International Journal of Research and Review
Volume 11; Issue: 8; August 2024
Website: www.ijrrjournal.com
Research Paper E-ISSN: 2349-9788; P-ISSN: 2454-2237

Effect of Various Biochar Materials and Levels of Chicken Manure Fertilizer on Soil Chemical, Growth and Yield of Soybean (*Glycine max L Merrill)*

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DOI: https://doi.org/10.52403/ijrr.20240830

ABSTRACT

This study aims to determine the effect of various biochar materials and doses of chicken manure fertilizer on soil chemical properties, growth and yield of soybean. The research method used a 2 factorial Randomised Group Design. The first factor was the treatment of various biochar materials consisting of 4 levels, namely: B0 without treatment, B1 (corn cob biochar 1.5 kg/m2, B2 (jengkol bark biochar 1.5 kg/m2), B3 (rice husk biochar 1.5 kg/m2). Factor II was chicken manure (P) consisting of P0 (0 kg/m2), P1 (0.5 kg/m2), P2 (1 kg/m2 and P3 (1.5 kg/m2). The application of various biochar materials and chicken cohe fertilizer gave a real response to soil pH, organic C, total N, available P and K available. The results showed that the application of biochar to the growth and yield of soybean plants gave a significant effect on the parameters of stem diameter, number of productive branches, number of pods, dry weight of seeds/m2, seed production/ha. The application of jengkol skin biochar gave the highest effect on stem diameter (1.750 cm), number of productive branches (5.06 branches), number of pods (181.60 pods), dry weight of seeds/m2 (442.98 grams). The application of chicken manure fertilizer on the growth and yield of soybean plants gives a significant effect on stem diameter, number of productive branches, number of pods, dry weight of seeds/plot. The dose of chicken manure fertilizer 1.5 kg/m2 showed the highest effect on stem diameter (1.79 cm), number of productive branches (5.19 branches), number of pods (184.22 pods), dry weight of seeds/m2 (398.50 g). The interaction of biochar and chicken manure fertilizer did not give significant effect on all treatments.

Keywords: Biomass, Biochar, Chicken Manure, Soybean

INTRODUCTION

According to the Centre for Data and Information Systems of the Ministry of Agriculture (BPS, 2022), the high level of soybean consumption in Indonesia over the past five years has led to a surge in soybean imports reaching 7 million tonnes, of which around 40% or 2.7 million tonnes are fresh soybeans, which are the raw material for making tempeh and tofu. Another thing is that the price of imported soybeans in the international market is cheaper. Based on the Market Monitoring System and Basic Needs of the Ministry of Trade as of 2 June 2022, the price of imported soybeans was IDR 14,100 per kilogram. This price increased compared to the middle of May, which was IDR 13,500 per kilogram.

Indonesia's dependency on imported soybeans is very high as indicated by the Import Dependency Ratio (IDR) value of 78.44% per year and has increased every year. This IDR value is in line with the Self Sufficiency Ratio (SSR) value of 21.61% per year which explains that Indonesia in the last five years can only meet the needs of soybean from its own production by 9.15% of the total domestic soybean needs. This condition is a red light for Indonesia's soybean sufficiency. If we do not make a real breakthrough in increasing domestic soybean production then in the next five years it is predicted that Indonesia will become a net soybean import. Therefore, a breakthrough is needed to significantly reduce soybean imports and maintain price stability. A strategic programme is needed through strengthening production innovation. Innovation in the expansion of soybean cultivation that is productive, adaptive to climate change and has a good taste image is very important. (Agungnoe, 2022).

The development of soybean crops in Indonesia is hampered by land use competition with other strategic commodities such as rice and corn and the increasing land conversion in potential land areas. In most of the soybean production centres in Indonesia, there are almost no producer farmers who make soybean as their main crop. The government continues to increase soybean production through intensification and extensification. Given the vast area in Indonesia, Indonesia can actually grow soybean in large quantities but the condition of the land that can be planted is mostly nutrient poor soil with low pH and acid soil reaction (Dariah *et al.*, 2015).

According to Balittanah (2014), dry land in Indonesia is quite extensive and can be utilised for soybean cultivation. However, the existing land is acidic soil which is a limiting factor for plant growth because acidic soil has a low pH, high Aluminium content, high Phosphate element fixation, low cation exchange capacity, poor nutrients N, P, K, Ca, Mg and Mo and low aggregate stability causing easy erosion. Sudaryono et al (2011) stated that in marginal soils with pH ranging from 4.2-5.5, nutrients such as Ca and P are fixed by Al and Fe, which makes plant growth not optimal. The provision of inputs to the soil in the form of organic fertilizers and inorganic fertilizers as well as soil improvers is needed (A. Harsono, Prihastuti, 2011).

Fertilizer is a production factor in farming, as it serves as a nutrient provider for plants so that they grow optimally and produce maximum yields. Data from 2022 notes that the allocation for subsidised fertilizers from the government is only around 37-42% of the total needs of Indonesian farmers, the rest of the farmers have to buy non-subsidised fertilizers which are more expensive and also limited in number. This causes farmers to spend more on farming, reducing their income during harvest. Various conditions in the world starting from the Covid pandemic, the energy crisis in Europe, the war between Russia and Ukraine, the war between Israel and Palestine and others have contributed to the increase in fertilizer prices. Countries exporting raw materials for N, P, K fertilizers such as Russia and Belarus which contribute 30% percent of the world's supply of phosphate which is the raw material for making NPK fertilizers.

