The Role of Different Types of Biochar Sources and Organic Fertilizers on Soybean Growth in Kayu Putih Agroforestry Systems

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Abstract. Dry land based on agroforestry has the potential to be utilized, but there are limiting factors such as low soil fertility. The use of organic fertilizers and biochar can increase soil fertility. The purpose of this study was to examine the response of soybean growth to the application of types of organic fertilizers and types of biochar. The study was conducted in March-June 2022 at Forest Management Resort, Gunung Kidul, Yogyakarta and was designed with CRBD. The first factor: biochar type i.e. without biochar, rice husks, and coconut shells. The second factor: the type of organic fertilizer consisting of control, chicken manure, cow manure, goat manure. Experiment was repeated 3 times. The data will be analysed using ANOVA, if there is a significant difference, continue Duncan's test at 5% level. The results showed that rice husk biochar gives the highest plant height, number of leaves, number of branches, leaf area and dry weight to soybeans. Chicken manure gives the highest yield on plant height. Goat manure gives the highest yield on the number of branches and number of leaves. Cow manure gives the highest yield on leaf area and dry weight.

Keywords: Soil Fertility · Growth · Soybean · Biochar · Agroforestry

1 Introduction

Cultivate crops are can be conducted in Degraded land or marginal land. The success of an agroforestry system based on a forestry system can be seen from the benefits that can be calculated directly through increased food production for food security. Increased production can be realized by selecting the right commodities. Types of plants in agroforestry systems that can be used as food include rice, maize, soybeans, beans, and cassava [3].

Soybean is an important commodity for people who have a role as a source of protein, carbohydrates, and vegetable oils. Soybean plants are used as strategic main food crops

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besides rice and maize because soybeans contribute greatly to the provision of nutritious ingredients for the community [2].

Degraded land has poor soil structure and texture and low soil fertility [1]. Efforts to increase soil fertility can be done by fertilizing. Application of organic fertilizers including cow manure to increase the quantity of yield and can improve and maintain soil fertility. Organic fertilizers if used in the long term have a good impact on land productivity. In addition, to the use of organic fertilizers, the application of biochar can help increase soil fertility both physically and chemically. The function of biochar in the soil serves to increase the availability of cations, CEC, soil pH and nutrients such as nitrogen and phosphate. The increase reaches 40% [4]. It is necessary to study the effect of organic fertilizers types and biochar types in supporting the growth of food crops such as soybeans. This study aims to examine the response of soybean growth to the application of organic fertilizers and biochar.

2 Materials and Methods

This research was conducted at the Forest Management Resort, Playen District, Gunung Kidul Regency, Special Province of Yogyakarta from March to June 2022. The soybean seed used is the Grobogan variety. This study was designed in a Completely Randomized Block Design with two factors namely type of biochar which consists of three levels, namely without biochar, coconut shell, and rice husk. The second factor is the type of organic fertilizer namely control, chicken manure, cow manure, and goat manure. Treatment repeated 3 times. Parameters observed were plant height, number of leaves, number of branches, leaf area and plant dry weight. The data will be analyzed using Annova and continued with the DMRT if there is a real difference with a level of 5%.

3 Results and Discussion

3.1 Plant Height

Table 1 shows no interaction between the application of biochar and organic fertilizers. Type of biochar have significant effect on plant height. Rice husk biochar exerts higher

Table 1. Average plant height

8 WAP	Types of Organic Fertilizer	Types of Biochar			
		control	Rice Husk	Coconut shell	Average
	without	17.17	28.56	34.13	26.62
	Chicken	32.39	35.55	36.85	34.93
	Cow	25.74	34.82	31.13	30.57
	Goat	26.38	41.96	34.71	34.50
Average		25.42 a	35.22 b	34.21 b	(−)

Description: The average number followed by the same letter that are not significantly based on DMRT level 5%. (−): No interaction

plant height effect compared to without biochar. The highest average is found in rice husk biochar with an average value of 35.22 cm.

Rice husk biochar has a significant effect on the C-organic content of the soil. The higher the dose of biochar, the higher the increase in organic C content in the soil. Giving biochar can increase organic C so that it can increase plant growth [5].

Types of organic fertilizers have no noticeable effect on plant height. The highest average is found on chicken manure, which is 34.93 cm (Table 1). The effect of organic fertilizer on plant height because organic fertilizer is able to supply the nutrients needed by plants [6]. The addition of organic fertilizers causes an increase in organic matter and improves the physical properties of the soil so that it has an impact on plant growth [7].

3.2 Number of Branches

Table 2 shows that no interaction between the type of biochar and organic fertilizers. The type of biochar treatment had no significant effect on the number of branches. The highest average is found in rice husk biochar with an average of 7.8 pieces. This is supported by other study that the giving of 18 ton.ha^{-1} of rice husk biochar can increase the number of productive branches because biochar in large quantities can make the soil conditions and microorganisms work optimally [8]. Biochar as a soil enhancer is able to provide stable nutrient availability for plants. The availability of sufficient nutrients in this growth phase can spur the process of cell division and differentiation to form new shoots, so that the number of branches and leaves formed is getting more and more [9].

