The Effect Of Combination Of Organic Fertilizer And Rice Husk Biochar On Growth, Production, Available N And N Absorption Of Soybean (Glycine Max L) In Ultisol Soil

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The Effect Of Combination Of Organic Fertilizer And Rice Husk Biochar On Growth, Production, Available N And N Absorption Of Soybean (*Glycine Max* L) In Ultisol Soil

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ABSTRACT

This research was conducted on Jl. Bunga Sedap Malam XVIII Medan North Sumatra with an altitude of ± 30 meters above sea level (masl), this research took place from February to April 2022. This study used the Non Factorial Randomized Group Design method. Factor B1 = Control, B2 = Organic fertilizer 15 tons/ha, B3 = Rice husk biochar 15 tons/ha, B4 = Organic fertilizer 12.5 tons/ha + Rice husk biochar 2.5 tons/ha, B5 = Organic fertilizer 10 tons/ha + Rice husk biochar 5 tons/ha, B6 = Organic fertilizer 7.5 tons/ha + Biochar rice husk 7.5 tons/ha, B7 = Organic fertilizer 5 tons/ha + Biochar rice husk 10 tons/ha, B8 = Organic fertilizer 2.5 tons/ha + Biochar rice husk 12.5 tons/ha. From the results of the study it can be concluded that the treatment of cow organic fertilizer and rice husk biochar had a significant effect on plant height, number of branches, root nodules, wet weight of pods/plot, dry weight of pods/plot, soil pH, base saturation (KB), and N absorbed, but had no significant effect on the number of filled pods, number of empty pods, cation exchange capacity (CEC), and N available. The average number of filled pods was highest in treatment B4 (36.67%) and lowest in treatment B1 (1.33%). The highest average cation exchange capacity (CEC) was found in treatment B2 (18.76m3/100g) and the lowest average was found in treatment B6 (10.79me/100g). The highest average available N was found in treatment B2 (4.13%) and the lowest was found in treatment B8 (3.15%).

INTRODUCTION

Soybeans (Glycine max L) are one of the food commodities that play an important role in Indonesia, because soybeans have a high nutritional content, Suprapto (2020) states that soybean seeds have a nutritional content consisting of 40% - 45% Protein, 18% Fat, 24% -36% Carbohydrates, 8% Water content, amino acids and other nutritional content that is beneficial to humans. In addition, soybeans can also be used as industrial raw materials, animal feed and also for making oil.

The demand for soybeans in Indonesia has increased from year to year, but soybean productivity has decreased from year to year, including in North Sumatra. North Sumatra's soybean production in 2018 reached 18,152 tons, and

in 2019 decreased by 8,526 tons to 9,626 tons, and in 2020 North Sumatra's soybean production decreased again by 5,623.43 tons compared to the previous production to only 4,003 tons. The rate of decline in production is partly due to low land productivity, reduced harvest area, crop failure due to an unsuitable climate for growth (BPS 2020).

One of the efforts to increase the availability of nutrients in the soil is through fertilization. Fertilization is effective and efficient if given at the right time in the right way, namely the optimum dose and type of fertilizer in accordance with the nutrient needs of plants. Organic fertilizers contain low macro-nutrients but also contain sufficient amounts of micro-nutrients that are indispensable in plant growth because they affect the physical properties, chemical properties, and biological properties of the soil. Prevent erosion and reduce soil cracking. One type of organic fertilizer is manure, manure is a waste product from domestic animals such as chickens, goats, cows and buffaloes that can be used to add nutrients, improve the physical and biological properties of the soil. The quality of manure is very influential on plant response. Another addition of nutrients in soybean cultivation is the utilization of rice husk. Rice husk production in Indonesia can reach 4 million tons per year. This means that 400 thousand tons of rice husk ash are produced per year. This can be of value to rice farmers, if they know its benefits. Rice husk ash serves to loosen the soil so that it can make it easier for plant roots to absorb the nutrients in it. The nutrient content of rice husk ash is not as much as that in artificial fertilizer, so the best use is to mix compost (e.g. rice husk) and artificial fertilizer, with the quantity according to the needs of the soil (Pane et al., 2014)