There needs to be an effort to find ways to fertilise by utilising natural resources around farmers. One of them is utilising agricultural and livestock waste. Agricultural waste if left unattended will pollute the environment because it becomes rotting garbage, as well as livestock waste that makes odours in the environment and pollution to water sources and the surrounding environment. One of the efforts to overcome these problems is the use of organic plant biomass waste as biochar and chicken farm waste, namely chicken manure which is fermented into chicken manure fertilizer.

Biochar is a carbon-rich solid that is the result of conversion of biomass through pyrolysis. Agricultural waste that is difficult to decompose can be converted into soil improvers. In Indonesia, the potential for biochar use is quite large because raw materials such as rice husk residues, coconut shells, wood residues, cocoa pod shells are quite available. The application of biochar to agricultural soils is beneficial for (a) increasing nutrient availability (b) increasing nutrient and water retention (Glaser *et al.* 2002; Liang *et al.* 2006) (c) creating a good habitat for symbiotic microorganisms (Ogawa, 1994) (d) increasing crop production (Sukartono *et al.* 2011; Lehmann *et al*. 2006; Chan *et al*. 2007) and (e) reducing the rate of CO2 emissions (Laird 2008; Sohi *et al.* 2010).

Chicken farming in Indonesia is increasing rapidly in order to fulfil the food and protein needs of the community. This is characterised by the increasing chicken population and egg production. According to BPS data (2022), the broiler chicken population of 3,765,573.09 tonnes increased to 3,997,652.70. Layer production in 2022 was 378,590.549 tonnes. Daily chicken manure waste averages 0.075 kg/head. Based on the number of chickens from the chicken farm, it is certain that the volume of chicken manure produced is also large which if not utilised will be wasted into the environment which causes pollution. Utilising chicken manure into compost is the right way to process waste into a new form of organic fertilizer that can be applied to the soil to improve soil fertility.

Based on the explanation above, the authors are interested in conducting a study entitled ‘Response of Plant Biomass Biochar and Chicken Manure Fertilizer to Changes in Growth and Production of Soybean Plants (Glycine max.LMerill.) This study aims to investigate the response of soybean plants to a combination of biochar, plant biomass, and chicken cohe fertilizer in the Glugur Rimbun environment.

LITERATURE REVIEW

In soybean crops, especially in Indonesia, the effect of biochar residues has not been widely reported, both as a soil improver and for plant growth and yield. Biochar residues can be reused for soybean planting media. Soil in which there is biochar residue has a lot of microorganism activity because biochar has the ability to retain water, reduce soil density in soil with clay texture, and increase soil C content (Sonia *et.al*. 2014). Soil that has biochar residue is a good planting medium because biochar has pores that can keep nutrients available when plants need them.

Biochar does not undergo further weathering so that when applied in the soil can last a long period of time so that the soil that has been applied biochar can be used until the next planting season (Mawardiana et al., 2013). Biochar raw materials can be agricultural waste such as rice husks, coconut shells, cocoa shells and so on. Mawardiana et al. (2013) stated that the residue from the application of biochar at a dose of 10 tonnes ha-1 can increase the growth and production of rice plants. Biochar derived from rice husk charcoal is an agricultural waste product that can fertilise the soil and can be used as an alternative for soil management. The addition of biochar to the soil can improve the physical, chemical and biological properties of the soil, especially on sandy soils. The use of the right planting media composition is the first step that is very decisive for the success of catfish cultivation which will ultimately encourage increased productivity of catfish. The addition of biochar into the soil can increase the availability of the main cations of P and N in the soil. The increase in soil CEC and pH can increase up to 40%.

Research by Sajar (2022), stated that the application of 30 tonnes/ha chicken manure to the soil gave a positive response to vegetative growth (plant height, stem diameter, crown dry weight and root dry weight) but did not give a significant effect on the generative parameters of soybean plants (number of productive branches, number of pods, dry weight of seeds, weight of 100 seeds). The nutrient content in chicken cohe fertilizer is not too high, but the application of this organic fertilizer can improve soil permeability, porosity, soil structure, water holding capacity and soil cation content (Melati, 1990).

The provision of inorganic fertilizers and synthetic soil amendments requires considerable funds, while alternatives are available to replace them by using plant biomass waste and chicken manure.

MATERIALS & METHODS

This research was conducted in Sampecita Village, Kutalimbaru Sub-district, Deli Serdang Regency with an altitude of +/- 30 metres above sea level from November 2023 to March 2024. Soil analysis was conducted at the Agricultural Research and Development Agency (BPTP) Medan.

Materials and Tools

The materials and tools used in this research are molasses for the manufacture of chicken manure fertilizer, tarpaulin for cover during fermentation of chicken manure, chemicals for laboratory analysis. Hoes for soil sampling, burlap for soil sample containers, machetes, ropes, meters for observation purposes, handsprayers, small shovels for filling soil into polybags, bamboo for fencing the experimental area, calculators for calculating elemental requirements, scales for weighing soil and fertilizer, ovens for drying plants, rulers, notebooks for watering plants, and other tools that support research.

Type and Scope of Research

This research is an experimental research that uses Factorial Randomised Group Design consisting of 2 treatment factors and 3 blocks. The scope of the research focused on the application of organic fertilizer. Soybean plants were planted as indicator plants by observing the production of soybean plants.

