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Utilization of biochar and NPK fertilizer for soybean planting (*Glycine max* (L.) Merrill) in Ultisol media

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Abstract

This study aimed to obtain the growth and yield of soybean plants on ultisol medium after being treated with biochar and NPK fertilizer. The research was carried out in the experimental garden of the Faculty of Agriculture, Riau University, from November 2020 to February 2021. The research was carried out experimentally in a 3 x 3 factorial form, arranged using a Completely Randomized Design. Factor I, biochar doses (0, 10, and 20 ton.ha $^{-1}$ were equivalent to 0, 100, and 200 g per plant). Factor II, NPK doses (175, 350, and 525 kg.ha $^{-1}$ equivalent to 1.75; 3.5; and 5.25 g per plant). Of the two factors, 9 combinations were obtained, and each combination was repeated 3 times to obtain 27 experimental units. Each experimental unit contained 7 plants in 7 polybags observed. Observed parameters; plant height, number of primary branches , number of effective root nodules, plant growth rate, number of pods per plant, number of pithy pods per plant, number of seeds per plant, seed weight per plant. The results showed that the combination of biochar 20 ton.ha $^{-1}$ and NPK 350 kg.ha $^{-1}$ gave good results for plant growth (number of effective root nodules and plant growth rate) and soybean yield (number of pods and seed weight per plant). The application of biochar 20 ton.ha $^{-1}$ significantly increased plant growth (number of effective root nodules and plant growth rate) and soybean yield (number of pods, number of pithy pods, number of seeds, and seed weight per plant), but administration of NPK did not significantly increase growth and yield of soybeans.

Keywords: Biochar; NPK fertilizer; Ultisol; Soya beans

1. Introduction

Soybean (*Glycine max* L.) is a commodity that is of concern to the government because the need continues to increase, especially for tofu and tempeh raw materials. This product is favored by all walks of life and is also used as a substitute for animal protein in several conditions. Soybean seeds contain 35% protein, 35% carbohydrates, 18% fat, and the rest is water, vitamins and minerals . Waste from soybean processing has the potential to be used as animal feed. According to the [1], Indonesia's 2018 soybean production was only 538,728 tons while the national consumption needs were 2.8 million tons (imports were 2,261,272 tons).

It is important to increase soybean production in Indonesia to suppress imports. Increased production can be done through extensification accompanied by intensification. Extensification can be done by using marginal land, including Ultisol soil.

The use of Ultisol soil in plant cultivation has disadvantages including organic matter content, water holding capacity, low CEC and base saturation and poor macro and micro nutrients [2]. High Al content, low pH can inhibit plant growth [3]. High Al and Mn content and low soil pH can inhibit the growth of root nodules and the effectiveness of rhizobium

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on soybean plants [4]. Intensification measures that can be taken to increase the productivity of Ultisol soil by improving the physical, chemical and biological properties of the soil include the provision of biochar and NPK fertilizers.

Biochar is a solid material derived from the carbonization of the biomass of living things containing lignicellulose, such as wood, rice straw, rice husks, empty fruit bunches of oil palm and sago waste. Biochar is composed of carbon rings which are more stable and last longer in the soil. The quality of biochar is determined by the manufacturing process and raw materials [5]. [6], reported that the ability of biochar to bind water can maintain soil moisture and prevent nutrient loss due to leaching. [7] Stated that soil containing biochar is a good habitat for soil microbes, one of which is bacteria that help in the availability of nutrients.

According to [8], the addition of biochar to the growing media can increase the pH and CEC of the soil so that nutrients can be made available to plants . [7] Stated that biochar added to the soil was more effective in retaining nutrients than the addition of organic matter. [2] States that increasing the availability of nutrients in the planting media needs to be fertilized. The results of the research by [9], showed that the biochar factor, a dose of 20 ton.ha $^{-1}$ produced significantly higher rice plants, the number of productive tillers, the percentage of full grain, the number of grains per panicle was significantly higher, and the production of grain per plot was significantly higher. heavier than the other treatments (0, 5, 10, and 15 ton.ha $^{-1}$). The NPK fertilizer treatment of 400 kg.ha $^{-1}$ was significantly better than the other treatments (0, 200, and 300 kg.ha $^{-1}$) for plant height, number of productive tillers, number of grain per panicle, percentage of full grain and grain production per panicle. plots. The combination of biochar 20 ton.ha $^{-1}$ and NPK 400 kg.ha^{-1} is the best combination for yield and production components. which is obtained.