Biochar is a high-carbon (C) charcoal solid resulting from the conversion of biomass processed by incomplete combustion and minimum oxygen. In the soil, biochar provides a good habitat for soil microbes, but is not consumed like other organic matter. Biochar does not disrupt the carbon - nitrogen balance, and can even retain and make water and nutrients more available to plants (Maftuhah et al., 2015). Biochar has been known to improve soil quality and is used as an alternative to fertilizers. Application of biochar to soil has the potential to increase soil C- content, water retention and nutrients in the soil.

The availability of nitrogen nutrients in the soil is relatively low, especially in ultisol soil types. The following are factors that can affect the availability of nitrogen in the soil, 1) soil pH, 2) availability of Al and Fe ions in the soil solution, 3) oxide-hydroxide minerals Al and Fe, 4) availability of Ca in soils that have a pH above 7, and 5) the amount and level of decomposition of organic matter (Hakim et al., 2015).

Ultisol soil improvement efforts with protection against erosion in the soil, provision of organic matter, provision of biochar, use of mycorrhiza and soil management. It is expected to increase the fertility of ultisol soil. Based on the explanation above, researchers are interested in conducting research with the title Effect of Combination of Organic Fertilizer and Rice Husk Biochar on Growth, Production, Available N and N Uptake of Soybean Plants (Glycine max L). in Ultisol Soil.

METHODOLOGY

Place and Time of Research

This research was conducted at Jalan Bunga Sedap Malam XVIII, Medan Selayang, North Sumatra with an altitude of ± 30 meters above sea level (masl) from February to April 2022.

Materials and Tools

The materials used in this research are Anjasmoro variety soybean seeds, rice husk biochar, cow dung organic fertilizer, bioactivator, Ultisol soil taken from Bangun Purba village, and other materials needed in this research. The tools that will be used are 10 kg polybags measuring 40 x 50 cm, ram wire, burning iron, hoes, meters, paddles, knives, handsprayers, analytical scales, stationery, books, rulers, sample boards, and other tools that support this research.

Research Methodology

The research design used was a Non-Factorial Randomized Group Design (RAK) consisting of 8 treatment combinations, as follows:

B1 = Control
B2 = Organic fertilizer 15 tons/ha equivalent to 626 grams/polybag
B3 = Rice husk biochar 15 tons/ha equivalent to 626 grams/polybag
B4 = Organic fertilizer 12.5 tons/ha equivalent to 522 grams/polybag + Biochar rice husk 2.5 tons/ha equivalent to 104 grams/polybag
B5 = Organic fertilizer 10 tons/ha equivalent to 418 grams/polybag + Rice husk biochar 5 tons/ha equivalent to 208 grams/polybag
B6 = Organic fertilizer 7.5 ton/ha equivalent to 313gram/polybag + Rice husk biochar 7.5 ton/ha equivalent to 313 gram/polybag
B7 = Organic fertilizer 5 tons/ha equivalent to 208 grams/polybag + Rice husk biochar 10 tons/ha equivalent to 418 grams/polybag
B8 = Organic fertilizer 2.5 tons/ha equivalent to 104 grams/polybag + Rice husk biochar 12.5 tons/ha equivalent to 522 grams/polybag

Data Analysis Method

Data analysis was carried out with variance analysis with a linear model of Non Factorial RAK as follows:

$$Yij = \mu + \tau i + \beta j + \varepsilon ij$$

where :
Yij = observation value in the i-th treatment, j-th group
μ = generalized mean value
τi = ith treatment effect
βj = j-th group effect
εij = experimental error in treatment i & group j
p = number of treatments
r = number of groups/replications

Furthermore, data were analyzed by Analysis of Variance (ANOVA) for each parameter measured and further tested for significant treatments using Duncan's Multiple Range Test at the 5% level.