Factor I. Biochar (B) which consists of 4 treatment levels, namely:

B0 = No treatment (0 kg/m2)

B1 = corn cob biochar (1.5 kg/m2)

B2 = jengkol bark biochar (1.5 kg/m2)

B3 = rice husk biochar (1.5 kg/m2)

Factor II. Chicken manure fertilizer (A) which consists of 4 treatment levels, namely:

P0 = 0 kg/m2

P1 = 0.5 kg/m2

P2 = 1 kg/m2

P3 = 1.5 kg/m2

The application of biochar and chicken manure is done 2 weeks before planting by mixing and stirring until smooth using a hoe according to the treatment. The soil is ready to be used to see its effect on the growth and production of soyabean plants (indicator plants).

Soya bean seeds were planted in the planting holes that had been provided. Soybean seeds were planted with 2 seeds per planting hole that were drilled 2 - 3 cm deep with a spacing of 40 cm × 20 cm. At the age of 7 days after planting (HST), plant thinning was carried out and one plant was left per hole so that there were 8 plants per experimental plot.

Watering was done every day in the morning and evening. Weeding is done once a week depending on the growth of weeds in each plot and research land, done manually by pulling weeds directly and loosening the soil. Harvesting of soybean plants was carried out when the plants were 90 HST. with the criteria that the leaves become yellow and fall off easily, the stems begin to harden and the plants dry out. The observation parameters were plant height, stem diameter, number of productive branches, number of pods, dry weight of seeds per ha.

STATISTICAL ANALYSIS

Data from the study were analysed using variance analysis based on the following linear model:

$$Yijk = \mu + \rho i + \alpha j + \beta k + (\alpha\beta)jk + \varepsilon ijk$$

Where:

$\hat{Y}ijk$ = Observation result in the i-th block that received biocar treatment from the jth source and chicken cochlea fertilizer at the kth level

μ = Central value effect
pi = The effect of the i-th block
αj = Effect of biocar from various sources at level j
βk = Effect of application of chicken manure at level k
(αβ)jk = Interaction between the factors of biochar from various sources at level j and chicken manure at level k
Ɛijk = Effect of error in the i-th block of various biochar sources at the jth level and chicken manure at the kth level (Steel and Torrie, 1980)
All data were analysed by analysis of variance at the 5% test level to determine the differences in treatment effects that can be seen in the significance of F count. In variables with F counts that showed significance at the 5% test level, then a real difference test was conducted based on the Duncan Multiple Range Test at the 5% α level to determine differences between treatments.

RESULT

Chemical composition of chicken manure fertilizer

Based on the analysis of chicken manure fertilizer Table 1, the content of Nitrogen (N) is 2.19%, Phospor (P) is 3.23%, Potassium (K) is 3.77%, and C-Organic is 15.00%. The results of the above analysis show that the C/N ratio is quite high but the content of Nitrogen, Potassium and Phosphorus is low. The results of this study differ in terms of nutrient levels of chicken cohe fertilizer with other studies, this is thought to be due to differences in the type of feed given to chickens. (Hartati el al., 2015) stated that the content of nutrients contained in chicken manure fertilizer can vary depending on the feed given to chickens, besides the use of husks as a base for chicken manure can add nutrients to manure.

Table 1. Chemical composition of chicken manure fertilizer

Chemical properties	Chicken manure fertilizer	Unit
C org	15,00	%
N	2,19	%
P	3,23	%
K	3,77	%
C/N	17,00	%

According to the results of research by Sajar (2020), chicken manure fertilizer has a Nitrogen (N) content of 1.73%, Phospor (P) 1.45%, Potassium (K) 1.12%, and C-Organic 18.15%. Chicken manure fertilizer can be a source of Nitrogen, Phosphorus, Potassium and other elements. Nitrogen is one of the main nutrients for plants. Nitrogen needs of plants can be obtained from the application of manure fertilizer >25 tonnes/ha. Nitrogen from chicken manure fertilizer will be converted into the form of available nitrate. Nitrate dissolves easily and moves to the root zone of the plant. This form of nitrate is the same as the form of nutrients that can be taken by plants from organic fertilizers made by fertilizer factories (Hartatik and Widowati, 2006).
In terms of the proportion of N, P and K content, the results of this study are in line with (Hartati *et al*., 2015) which states that chicken cohe fertilizer has low N, P and K nutrients but if applied to the soil can improve the availability of soil nutrients through changes to chemical properties, physical and biological properties of the soil.
The results of research by Ramdhan *et al.,* (2021), that 40 tonnes/ha chicken manure fertilizer gives the best effect on plant height, stem diameter, fresh weight per plant, plant dry weight, and root length of kale plants. Some research results of chicken manure fertilizer application always give the best plant response in the first season. This happens because chicken manure fertilizer is relatively faster to decompose and has sufficient nutrient content when compared to the same number of units as other pukans (Hartatik and Widowati, 2006).

Changes in Soil Chemical Properties

pH

Table 2 shows that the single application of biochar is not significantly different from pH and the treatment of chicken manure fertilizer is also not significantly different from soil pH but the combination of biochar and chicken manure fertilizer gives a real response to the average soil pH. The average soil pH ranged from 4.34 to 6.85. There was an increase in soil pH due to the application of biochar and chicken manure fertilizer after incubation for 2 weeks. The highest increase in soil pH was found in the average B2P2 treatment (biochar of jengkol bark with 1.0 kg/m2 of chicken manure fertilizer) with a pH value of 6.85, significantly different from other treatments. While the lowest average soil pH was found in the B1P2 treatment (corn cob biochar with 1.0 kg/m2 chicken manure) with a pH value of 4.34.