The results of [10], showed that the application of biochar, NPK fertilizer and their interaction had an effect on plant height, number of tubers and tuber weight per clump, and weight of potato tubers per plot. The highest production was obtained from the combination of biochar 30 tons ha $^{-1}$ with NPK fertilizer 400 kg ha $^{-1}$ which was 16.33 kg/plot (30.02 tons ha $^{-1}$). The treatment without biochar and NPK production obtained was only 5.43 kg/plot. Biochar at a dose of 30 tons ha $^{-1}$ and without NPK showed a potato tuber weight of 7.27 kg/plot, while without biochar and NPK at a dose of 400 kg ha $^{-1}$, the weight of potato tubers was 11.13 kg/plot. [11], concluded his research results that the application of NPK Phonska fertilizer 350 kg.ha $^{-1}$ on soybean plants gave the best production of 1.44 kg/plot (1.91 ton.ha $^{-1}$ assuming an effective land of 80% per ha).

The use of compound fertilizers can increase the effectiveness and efficiency of fertilization because it is slow to release (*slow release*), easy to transport, store, and apply. NPK fertilizer (15^{-1}5^{-1}5) contains nitrogen (N): 15 %, phosphate (P_2O_5) : 15 %, potassium (K_2O): 15 %, sulfur (S) : 10 % and maximum water content 2%., as well as micro elements boron (Bo), copper (Cu), and manganese (Mn) [12].

[13] stated that nitrogen plays a role in the formation of proteins, nucleic acids, nucleotides and the formation of chlorophyll. Plants lacking nitrogen have stunted growth and stunted root systems. Phosphorus plays an important role in assimilation and respiration, stimulates root growth and development, accelerates flowering and fruiting processes, and ripens fruit and seeds. Plants that are deficient in P cause the leaves to turn dark or appear shiny reddish, the edges of the leaves, branches and stems are purplish red and then turn yellow. The fruit becomes small and ripens quickly. Potassium acts as an activator of various enzymes that are essential in the reactions of photosynthesis and respiration, as well as enzymes involved in protein and starch synthesis. Plants that lack K cause brownish red leaf spots , dry and die, fruit growth is not perfect which results in low fruit quantity and quality and cannot be stored.

2. Material and methods

The research was carried out in the experimental garden of the Faculty of Agriculture, Riau University Jalan Bina Widya km 12.5 Pekanbaru from November 2020 to February 2021. The materials used in this study were Anjasmoro soybean seed, ultisol soil media, biochar, Rhizobium, NPK fertilizer, Decis insecticide. 25 EC, Dithane M-45 fungicide. The tools used in the research were hoe, soil sieve, sprayer, *polybag,* measuring cup, digital scale, oven, rice envelope, camera, and stationery.

The research was carried out experimentally in the form of a 3 x 3 factorial, arranged using a completely randomized design. Factor I, dose of biochar (0, 10, and 20 ton.ha $^{-1}$ is equivalent to 0, 100, and 200 g per plant), f actor II, dose of NPK fertilizer (175, 350, and 525 kg.ha $^{-1}$ is equivalent to with 1.75 ; 3.5 ; and 5.25 g per plant). Of the two factors, 9 combinations were obtained, and each combination was repeated 3 times to obtain 27 experimental units. Each experimental unit contained 7 plants in 7 *polybags* observed, so the population was 189 plants in 189 *polybags.*

Parameters observed were plant height, number of primary branches, number of effective root nodules, plant growth rate, number of pods per plant, number of pithy pods per plant, number of seeds per plant, seed weight per plant. The research data were analyzed using variance fingerprint. The results of the variance were continued with a further test of the Smallest Significant Difference (BNT) at 5% level.

3. Results

3.1. Plant Height

Parameters for soybean plant height, the results of the variance showed that the application of biochar, NPK fertilizer and their interaction had no significant effect. Further test results are presented in Table 1.

Table 1 Height of soybean plants with the application of biochar and NPK fertilizer on Ultisol soil

Biochar (ton.ha $^{-1}$)	Pupuk NPK (kg.ha^{-1})			Rata-rata biochar
	175	350	525	
	..... cm.....			
0	36,73 a	37,11 a	33,81 a	35,88 A
10	40,41 a	40,23 a	39,51 a	40,05 A
20	39,10 a	42,18 a	40,75 a	40,67 A
Rata-rata NPK	38,75 A	39,84 A	38,02 A	

The numbers followed by the same lowercase letter in the same row and column and the numbers followed by the same capital letter in the same row or column were not significantly different according to the BNT test at the 5% level.