RESULT

Plant Height (cm)

The list of variance showed that the combination of organic fertilizer and biochar had a significant effect on the height of soybean plants at the age of 2, 3, 4 and 5 weeks after planting. The average height of soybean plants at the age of 2, 3, 4 and 5 weeks can be seen in Table 1.

Tabel 1. Average Soybean Plant Height (cm) due to the combination treatment of cow organic fertilizer and rice husk biochar at the age of 2, 3, 4, and 5 weeks after planting

Treatment	Plant Height			
	2 MST	3 MST	4 MST	5 MST
B1	8,04a	14,92a	18,08a	19,70a
B2	12,67c	22,69c	27,22b	36,18b
B3	8,52a	19,49b	24,04b	31,46b
B4	11,87bc	20,74bc	25,39b	35,20b
B5	11,42bc	19,84bc	24,09b	34,26b
B6	9,77ab	19,51b	25,09b	33,31b
B7	10,81bc	20,88bc	25,53b	32,28b
B8	11,30bc	20,94bc	24,38b	31,79b

Notes: Numbers followed by the same letter in the same column are not significantly different based on the 5% Duncan test.

Table 1 shows that in the treatment of a combination of organic fertilizer and biochar at the age of 6 weeks after planting, the highest plants were found in the B2 treatment, which was not significantly different from B4, B5, B7 and B8, but significantly different from B1, B3 and B6. The highest plants at the age of 3 weeks after planting were found in the B2 treatment, which was not significantly different from B4, B5, B7 and B8, but not significantly different from B1, B3 and B6. The highest plants at the age of 4 weeks after planting were found in the B2 treatment, which was not significantly different from the B3, B4, B5, B6, B7 and B8 treatments, but significantly different from B1. The highest plants at the age of 5 weeks after planting were found in the B2 treatment, which was not significantly different from B3, B4, B5, B6, B7 and B8, but significantly different from B1.

Number of Branches (stalk)

The list of variance showed that the combination of organic fertilizer and biochar had a significant effect on the number of soybean branches at the age of 2, 3 and 4 weeks after planting. The average number of branches of soybean plants due to the treatment of the combination of organic fertilizer and biochar can be seen in Table 2.

Tabel 2. Average Number of Soybean Branches due to the combination treatment of cow organic fertilizer and rice husk biochar at the age of 2,3,4 WAP

Treatment	Number of Branches		
	2 MST	3 MST	4 MST
B1	0,89a	1,89a	2,22a

B2	2,00b	3,33bc	4,56b
B3	1,89b	3,22bc	4,67b
B4	1,89b	3,78c	6,22c
B5	1,89b	3,00bc	5,33bc
B6	1,67b	3,00bc	4,67b
B7	1,56b	3,33bc	4,67b
B8	1,67b	2,67b	4,33b

Notes: Numbers followed by the same letter in the same column are not significantly different based on the 5% Duncan test.

Table 2 shows that in the combined treatment of organic fertilizer and biochar at the age of 2 weeks after planting, the highest number of branches is found in the treatment of B2, which is not significantly different from B3, B4, B5, B6, B7 and B8, but significantly different from B1. The highest number of branches at the age of 3 weeks after planting was found in treatment B4, which was not significantly different from B2, B3, B4, B5, B6, and B7, but significantly different from B1 and B8. The highest number of branches at the age of 4 weeks after planting was found in treatment B7 which was not significantly different from B5, but significantly different from B1, B2, B3, B6, B7 and B8.

Number of Root Nodules

The list of variance showed that the combination of organic fertilizer and rice husk biochar had a significant effect on the number of root nodules of soybean plants. Table 3 presents the average number of root nodules of soybean plants due to the combination of organic fertilizer and rice husk biochar.

Tabel 3. Average Number Of Root Nodules Of Soybean Plant

Treatment	Average
B_1	0,33a
B_2	26,67bc
B_3	7,67a
B_4	50,00d
B_5	35,00c
B_6	33,00c
B_7	13,33ab
B_8	11,33ab

Notes: Numbers followed by the same letter in the same column are not significantly different based on the 5% Duncan test.