Table 2. Average soil pH due to the application of biochar and chicken manure fertilizer

Biochar plant biomass	Chicken manure fertilizer								Average	
	P0 (0 kg/m2)		P1 (0,5 kg/m2)		P2 (1,0 kg/m2)		P3(1,5 kg/m2)			
	…..................….............%………………....................									
B0= no treatment	5.24	abcd	5.98	abcd	6.33	bcd	5.59	abcd	5.79	a
B1= corn cob	4.46	ab	4.95	abcd	4.34	a	6.49	bcd	5.06	a
B2= jengkol bark	6.83	abcd	5.17	abcd	6.85	d	4.96	abcd	5.95	a
B3= rice husk	4.53	abcd	6.14	bcd	4.49	abc	6.71	cd	5.47	a
Average	5.27	a	5.56	a	5.50	a	5.94	a		

Notes: Numbers with the same letter in the same column are not significantly different according to the DMRT test at the 5% level.

Sukmawati's research (2020) states that the pH of biochar from corn cobs is alkaline with a value of 7.3, C-organic 70.2%, this shows that biochar from corn cobs can be used as a soil improver for soil fertility. For more details on the difference in soil pH due to the application of biochar and chicken kohe fertilizer can be seen in Figure 1.

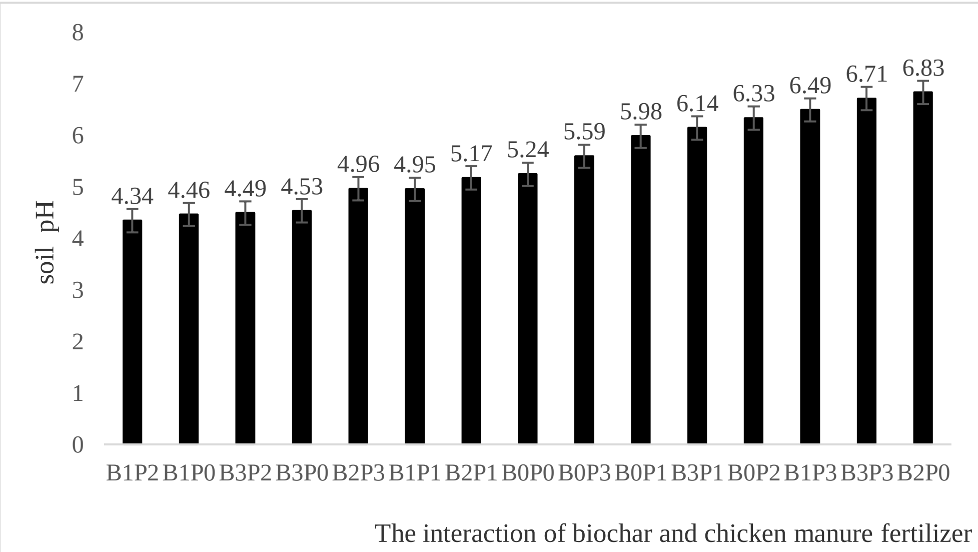

Figure 1. Soil pH relationship due to the application of biochar and chicken manure fertilizer to the soil after 2 weeks incubation

C-organic

The application of biochar and chicken manure fertilizer and the combination of both had a significant effect on soil C-organic content. Average C organic due to the application of biochar and chicken manure fertilizer can be seen in Table 3. The highest average was found in the B0P2 treatment (without biochar and 1.0 kg/m2 chicken manure fertilizer at 3.47%, significantly different from other treatments. While the lowest average C organic was found in the B1P0 treatment (corn cob biochar and 0 kg of chicken manure fertilizer) at 1.13%.

The application of biochar and chicken manure fertilizer increases the availability of organic matter in the soil. Organic matter will be broken down by microbes living in the soil by releasing enzymes needed to decompose simple compounds, some of which are used by bacteria and fungi as energu. The freed nutriens can be used for plant growth (Hanafiah, 2009).

Table 3. Average organic C due to the application of biochar and chicken kohe fertilizer after 2 weeks incubation

Biochar plant biomass	Chicken manure fertilizer								Average	
	P0 (0 kg/m2)		P1 (0,5 kg/m2)		P2 (1,0 kg/m2)		P3(1,5 kg/m2)			
	….............…..............%…………………...................									
B0= no treatment	2.01	bcd	2.05	bcd	3.47	f	2.11	bcd	2.41	b
B1= corn cob	1.13	a	2.06	bcd	2.30	bcde	2.58	cdef	2.02	a
B2= jengkol bark	2.17	bcd	2.04	bcd	2.04	bcd	2.26	bcde	2.13	a
B3= rice husk	1.81	b	2.52	cdef	2.01	bc	3.20	def	2.39	b
Average	1.78	a	2.17	b	2.21	b	2.54	b		

Notes: Numbers with the same letter in the same column are not significantly different according to the DMRT test at the 5% level.

To see the difference in soil C organic content due to the application of biochar and chicken cohe fertilizer can be seen in Figure 2.