The data in Table 1 shows that soybean plant height after being treated with a combination of biochar and NPK fertilizer at different doses, and each factor tended to be the same.

3.2. Number of primary branches

The results of variance for the parameters of the number of primary branches of soybean plants, the interaction of biochar and NPK fertilizer and each factor had no significant effect. Further test results are presented in Table 2.

Table 2 Number of primary branches of soybean plants with the application of biochar and NPK fertilizer on Ultisol soil

Biochar (ton.ha $^{-1}$)	Pupuk NPK (kg.ha $^{-1}$)			rat-rat biochar
	175	350	525	
	..... Cabang.....			
0	3.16 to	3.33 to	3.00 to	3.16A
10	3.33 to	4.00 to	4.50 to	3.94A
twenty	4.00 to	5.00 to	3.50 to	4.16A
Rat-rat NPK	3.50A	4.11A	3.66A	

The numbers followed by the same lowercase letter in the same row and column and the numbers followed by the same capital letter in the same row or column were not significantly different according to the BNT test at the 5% level.

The number of primary branches of soybean plants (Table 2) was relatively the same, although treated with biochar and NPK fertilizer with different doses, either singly or in combination.

3.3. The number of effective root nodules

Parameters of the number of effective root nodules of soybean plants, the application of biochar had a significant effect, while the application of NPK fertilizer and the interaction of the two had no significant effect. Further test results are presented in Table 3.

Table 3 The number of effective root nodules of soybean plants with the application of biochar and NPK fertilizer on Ultisol soil

Biochar (ton.ha $^{-1}$)	Pupuk NPK (kg.ha^{-1})			Rata-rata biochar
	175	350	525	
	..... bintil akar			
0	4,74 a	4,08 a	3,29 a	4,04 B
10	5,61 a	5,46 a	5,84 a	5,63 A
20	6,07 a	6,70 a	5,98 a	6,25 A
Rata-rata NPK	5,47 A	5,41 A	5,04 A	

The numbers followed by the same lowercase letter in the same row and column and the numbers followed by the same capital letter in the same row or column were not significantly different according to the BNT test at the 5% level.

The data in Table 3 shows that soybean plants after being treated with a combination of biochar with NPK and NPK alone, the number of effective root nodules was relatively the same but those treated with biochar increased the dose significantly increased the number of effective root nodules (biochar 20 ton.ha $^{-1}$ yielded 6.25 nodules/nodules)

3.4. Plant growth rate

The results of variance for soybean plant growth rate showed that biochar had a significant effect, while the application of NPK fertilizer and the interaction of the two had no significant effect. Further test results are presented in Table 4.

Table 4 Growth rate of soybean plants with the application of biochar and NPK fertilizer on Ultisol soil

Biochar (ton.ha $^{-1}$)	NPK Fertilizer (kg.ha $^{-1}$)			Average biochar
	175	350	525	
	..... g/day.....			
0	0.96 a	0.92 a	0.76 a	0.89 B
10	1.13 a	0.98 a	0.99 a	1.04 AB
20	1.20 a	1.33 a	1.17 a	1.23 A
Average NPK	1.10 A	1.08 A	0.98 A	

The numbers followed by the same lowercase letter in the same row and column and the numbers followed by the same capital letter in the same row or column were not significantly different according to the BNT test at the 5% level.

The data in Table 4 shows that soybean plants treated with a combination of biochar and NPK produced a plant growth rate (LPT) that was not significantly different, but the combination of 20 tons biochar with NPK 350 kg.ha $^{-1}$, resulted in LPT (= 1.33 g/ days) which is relatively better than other treatments. The NPK factor produced LPT which was also relatively the same between treatments, but the increasing dose of biochar factor resulted in significantly heavier LPT.

3.5. Number of pods per plant

The results of variance for the parameter of the number of pods per soybean plant, the application of biochar had a significant effect, but the application of NPK fertilizer and the interaction of the two had no significant effect. Further test results are presented in Table 5.

