertilizer and biochar at 7 WAP

Types of Organic Fertilizer	Types of Biochar			Avg
	Control	Coconut shell	Rice husk	
Control	141.40	157.53	177.47	158.80a
Chicken	194.07	197.53	184.72	192.10b
Cow	174.67	170.67	156.47	167.30a
Goat	152.93	180.13	180.13	171.06a
Avg	165.77a	176.50a	174.70a	(-)

Description: Numbers followed by the same letter in the same column and row indicate an unreal difference in the Duncan test type (DMRT) of 5%. [-]: no interaction

Table 2. Average diameter with the application of organic fertilizer and biochar at 7 WAP

Types of Organic Fertilizer	Types of Biochar			Avg
	Control	Coconut shell	Rice husk	
Control	13.95	16.02	15.91	15.29a
Chicken	19.20	17.09	17.29	17.86c
Cow	15.96	16.61	15.83	16.13ab
Goat	16.81	17.72	16.53	17.01bc
Avg	16.48a	16.86a	16.38a	(-)

Description: Numbers followed by the same letter in the same column and row indicate an unreal difference in the Duncan test type (DMRT) of 5%. [-] no interaction

necessary for forming compounds such as nucleic acids, enzymes, and chlorophyll. This compound is needed to trigger processes from metabolism. Plant growth will be good if all the metabolism processes can run well. Lack of nitrogen in the soil can interfere with growth and development and reduce the yield of plants because the process of photosynthesis will be disrupted [11].

The application of biochar had an intangible effect on the height of maize crops at 7 WAP (Table 1). However, the biochar treatment of coconut shells gave the best results compared to other treatments, which was 176.50 cm. There is no difference between the increase in plant height and the biochar treatment due to the effect given by biochar. Biochar only helps retain nutrients but does not provide nutrients for plants due to the high C/N ratio of biochar [12]. The higher the C/N ratio that biochar has, the mineralization process is hampered so that plants get less nutrient supply.

3.2 Stem Diameter

Table 2 shows that the application of organic fertilizer and biochar has no interaction with the diameter of maize stalks at 7 WAP. The results of the various analysis show that

Table 3. The average number of leaves with the application of organic fertilizer and biochar at 7 WAP

Types of Organic Fertilizer	Types of Biochar			Avg
	Control	Coconut shell	Rice husk	
Control	10.00	10.73	10.60	10.43a
Chicken	11.73	11.60	10.90	11.40b
Cow	10.67	11.07	11.13	10.95ab
Goat	10.67	11.20	11.67	11.18b
Avg	10.77a	11.15a	11.06a	(-)

Description: Numbers followed by the same letter in the same column and row indicate an unreal difference in the Duncan test type (DMRT) of 5%. [-]: no interaction

organic fertilizers have a significant effect on the diameter of the stem. Chicken organic fertilizer is significantly different from other treatments, shown by a stem diameter of 17.86 mm. The increase in the diameter of the stem is influenced by the content of potassium absorbed by the plant. [13] The addition of organic fertilizers can increase the number of potassium nutrients and the addition of stem diameters. One of the uses of potassium is to increase the level of *sclerenchyma* which functions as a thickening and strength in the stem tissue so that the plant is stronger or does not fall easily [14].

The application of biochar had an intangible influence on the diameter parameters of maize stalks at 7 WAP (Table 2). However, the coconut shell biochar treatment gave the best results compared to other treatments, which was 16.87 mm. The availability of the element in the soil greatly affects the growth of plants on the diameter of the stem. The low availability of K elements causes the development of the trunk diameter to be less good [15].

3.3 Number of Leaves

Table 3 shows that the application of organic fertilizers and biochar has no interaction with the number of maize leaves at 7 WAP. The results of the various analysis show that organic fertilizers have a significant effect on the number of maize leaves in 7 WAP. Chicken organic fertilizer is significantly different from other treatments, indicated by the number of leaves of 11.40 strands. The application of chicken organic fertilizer can affect the growth of maize, one of which is the number of leaves. This is because organic chicken fertilizer contains N, P, and K nutrients which are quite high in proportion to the increasing amount [16]. Chicken organic fertilizer carries organic matter with a high pH and calcium content. Nutrients such as macro elements N, P, and K are very useful for the growth of n plants [17].