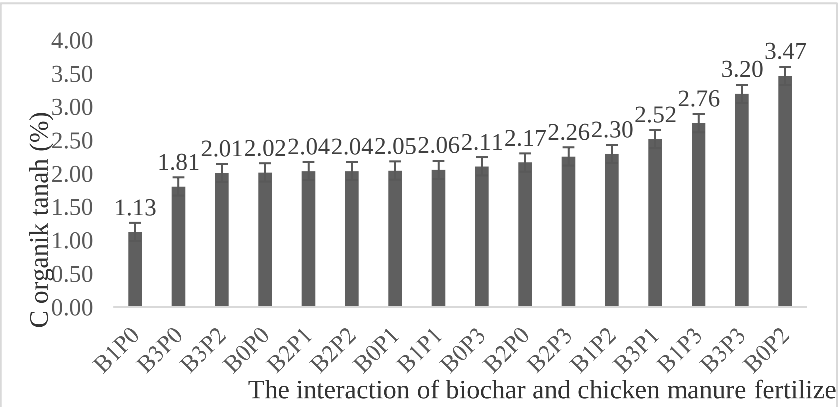

Figure 1. The relationship between C-organic and the application of biochar and chicken manure fertilizer

According to Lehmann *et al. (*2003), in a study using cowpea (*Vigna unguiculata* L.) and rice (*Oryza sativa* L). concluded that the addition of biochar significantly increased plant growth and nutrition. The utilisation of biochar as a soil improver and energy source, can improve soil fertility by improving cation exchange capacity and nutrient retention resulting in increased land productivity. Apllication of biochar to the soil can improve C absorption and soil quality.

N total

The application of biochar and chicken manure fertilizer wre significantly different on N-total. The combination of biochar and chicken manure fertilizer gave a significant response to N total.

Table 4. Mean N due to biochar and chicke manure fertilizer application to soil after 2 weeks of application

Biochar plant biomass	Chicken manure fertilizer								Average	
	P0 (0 kg/m2)		P1 (0,5 kg/m2)		P2 (1,0 kg/m2)		P3(1,5 kg/m2)			
	….............….............%………………....................									
B0= no treatment	0.22	a	0.24	abcd	0.50	g	0.27	abcde	0.31	ab
B1= corn cob	0.22	ab	0.26	abcde	0.37	fg	0.56	efg	0.31	ab
B2= jengkol bark	0.45	fg	0.31	abcdef	0.32	bcdef	0.54	defg	0.36	b
B3= rice husk	0.23	abc	0.30	defg	0.22	abc	0.34	cdefg	0.27	a
Average	0.28	a	0.28	a	0.35	b	0.34	b		

Notes: Numbers with the same letter in the same column are not significantly different according to the DMRT test at the 5% level.

In table 4, it can be seen that the highest average was found in the BOP2 at 0,50% and the lowest average N total was found in the B0P0 0,22%. To see the difference in N total content due to the provision of biochar and chicken manure fertilizer can be seen in Figure 3.

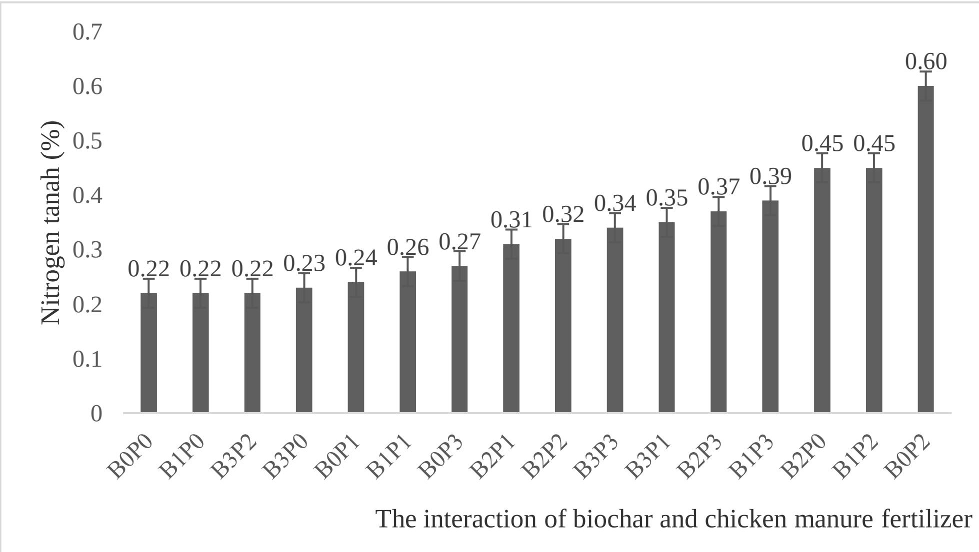

Figure 3. Relationship between N total and biochar and chicken manure fertilizer after 2 weeks incubation

P available

The application of biochar and chicken manure fertilizer were significantly different on P-available. The interaction of biochar and chicke manure gave a signicant response to the average P available.