Table 5 Number of pods per soybean plant with the application of biochar and NPK fertilizer on Ultisol soil

Biochar (ton.ha $^{-1}$)	Pupuk NPK (kg.ha $^{-1}$)			Rata-rata biochar
	175	350	525	
	..... Buah.....			
0	61.67 a	74.50 a	49.67 a	61.94 B
10	81.00 a	73.00 to	87.67 a	80.55 A
20	89.33 a	93.50 a	72.83 a	85.22 A
Installment-installment NPK	77.33 A	80.33 A	70.05 A	

The numbers followed by the same lowercase letter in the same row and column and the numbers followed by the same capital letter in the same row or column were not significantly different according to the BNT test at the 5% level.

The results of observations on the number of pods in Table 5 show that the combination of biochar and NPK fertilizers tends to be the same and also for the NPK fertilizer factor, but for the biochar factor the increase in the dose of the number of pods increases significantly.

3.6. Number of pithy pods

The interaction between biochar and NPK fertilizer and the biochar factor gave a significant effect for the parameter of the number of pithy pods per soybean plant, but for the NPK fertilizer factor the effect was not significant. Further test results are presented in Table 6.

Table 6 Number of pithy pods per soybean plant with the application of biochar and NPK fertilizer on Ultisol soil

Biochar (ton.ha $^{-1}$)	NPK Fertilizer (kg.ha $^{-1}$)			Average biochar
	175	350	525	
	..... Fruit.....			
0	49.33 dc	51.50 dc	28.67 d	43.16 B
10	51.33 dc	57.33 bc	77.17 ab	61.94 A
20	81.50 a	77.33 ab	57.67 bc	72.16 A
Average NPK	60.72 A	60.05 A	54.50 A	

The numbers followed by the same lowercase letter in the same row and column and the numbers followed by the same capital letter in the same row or column were not significantly different according to the BNT test at the 5% level.

The results of observations on the number of pithy pods in Table 6 show that the combination of biochar 20 ton.ha $^{-1}$ and NPK fertilizer 175 kg.ha $^{-1}$ the number of pithy pods per plant was 81.50 fruit significantly more than without biochar with NPK fertilizer 175, 350 and 525 kg.ha $^{-1}$, a combination of 10 ton.ha $^{-1}$ biochar with NPK fertilizer 175 and 350 kg.ha $^{-1}$, but with a combination of 20 ton.ha $^{-1}$ with NPK fertilizer 350 kg.ha $^{-1}$ and a combination of 10 tons bichar .ha $^{-1}$ with NPK fertilizer 525 kg.ha $^{-1}$ tend to be the same.

3.7. Number of seeds per plant

The results of the variance showed that the interaction between biochar and NPK fertilizer and the NPK fertilizer factor had no significant effect, but the biochar factor had a significant effect on the number of seeds per soybean plant parameter. Further test results are presented in Table 7.

Table 7 Number of seeds per soybean plant with the application of biochar and NPK fertilizer on Ultisol soil

Biochar (ton.ha $^{-1}$)	NPK Fertilizer (kg.ha $^{-1}$)			Average biochar
	175	350	525	
	..... Seed.....			
0	101.25 a	116.33 a	63.67 a	92.81 B
10	111.00 a	140.17 a	170.00 a	140.39 A
20	138.50 a	158.83 a	109.17 a	135.50 A
Average NPK	118.88 A	138.44 A	114.28 A	

The numbers followed by the same lowercase letter in the same row and column and the numbers followed by the same capital letter in the same row or column were not significantly different according to the BNT test at the 5% level.

Data on the number of seeds per plant (Table 7) showed that the combination of various doses of biochar with NPK fertilizer produced an insignificant difference in the number of seeds in the range of 63.76 – 158.83 seeds. The same thing for the NPK fertilizer factor (the number of seeds produced was not significantly different), but for the biochar factor it produced a significantly different number of seeds (a dose of 10 ton.ha $^{-1}$ resulted in a significantly higher number of seeds than a dose of 0, but relatively the same as 20 ton.ha $^{-1}$)

3.8. Seed weight per plant

The results of the variance showed that the interaction of biochar with NPK fertilizer and biochar factor had a significant effect but the NPK fertilizer factor had no significant effect on the parameter of seed weight per soybean plant. Further test results are presented in Table 8.

Table 8 Seed weight per soybean plant with the application of biochar and NPK fertilizer on Ultisol soil

Biochar (ton.ha $^{-1}$)	NPK Fertilizer (kg.ha $^{-1}$)			Average biochar
	175	350	525	
	..... Grams.....			
0	14.96 bc	16.09 b	8.13 c	13.06 B
10	16.77 b	20.20 a	24.40 a	20.46 A
20	24.29 a	26.14 a	14.86 bc	21.76 A
Average NPK	18.67 A	20.81 A	15.80 A	

The numbers followed by the same lowercase letter in the same row and column and the numbers followed by the same capital letter in the same row or column were not significantly different according to the BNT test at the 5% level.