Table 3 shows that due to the combination of organic fertilizer and rice husk biochar on the number of root nodules of soybean plants, the highest average was obtained in B4, significantly different from B1, B2, B3, B5, B6, B7 and B8.

Wet Weight of Pods/Plot (39)

The list of variance showed that the combination of organic fertilizer and rice husk biochar had a significant effect on the wet weight of pods/plot. The

average wet weight of pods/plot of soybean plants due to the Combination Treatment of organic fertilizer and biochar can be seen in Table 4.

Tabel 4. Average Wet Weight of Pods per Plot of Soybean Plants (gr)

Treatment	Average
B1	8,67a
B2	67,60ab
B3	89,43abc
B4	170,47c
B5	95,83bc
B6	82,63abc
B7	129,16bc
B8	112,43bc

Notes: Numbers followed by the same letter in the same column are not significantly different based on the 5% Duncan test.

Table 4 shows that the average wet weight of pods per plot found in B4 was not significantly different from B3, B5, B6, B7, and B8, but significantly different from B1 and B2.

Dry Weight of Pods/plot (gr)

The list of variance showed that the combination of organic fertilizer and rice husk biochar had a significant effect on the dry weight of pods/plot of soybean plants. The average wet weight of soybean/plot due to the treatment of the combination of organic fertilizer and biochar can be seen in Table 5.

Tabel 5. Average Dry Weight of Pods/plot of Soybean Plants (gr)

Treatment	Average
B1	5,33a
B2	51,33ab
B3	47,60ab
B4	107,77c
B5	64,93bc
B6	55,97bc
B7	76,40bc
B8	63,93bc

Notes: Numbers followed by the same letter in the same column are not significantly different based on the 5% Duncan test.

Table 5 shows that the highest average dry weight of pods per plot was found in treatment B4, which was not significantly different from B2, B3, B5, B6, B7, and B8 but significantly different from B1.

Number of Pods Contained/Sample

The list of variance showed that the combination of organic fertilizer and biochar had a significant effect on the number of filled pods/sample. The average wet weight of soybean per plot due to the combination of organic fertilizer and biochar treatment can be seen in Table 6.

Tabel 6. Average number of filled pods/sample Soybean Plants

Treatment	Average
B1	3.00a
B2	24.67b
B3	24.00ab
B4	36.67b
B5	32.67b
B6	25.89b
B7	26.33b
B8	32.11b

Notes: Numbers followed by the same letter in the same column are not significantly different based on the 5% Duncan test.

Table 6 explains that the average number of filled pods per sample was highest in treatment B4, which was not significantly different from B5, B6, B7, and B8 but significantly different from B1, B2, and B3.

Number of Empty Pods/Sample

The list of variance shows that the combination of organic fertilizer and biochar has no significant effect on the number of empty pods/sample. The average number of empty pods of soybean plants due to the treatment of the combination of organic fertilizer and biochar can be seen in Table 7.

Tabel 7. Average number of empty pods per sample due to combined treatment of organic fertilizer and rice husk biochar

Treatment	Average
B1	1.33
B2	3.78
B3	3.11
B4	5.33
B5	3.78
B6	3.11
B7	4.78
B8	5.78

Notes: Numbers followed by the same letter in the same column are not significantly different based on the 5% Duncan test.

Table 7 shows that in the combined treatment of organic fertilizer and rice husk biochar, the highest average number of empty pods per sample was found in treatment B8 and the lowest average was found in B1.

Soil pH

The list of variance shows that the combination of organic fertilizer and biochar has a significant effect on soil pH. The average soil pH of soybean plants due to the treatment of the combination of organic fertilizer and rice husk biochar can be seen in Table 8.

Tabel 8. Average soil pH of Soybean Crops

Treatment	Average
B1	5.17a

B2	6.17bcd
B3	6.10bc
B4	6.07b
B5	6.23cd
B6	6.17bcd
B7	6.10bc
B8	6.27e

Notes: Numbers followed by the same letter in the same column are not significantly different based on the 5% Duncan test.