Table 5. P available (ppm) due to biochar and chicken manure fertilizer application to soil after 2 weeks of application

Biochar plant biomass	Chicken manure fertilizer									
	P0 (0 kg/m2)		P1 (0,5 kg/m2)		P2 (1,0 kg/m2)		P3(1,5 kg/m2)		Average	
	….............…............ppm ………………....................									
B0= no treatment	1.77	abc	2.43	bcd	1.65	abc	3.56	def	2.35	a
B1= corn cob	5.29	g	2.64	cde	1.17	a	3.3	def	3.10	b
B2= jengkol bark	4.11	efg	1.32	ab	4.42	fg	2.77	cde	3.16	b
B3= rice husk	1.79	abc	3.56	def	3.99	efg	4.02	efg	3.34	b
Average	3.24	b	2.49	a	2.81	a	3.41	b		

Notes: Numbers with the same letter in the same column are not significantly different according to the DMRT test at the 5% level

In Table 5, it can be seen that the highest average was found in the B1P0 (5,29 ppm) and the lowest P available was foun in the B1P2 (1,17 ppm). On average, there was an increase in P available in the soil compared to the soil without biochar and chicken manure fertilizer. To see the difference in P available content due to the application of biochar and chicke manure fertilizer can be seen in Figure 4.

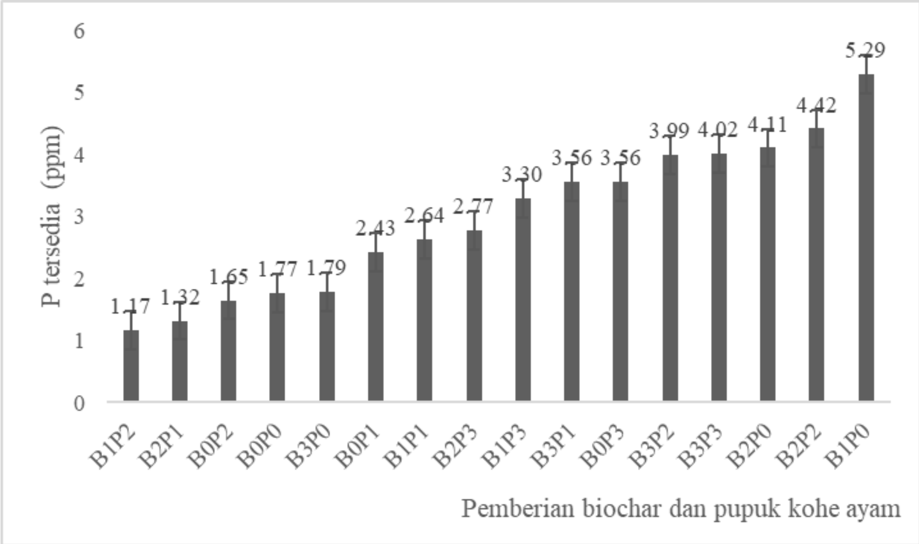

Figure 4. Relationship between P available and biochar and chicken manure fertilizer application

The result showed that the combination of plant biomass waste in the form of biochar and chicken farm waste as chicken manure fertilizer can increase the availability of P in the soil.

K available

The average K due to the application of biochar and chicken manure can be seen in Table 6. Application of biochar and chicken manure fertilizer and the interaction of both had a significant effect on the K available. The highest average was found in B0P2 (9,76 me/100 g), significantly different from other treatments. The lowest K available was found in B0P0 (0,50 me/100 g).

Table 6. Mean K available due to application of biochar and chicken manure fertilizer after 2 weeks incubation

Biochar plant biomass	Chicken manure fertilizer								Average	
	P0 (0 kg/m2)		P1 (0,5 kg/m2)		P2 (1,0 kg/m2)		P3(1,5 kg/m2)			
	…..............…..............me/100 g……………...........									
B0= no treatment	0.50	a	1.34	bcd	9.76	h	6.49	g	4.52	bc
B1= corn cob	0.84	abc	2.53	de	4.50	f	8.46	h	4.08	b
B2= jengkol bark	1.02	abc	2.19	d	5.75	fg	5.99	g	3.74	b
B3= rice husk	0.65	ab	3.90	e	1.61	bcd	1.90	cd	2.02	a
Average	0.75	a	2.49	b	5.41	c	5.71	d		

Notes: Numbers with the same letter in the same column are not significantly different according to the DMRT test at the 5% level

To see the difference in soil K available due to the application of biochar and chicken manure fertilizer can be seen in Figure 5.

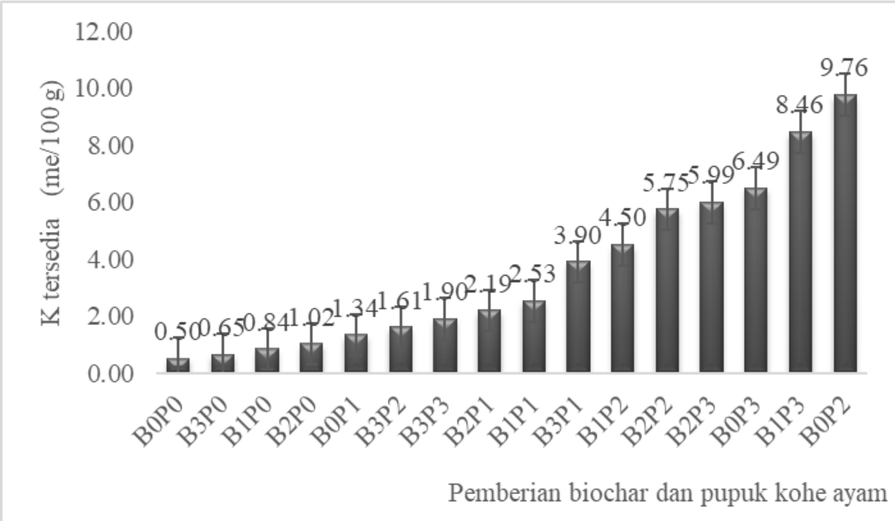

Figure 5. Relationship between K available with biochar and chicken manure fertilizer

Growth and Yield of Soybean Plants

Table 8 presents data on the average vegetative growth of soybean plants resulting from the application of various biochar and chicken manure fertilizers, namely plant height, stem diameter, shoot dry weight and root dry weight. Statistical analysis showed that the provision of plant biomass biochar had no significant effect on soybean plant height. Providing chicken manure fertilizer did not have a real effect on soybean plant height.