The results of observations of seed weight per plant in Table 8 show that the combination of biochar at a dose of 20 ton.ha $^{-1}$ and NPK fertilizer at a dose of 350 kg.ha $^{-1}$ seed weight per plant (26.14 g) was significantly heavier than the combination without biochar with NPK. 175, 350 and 525 kg.ha $^{-1}$, the combination of biochar 10 ton.ha $^{-1}$ with NPK 175 kg.ha $^{-1}$, and biochar 20 ton.ha $^{-1}$ with NPK 525 kg.ha $^{-1}$, but tends to be the same as the combination biochar 20 ton.ha $^{-1}$ with NPK 175 kg.ha $^{-1}$ and a combination of bichar 10 ton.ha $^{-1}$ with NPK 350 and 525 kg.ha $^{-1}$.

4. Discussion

Soybean plant height (Table 1) after being treated with a combination of biochar with NPK fertilizer and each factor (biochar and NPK fertilizer) there was no significant difference. This is presumably because soybeans are grown on marginal soil medium (ultisol) so that the treatment given has not been able to produce significantly different plant

heights. [2] States that genetic factors from plants will play a good role, if environmental factors are in optimum conditions.

Soybean plant height which tends to be the same after being given various treatments is also due to genetic factors being more dominant so that environmental factors (including the treatment given) have no effect. The environmental factor that is very influential for plant height is light intensity and in this study the light intensity received by plants was the same because they were planted in the same place and the land was exposed to direct sunlight and used a completely randomized design. [14], [15], [16] stated that stem elongation is strongly influenced by light intensity and temperature.

Observations on the number of primary branches of soybean plants in Table 2 are also relatively the same, although given different treatments (combination of biochar with NPK fertilizer or each factor). This condition is closely related to plant height (Table 1) which is also relatively the same (not significantly different) because primary branches grow from shoots on the main stem. Plants that get the same light intensity, the same plant height also have the same axillary nodes and these shoots grow to form branches.

The results of observations for the number of effective root nodules (Table 3) showed that there was a tendency to increase the dose of biochar at the same NPK dose, increasing the number of effective root nodules. The number of effective root nodules which tended to be higher resulted from the combination treatment of 20 tons of biochar with 350 kg.ha NPK $^{-1}$ and the increase was 22.71% and 64.22% when compared to the combination of 10 tons of biochar with 350 kg of NPK and no biochar with NPK. 350 kg.ha $^{-1}$, the highest increase when compared with no biochar with NPK 525 ton.ha $^{-1}$) which is 103.65%. The increase in the number of effective root nodules was due to the fact that biochar added to ultisol media could improve the physical conditions of ultisol soils including soil aeration as stated by [14],[7], and [17] . that the addition of biochar to the growing media improves soil physical conditions, reduces soil density, and increases soil porosity.

So that O2 is available for *Rhizobium bacteria* found in root nodules. This bacterium is aerobic in nature as stated by [15] that *Rhizobium bacteria* live aerobically that survive saprophytically in the soil until it infects root hairs.

The biochar factor, increasing the dose increases the number of root nodules significantly effective because biochar can improve soil fertility including improving [7] stated that soil containing biochar is a good habitat for soil microbes.

NPK factor, increasing the dose did not significantly increase the number of effective root nodules. This is due to the physical condition of the soil, especially the same porosity because inorganic fertilizers are added to improve the chemical properties of the soil.

Observation of Plant Growth Rate (LPT) in soybean plants (Table 4), the combination of biochar with NPK fertilizer was not significantly different, but increasing the dose of biochar at the same NPK dose tended to increase the LPT of soybean plants, as was the case with the number of effective root nodules (Table 3). The plant growth rate that tends to be higher is the combination treatment of 20 tons of biochar with NPK 350 kg.ha $^{-1}$ (1.33 g/day) 44.57% higher than without biochar with NPK 350 kg (0.92 g/day) , 35,71 % of 10 tons of biochar with 350 kg NPK (0.98 g/day), and 75% of without biochar with 525 kg NPK (0.76 g/day).