The application of organic fertilizer did not have a significantly different effect on the number of branches. The highest average is found in goat manure with an average value of 7.4 pieces (Table 2).

The application of goat manure increases plant growth such as the number of productive branches per plot. The need for plant nutrients can be fulfilled by adding organic fertilizers. The availability of plant nutrients greatly affects plant growth. Besides that, physiological processes can run well so that it will increase plant height, number of leaves, and number of branches [10].

Table 2. Average the number of branches

8 WAP	Types of Organic Fertilizer	Types of Biochar			
		control	Rice Husk	Coconut shell	Average
	without	4.53	8.07	6.67	6.42 a
	Chicken	6.13	7.80	7.00	6.98 a
	Cow	7.33	7.00	6.53	6.96 a
	Goat	6.67	8.33	7.33	7.44 a
Average		6.17 a	7.80 b	6.88 ab	(−)

Description: The average numbers with the different notation in rows have significant effect. (−): No interaction

3.3 Number of Leaves

Table 3 shows no interaction between biochar treatment and organic fertilizers. Giving biochar at the age of 8 WAP has no significantly different effect on the number of leaves. Rice husk biochar has the highest average with a value of 42.6 leaves. The addition of biochar in the soil affects the absorption of nutrients by plants, especially the N nutrient which has a role in accelerating overall plant growth, mainly the stems and leaves of plants [11].

The application of organic fertilizer has not affected the number of leaves parameters. The highest average is found in goat organic fertilizer with an average value of 41.4 pieces (Table 3). Goat manure contains three times more nitrogen than other manure. This content can increase the growth and development of the number of plant leaves more than other manure [12].

3.4 Leaf Area

Table 4 shows no interaction between types of biochar and organic fertilizers. Rice husk gave the highest average value on leaf area of 189.69 cm^2. The efficiency and

Table 3. The average number of branches

8 WAP	Types of Organic Fertilizer	Types of Biochar			
		control	Rice Husk	Coconut shell	Average
	without	25.80	43.00	35.80	34.87 a
	Chicken	32.27	42.53	41.07	38.62 a
	Cow	41.27	37.73	36.07	38.36 a
	Goat	35.60	47.13	41.47	41.40 a
Average		33.73a	42.60 a	38.60 a	(−)

Description: The average number followed by the same letter that are not significantly based on DMRT level 5%. (−): No interaction

Table 4. The average leaf area

5 WAP	Types of Organic Fertilizer	Types of Biochar			
		control	Rice Husk	Coconut shell	Average
	without	73.87	120.09	102.62	98.86 a
	Chicken	74.90	60.56	220.90	118.79 a
	Cow	111.17	364.12	45.94	173.74a
	Goat	73.14	214.00	217.43	168.19 a
Average		83.27 a	189.69 a	146.72 a	(−)

Description: The average number followed by the same letter that are not significantly based on DMRT level 5%. (−): No interaction

Table 5. The Average dry weight of plants

5 WAP	Types of Organic Fertilizer	Types of Biochar			
		control	Rice Husk	Coconut shell	Average
	without	1.20	1.67	1.42	1.43
	Chicken	1.24	0.84	2.16	1.42
	Cow	1.79	3.91	1.10	2.26
	Goat	1.03	2.42	2.27	1.91
Average		1.32 a	2.21 a	1.74 a	–

effectiveness of fertilization can be increased by the application of biochar so that the nutrients needed by plants can be available. Optimal leaf area growth indicates optimal availability of water and nutrients for plants [13].

Treatment of organic fertilizer types does not affect the area of leaves. The highest average is found in organic cow fertilizer with an average value of 173.74 cm^2 (Table 4). Large leaf surfaces raise light capture and CO_2 is more effective, resulting in an increased rate of photosynthesis. Chicken manure treatment can increase nutrients in plants which will later be used for the photosynthesis [14]. Leaves are plant organs that can carry out the process of photosynthesis, and an increase in plant leaf area will support the achievement of optimal production. [15].

3.5 Dry Weight

Based on Table 5 shows that there is no interaction between biochar and organic fertilizer type. Biochar does not exert a markedly different influence on dry weight parameters. Highest average dry weight on rice husk biochar treatment was 2.21 g. Supported by research results [16] that the addition of cow manure increases the number of pods per plant and the dry weight of the crop per plant.

The application of organic fertilizers has no noticeable effect on plant height. But the highest average is found in cow organic fertilizer with an average value of 2.26 g (Table 5). Application of organic matter is useful in providing nutrients, then it will be translocated to plant parts to stimulate the photosynthesis process so that it can affect the dry weight of the plant [17].

4 Conclusion

The conclusions that can be drawn from the explanation above are as follows:

a. The application of biochar and organic fertilizers together does not affect the growth of soybean crops on dryland agroforestry.
b. The provision of rice husk biochar types increases soybean growth namely in plant height and number of branches, with an average of 35.22 cm and 7.8 pieces, respectively.

c. Organic fertilizer has not yet had an influence on the growth of soybean plants, but the application of cow manure has the highest average values for leaf area and dry weight with successive values of 173.74 cm and 2.26 g.

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