Table 8. Mean vegetative growth of soybean plants due to the application of biochar and chicken manure fertilizer

Treatment	Plant heiht		Trunk diameter		Crown dry weight		Root dry weight	
Biochar	**…..cm…**		**…..mm...**		**…gram...**		**…gram…..**	
B0= no treatment	74,56	a	1.54	a	31.38	a	10.23	a
B1= corn cob	72,50	a	1.68	b	35.73	a	10.44	a
B2= jengkol bark	75,59	a	1.75	b	40.52	a	10.24	a
B3= rice husk	72,25	a	1.61	b	32.71	a	9.05	a
Chicken manure fertilizer	**….cm….**		**….mm…**		**….gram..**		**…gram…...**	
P0 (0 kg/m2)	69,00	a	1.43	a	24.01	b	7.59	a
P1(0,5 kg/m2)	73,38	a	1.68	b	35.29	ab	10.70	ab
P2(1,0 kg/m2)	75,78	a	1.67	b	39.61	a	9.77	a
P3 (1,5 kg/m2)	76,75	a	1.79	b	41.43	a	11.89	b

Notes: Numbers with the same letter in the same column are not significantly different according to the DMRT test at the 5% level

The application of plant biomass biochar was significantly different to the diameter of soybean stems, while the treatment of chicken manure fertilizer was also significantly different to the diameter of soybean stems, but the interaction between the two was not significantly different. The highest stem diameter was found in the jengkol barkbiochar treatment (1,750 cm) and the lowest was without biochar treatment (1.54 cm). In the treatment, the highest dose of chicken cohe was given at a dose of 1.5 kg/m2 (1.79 cm) and the lowest was at a dose of 0 kg/m2, namely 1.431 cm.

The application of biochar did not have a real effect on the dry weight of soybean shoots. Chicken manure fertilizer treatment did not have a significant effect on the dry weight of soybean shoots. The interaction between providing biochar and chicken manure fertilizer did not have a significant effect on shoot dry weight.

The results of the study showed that the application of biochar did not have a significant difference in the dry weight of soybean roots. The chicken kohe fertilizer treatment had a significant difference in the dry weight of soybean roots. The interaction between giving biochar and chicken kohe fertilizer was not significantly different on root dry weight. This research is in accordance with Hartati et al., (2015) that the application of chicken manure to the soil will cause better plant growth through changes in soil structure to become more crumbly, aeration and water absorption capacity as well as better water reserves, which shows that manure will improve the physical, chemical and biological properties of the soil simultaneously.

Table 9 presents data on the average generative growth of soybean plants, namely the number of productive branches, number of pods, dry weight of seeds/m2 and seed production of soybean plants per ha. Providing biochar did not have a real effect on the number of productive soybean branches, nor did giving chicken manure fertilizer have a real effect on the number of productive soybean branches. There was no interaction between the provision of biochar and chicken manure fertilizer on the number of productive branches.

Table 9. Mean generative growth of soybean plants due to application of biochar and chicken manure fertilizer

Treatment	Number of productive branches		Number of pods		Seed weight per m2		Production per ha	
Biochar	**cabang**		**polong**		**gram**		**ton**	
B0= no treatment	4.91	a	143.7	a	335.15	a	3.351	a
B1= corn cob	4.91	a	156.3	ab	422.66	b	4.226	b
B2= jengkol bark	5.06	a	181.6	b	442.98	b	4.429	b
B3= rice husk	4.44	a	175.5	ab	346.24	b	3.462	b
Chicken manure fertilizer	**cabang**		**polong**		**gram**		**ton**	
P0 (0 kg/m2)	4.22	a	144.4	a	348.61	a	3.486	a
P1(0,5 kg/m2)	5.09	a	149.3	b	357.54	a	3.575	a
P2(1,0 kg/m2)	4.88	a	179.2	c	427.85	b	4.278	b
P3 (1,5 kg/m2)	5.13	a	184.2	c	413.03	b	4.131	b

Notes: Numbers with the same letter in the same column are not significantly different according to the DMRT test at the 5% level

The highest number of soybean pods was given by jengkol bark biochar (181.64 pods) which was significantly different from rice husk biochar (175.47 pods), corn cobs (156.31 pods) and without treatment (143.66 pods). In the chicken manure fertilizer treatment, the highest number was found at a dose of 1.5 kg/m2, namely 184.22 pods, which was not significantly different from a dose of 1.0 kg/m2 (179.20 pods) but was significantly different from a dose of 0.5 kg/m2 (149.25 pods) and without treatment (144.4 pods).