Table 8 explains that the highest average soil pH is found in treatment B5, which is not significantly different from B2, B3, B6, and B7 but significantly different from B1, B4 and B8.

Cation Exchange Capacity (me/100gr)

The list of variance shows that the combination of organic fertilizer and biochar has no significant effect on cation exchange capacity. Cation exchange capacity of soybean plants due to the treatment of the combination of organic fertilizer and rice husk biochar can be seen in Table 9.

Tabel 9. Average Cation Exchange Capacity of Soybean Plants

Treatment	Average
B1	15.39
B2	14.19
B3	10.79
B4	15.44
B5	18.76
B6	16.82
B7	11.69
B8	12.19

Notes: Numbers followed by the same letter in the same column are not significantly different based on the 5% Duncan test

Table 9 explains that the highest average Cation Exchange Capacity is found in treatment B5, which is not significantly different from B1, B2, B3, B4, B6, B7 and B8.

Base Saturation (%)

The list of variance shows that the combination of organic fertilizer and biochar has a significant effect on base saturation. Average Saturation of Bases of soybean plants due to the Treatment of Combination of organic fertilizer and rice husk biochar can be seen in Table 10.

Tabel 10. Average Base Saturation due to the combination treatment of organic fertilizer and rice husk biochar

Treatment	Average
B1	13.69ab
B2	12.00a
B3	18.22bc

B4	19.41c
B5	21.00c
B6	20.15c
B7	16.77abc
B8	15.83abc

Notes: Numbers followed by the same letter in the same column are not significantly different based on the 5% Duncan test

Table 10 explains that the highest average Base Saturation is found in treatment B5, which is not significantly different from B3, B4, B6, B7 and B8 but significantly different from B1, B2.

Soil N availability (%)

The list of variance shows that the combination of organic fertilizer and biochar has no significant effect on soil N availability. The average soil N availability of soybean plants due to the treatment of the combination of organic fertilizer and rice husk biochar can be seen in Table 11.

Tabel 11. Average soil N availability

Treatment	Average
B1	0.12
B2	0.17
B3	0.19
B4	0.25
B5	0.27
B6	0.37
B7	0.21
B8	0.21

Notes: Numbers followed by the same letter in the same column are not significantly different based on the 5% Duncan test

Table 11 explains that the highest average available N is found in treatment B6, which is not significantly different from B1, B2, B3, B4, B5, B6, B7 and B8.

N Absorbed in Plants (%)

The average N absorbed by soybean plants due to the treatment of the combination of organic fertilizer and rice husk biochar can be seen in Table 12.

Table 12 explains that the highest average absorbed N is found in treatment B6, which is not significantly different from B1, B2, B3, B4, B5, B7 and B8.

Tabel 12. Average N Absorbed in Soybean Crops

Treatment	Average
B1	3.54
B2	4.13
B3	3.22
B4	3.92
B5	3.22
B6	3.43

	B7	3.78
	B8	3.15

Notes: Numbers followed by the same letter in the same column are not significantly different based on the 5% Duncan test

DISCUSSION

The combination treatment of organic fertilizer and rice husk biochar available N increased from 0.01% to 4.13% in the B2 treatment. Although there was an increase, the effect was not significant. This is probably due to the relatively short incubation time of organic fertilizer and biochar. Nitrogen is one of the main nutrients needed by all plants including legumes for optimal growth and production (Hakim et al., 2015).

The treatment of organic fertilizer and rice husk biochar had no significant effect on N uptake, the highest average was in treatment B6 0.37%. This is thought to be because the plants analyzed at the age of 5 MST have not maximally absorbed N nutrients. This is in line with research (Kasno & Rostaman, 2013), stating that the absorption of N by plants is influenced by several internal factors, such as the physiological conditions of plants, plant species and plant needs for certain nutrients. External or environmental factors that affect the absorption of N by plants, namely light, air, water and soil pH. Nitrogen in plants functions in expanding the leaf area so as to increase photosynthesis. Nitrogen is one of the main nutrients needed by all plants including legumes for optimal growth and production.