The application of biochar has an intangible influence on the parameters of the number of maize leaves at 7 WAP (Table 3). However, the biochar treatment of coconut shells gave the best results compared to other treatments, which amounted to 11.15 strands. The number of leaves belongs to one of the indicators of plant growth that is affected by the environment. In general, the number of leaves has a close relationship

Table 4. Average leaf area with the application of organic fertilizer and biochar at 3 WAP

Types of Organic Fertilizer	Types of Biochar			Avg
	Control	Coconut shell	Rice husk	
Control	24.42	22.17	22.56	23.05a
Chicken	35.16	26.62	26.50	29.43ab
Cow	35.41	54.90	41.35	43.89b
Goat	26.27	14.90	51.10	30.76ab
Avg	30.31a	29.65a	35.38a	(-)

Description: Numbers followed by the same letter in the same column and row indicate an unreal difference in the Duncan test type (DMRT) of 5%. [-]: no interaction

with the height of the plant. The higher a plant, the more leaves there will be. In maize crops, as the maize plant increases in height, it will affect the increase of segments as a place for leaves to grow. The number of leaves is related to the ability of plants to carry out the process of photosynthesis and produce biomass [18].

3.4 Leaf Area

Based on the results of the DMRT test analysis in (Table 4) shows that the application of organic fertilizers and biochar has no interaction with the maize leaf area at 3 WAP.

The results of the various analysis show that organic fertilizers have a significant effect on the area of corn leaves in 3 WAP. Cow organic fertilizer is significantly different from other treatments, as shown by the leaf area of 43.89 cm². Cow organic fertilizer can provide nutrients for maize crops. The application of cow organic fertilizer can increase the N, P, and K elements. Increasing soil nitrogen levels then nitrogen levels can increase pada plant tissue. Higher nitrogen levels can spur plant growth [19]. The application of fertilizers that are high in nitrogen levels can accelerate the growth and development of plants to shorten the time in increasing the number of leaves and the size of the leaf area.

The application of biochar had an intangible effect on the area of maize leaves at 3 WAP (Table 4). However, the biochar treatment of rice husks gave the best results compared to other treatments, which was 35.38 cm². The formation of vegetative parts in plants is helped by the availability of sufficient nutrients. The area of the leaves will be wider according to the large amount of chlorophyll produced by the plant. This improves the photosynthetic process thereby increasing crop biomass and maize crop production [20].

3.5 Dry Weight

Table 5 shows that the application of organic fertilizers and biochar has no interaction with the dry weight of maize shells at 3 WAP. The results of the various analysis show that organic fertilizers have a significant influence on the dry weight parameters of maize shells at 7 WAP. Cow organic fertilizer is significantly different from other treatments,

Table 5. Average dry weight with the application of organic fertilizer and biochar at 3 WAP

Types of Organic Fertilizer	Types of Biochar			Avg
	Control	Coconut shell	Rice husk	
Control	1.32	1.24	1.18	1.26a
Chicken	2.13	1.85	1.60	1.86ab
Cow	2.69	2.91	2.17	2.59b
Goat	1.68	1.55	2.90	2.04ab
Avg	1.95a	1.89a	1.96a	(-)

Description: Numbers followed by the same letter in the same column and row indicate an unreal difference in the Duncan test type (DMRT) of 5%. (-): no interaction

as indicated by the dry weight of 2.59 g [21]. The application of cow organic fertilizer can increase the productivity of the growing medium by meeting the availability of soil nutrients and help improve soil structure.

The application of biochar had an intangible effect on the dry weight parameters of maize shelling at 3 WAP (Table 5). However, the biochar treatment of rice husks gave the best results compared to other treatments, which was 1.96 g. The rice husk biochar application can increase the value of C-organic and dry biomass in plants [22]. The silica content in rice husks is a special nutrient needed for maize, sugarcane, and other cereal crops such as rice or wheat. The role of silica in plants is to increase oxygen to the roots thus helping the roots to oxidize [23].

4 Conclusion

1. The combination of organic fertilizers and biochar can affect the growth of maize plants
2. The application of chicken organic fertilizer has the highest average against plant height of 192.10 cm, stem diameter of 17.86 mm, and the number of leaves of 11.40 strands. Meanwhile, cow organic fertilizer has the highest average leaf area of 43.89 cm² and a dry weight of 2.59 g.
3. The application of coconut shell biochar has the highest average plant height of 176.50 cm, stem diameter of 16.87 mm, and several leaves of 11.15 strands. Meanwhile, rice husk biochar has the highest average leaf area of 35.38 cm² and dry weight of 1.96 g.

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