The application of biochar had a significant difference in the dry weight of seeds/m2 of soybeans. The chicken manure fertilizer treatment had a significant difference in the dry weight of soybean seeds/m2. The interaction between giving biochar and chicken manure fertilizer was not significantly different on seed dry weight/m2. The heaviest dry weight of seeds in the biochar treatment was found in the biochar treatment of jengkol bark (442.98 g), corn cobs (422.66 g), rice husks (345.24 g), without treatment (335.15 g). In the heaviest chicken manure fertilizer treatment there was a dose of 1.5 kg/m2 (398.50 g), a dose of 1 kg/m2 (391.08 kg/m2), a dose of 0.5 kg/m2 (343.49 kg/m2) and without treatment (280.49 g).

DISCUSSION

Giving biochar can increase the availability of organic matter in the soil. Organic matter will be broken down by microbes living in the soil by releasing enzymes needed to decompose simple compounds, some of which are used by bacteria and fungi as energy. The freed nutrients can be used for plant growth (Hanafiah, 2009).

Atkinson *et al*. (2010) point out that key characteristics of biochar are important for developing an understanding of its impact in agriculture. The chemical properties of biochar that play a role are that the surface of biochar has functional groups that can be hydrophilic hydrophobic, and can be acidic and basic, so that it can react with the surrounding solution. The physical properties of biochar that can be useful as a soil improver are the large surface area and the presence of micro pores, which make it have absorbent properties. These physical and chemical properties of biochar have the potential to improve soil properties such as pore distribution, bulk density, water holding capacity (Mukherjee & Lal, 2013).

Laird *et al.* (2010) reported that the application of biochar made from wood waste processed by pyrolysis, can increase the soil's ability to hold water, reduce soil content weight and increase the soil's ability to hold water. The results of research by Karhu et al. (2011) showed that the application of biochar made from pyrolysis of wood can improve the physical properties of medium-textured soil, namely ae

The results of research by Herath *et al.* (2013), biochar from pyrolysis of 350-500 0C corn straw, can increase aggregate stability and mesopores so as to facilitate drainage in poorly drained soils. Mukherjee & Lal (2013) also reported that biochar application can increase soil water holding capacity. Application of maize biomass biochar on sandy soil can reduce soil bulk density and increase total porosity, thereby increasing soil water availability.

The results of statistical data analysis showed that the effect of chicken manure fertilizer on the growth and yield of soybean did not significantly affect the parameters of plant height, crown dry weight and root dry weight. The application of chicken manure fertilizer to the growth and yield of soybean plants has a significant effect on stem diameter, number of productive branches, number of pods, dry weight of seeds per m2. The dose of chicken manure fertilizer 1.5 kg/m2 showed the highest effect on stem diameter (1.79 cm), number of productive branches (5.19 branches), number of pods (184.22 pods), dry weight of seeds/m2 (398.50 g.), and dry weight of seeds/m2 (398.50 g.).

The application of chicken kohe manure fertilizer at 1.5 kg/m2 showed the best plant height. This is thought to be because at this dose the available nutrients are better than other treatments. So that it can be absorbed by plants well to support their growth, especially plant height. In accordance with the opinion of Widowati (2005), which states that the function of chicken manure fertilizer is to increase the absorption and storage capacity of water which as a whole is able to increase soil fertility, so that the roots are easier to absorb nutrients contained in the soil, a good effect because in addition to adding nutrients it can also improve the physical properties and activities of soil microorganisms.

Andi *et.al.* 2023 stated that the use of various types and compositions of organic fertilisers obtained results comparable to inorganic fertilisers in all aspects of growth and yield of long bean plants. The provision of soil improvers in the form of biochar has a significant effect on the growth and production of shallot plants. (Luta *et.al*, 2019). The application of banana peel liquid organic fertiliser has a very significant effect on the growth and production of soybeans at a dose of 300 ml/litre/m2 and the application of chicken manure has a significant effect on the number of pods, seed weight/plant and seed weight/mw of soybean plants with a dose of chicken manure of 3 kg/m2 (Zamriyeti *et al*, 2021). Najla *et.al* (2019) stated that the provision of organic matter in the form of moringa leaf liquid organic fertiliser with the best dose of 300 ml/litre of water/m2 and quail manure 2 kg/m2 had a significant effect on the growth and production of long beans.

CONCLUSION

1. Application of various biochar materials and chicken cohe fertiliser gave a real response to soil pH, organic C, total N, available P and available K.
2. The application of biochar to the growth and yield of soybean plants gave a significant effect on stem diameter, number of productive branches, number of pods, dry weight of seeds per m2. Biochar application of jengkol skin gave the highest effect on stem diameter (1.750 cm), number of productive branches (5.06 branches), number of pods (181.60 pods), dry weight of seeds/m2 (442.98 gr).
3. The application of chicken kohe fertiliser on the growth and yield of soybean plants gives a significant effect on stem diameter, number of productive branches, number of pods, dry weight of seeds/m2. The dose of chicken kohe fertiliser 1.5 kg/m2 showed the highest effect on stem diameter (1.79 cm), number of productive branches (5.19 branches), number of pods (184.22 pods), dry weight of seeds/m2 (398.50 g).

Declaration by Authors

Acknowledgement: None
Source of Funding: None
Conflict of Interest: The authors declare no conflict of interest.

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How to cite this article: Suryani Sajar, Andi Setiawan, Adella Tri Anzani. Effect of various biochar materials and levels of chicken manure fertilizer on soil chemical, growth and yield of soybean (*Glycine max L Merrill*). *International Journal of Research and Review*. 2024; 11(8): 279-293. DOI: *10.52403/ijrr.20240830*

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