More effective root nodules can also increase the availability of N to plants through fixation. Nitrogen is needed during plant growth and development including for the synthesis of enzymes, proteins and chlorophyll which are important in plant metabolic processes including photosynthesis. [18] States that N is used for the synthesis of amino acids, peptides, amides, urides, amines and subsequently used to form protein compounds, nucleic acids, cell membrane constituents, coenzymes, chlorophyll.

Growth rate is the rate of increase in plant dry weight per unit time, the higher the LPT indicates better plant growth. [19] Stated that the accumulation of dry matter in plants is the result of photosynthesis.

The biochar factor, soybean LPT also showed the same thing with the number of effective root nodules, where increasing the biochar dose significantly increased the number of effective root nodules (Table 3) and also LPT (Table 3). The NPK factor had no impact on increasing LPT.

Parameter number of pods per plant (Table 5) the results were not significantly different after being treated with a combination of biochar and NPK fertilizer at various doses, but the trend increased with increasing doses of biochar to NPK 350 kg.ha $^{-1}$. The number of pods that tended to be higher, which was treated with a combination of 20 tons of biochar with 350 kg of NPK was 93.50 pieces. If the NPK dose was increased to 525 kg.ha $^{-1}$, without biochar, the lowest

number of pods was only 49.67 (only 53.12% from 93.50). This has something to do with LPT, where the LPT of plants that received a combination treatment of 20 tons of biochar with 350 kg of NPK tended to be higher (Table 4) and indicated the plant grew stronger so that it could support the flowers to develop into fruit (pods). [20] Stated that soybean waste was arranged in groups consisting of 2-35 flowers and not all of them succeeded in forming pods with a miscarriage rate of 20-80%.

The higher number of pods (Table 5) was supported by LPT which also tended to be better (Table 4), the combination treatment of 20 tons of biochar with 350 kg of NPK also resulted in significantly higher number of pithy pods than the combination without biochar with various doses of NPK and biochar 10 tons with NPK 175 and 350 kg (Table 6). The number of pithy pods produced from the combination of treatment with 20 tons of biochar with 350 kg of NPK was less but not significantly different from the combination of treatment with 20 tons of biochar with 175 kg of NPK.

For the number of seeds per plant (Table 7), the combination of various doses of biochar with NPK resulted in the number of seeds being not significantly different between treatments, but the combination treatment of 20 tons of biochar with 350 kg of NPK gave better results in terms of final yield (seed weight). in Table 8 and also better seed quality because the larger seed size can be seen from the weight of the seeds (Table 8)/number of seeds (Table 7) (data not shown). This is because with the provision of 20 tons of biochar plus 350 kg of NPK, the quality of the growing media is better in terms of porosity, water and nutrients become more available to plants.

The biochar factor, for the LPT parameters, the total number of pods and pithy pods, the number of seeds, and the weight of the seeds (Tables 4, 5, 6, 7, and 8) gave significantly different results, where the soybean growing media that was given biochar was significantly better than the biochar factor. with those who were not given for the parameters mentioned above, but those who were given 10 and 20 tons tended to be the same. This is because with the provision of biochar, the physical condition of the soil becomes better, the nutrients contained in the media become more available and can be utilized by plants for plant growth and development. [21] stated that biochar applied to soil is beneficial in increasing nutrient uptake by plants.

For the NPK factor, increasing the dose gave relatively the same results for all parameters. This is because the ultisol planting medium is one of the marginal soils with a lumpy structure, low organic matter content, low pH, high Al and Mn content, which is not a good soil to use for plant cultivation, so that the fertilizer given cannot be utilized by plants. Efforts to improve the quality/productivity of this soil, a good initial stage to do is to improve the physical condition of the soil by giving ameliorant, so that nutrients can be available to plants.

5. Conclusion

Based on the results of the research that has been carried out, it can be concluded that:

- Provision of biochar along with NPK fertilizer can increase the growth and yield of soybeans grown on ultisol media. The same is true for the biochar factor, but not for the NPK factor.
- Combination of 20 tons of biochar with NPK 350 kg.ha $^{-1}$ gave good results for growth (number of effective root nodules and LPT) and soybean yield (number of pods, number of pithy pods and seed weight per plant). For the biochar factor, the application of biochar 20 ton.ha $^{-1}$ significantly increased growth (number of effective root nodules, LPT) , and soybean crop yields (number of pods, number of pithy pods, number of seeds, and weight of seeds per plant), but NPK administration did not significantly increase the growth and yield of soybean plant.

Compliance with ethical standards

Disclosure of conflict of interest

All authors declare there is no conflict of interest in this paper.

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