The combination treatment of organic fertilizer and rice husk biochar had a significant effect on the height of soybean plant in the B2 treatment (15 tons/ha organic fertilizer). This is thought to be because the application of organic fertilizer can increase the nutrient content in the soil and rice husk biochar acts as a soil improver that can improve the chemical, physical, and biological properties of the soil so that plants can absorb nutrients to support their growth. The increase in plant height is also influenced by the increased soil CEC. In this study there was an increase in CEC from 7.67 m.e/100gr to 18.76 m.e/100gr. This is in accordance with the statement (Rahman, et al 2014) that the addition of biochar to the soil increases the availability of phosphorus, total nitrogen and soil cation exchange capacity (CEC) which ultimately increases yield. The high availability of nutrients for plants is the result of increased nutrients directly from biochar.

The increase in the number of branches of soybean plants does not only depend on organic fertilizers, in this study the provision of organic fertilizers and rice husk biochar has a significant effect on the number of branches of soybean plants, the highest average number of branches at 4 weeks after planting is found in treatment B4 (12.5 tons/ha organic fertilizer + 2.5 tons/ha rice husk biochar). According to (Suroso and Sodik 2015) states that the more organic matter is given to the soil, it will be followed by an increase in the soil's ability to bind water and an increase in total nitrogen. The need for sufficient nitrogen makes overall plant growth grow well.

The provision of a combination of organic fertilizer and rice husk biochar has a significant effect on the number of branches of soybean plants in treatment B4 (12.5 tons/ha organic fertilizer equivalent to 522 grams/polybag +2.5 tons/ha rice

husk biochar equivalent to 104 grams/polybag), this is thought to be because biochar coupled with organic fertilizer can increase the availability of nutrients for plants used by soybean plants in the vegetative and generative phases. The N element absorbed by plants is used for the formation of protein as a constituent of plant organs, especially in plant tissues that are actively dividing (meristem) both in roots, stems, branches and leaves.

The application of organic fertilizer and rice husk biochar has a significant effect on the number of soybean root nodules in treatment B4 (12.5 tons/ha organic fertilizer equivalent to 522 grams/polybag + 2.5 tons/ha rice husk biochar equivalent to 104 grams/polybag), rice straw without incubation (control) can increase the formation of root nodules. The longer the incubation period, the lower the formation of root nodules of soybean plants.

The combination of organic fertilizer and rice husk biochar had a significant effect on the wet weight of pods/plot and dry weight of pods/plot. The fresh weight of pods is related to the N content in the soil because the role of N elements helps in fruit formation and maturity of pods and seeds (Pakpahan et al., 2020). The results showed that the addition of biochar itself can significantly increase plant growth and absorption of nutrients that are important in the flowering period, can also spur the flowering time of soybean plants faster and increase the number of filled pods. The results explained that in the treatment of a combination of organic fertilizer and rice husk biochar had no significant effect on the average number of empty pods/sample. According to Gomez et al. 2014 states that the number of empty pods is more dominantly influenced by the planting environment than genetic factors if the elements of N, P, and K given are deficient, for example P is lacking, the process of seed formation does not run well. Biochar can spur the function of soil biology by providing a growing habitat for soil microorganisms that affect the availability of nutrients and enzymes. In general, nutrients are easily absorbed by plants at a soil pH around neutral, because at that pH most nutrients are easily soluble in water. Low pH conditions also affect the growth of root nodule bacteria in soybean plants.

The highest average Cation Exchange Capacity was found in the treatment of organic fertilizer and rice husk biochar in treatment B5. The highest and significantly different soil CEC was obtained in the treatment of biochar types of prunings, sepium and corn stover, compared to biochar treatments of cow dung and rice husks. The same pattern is also seen in the biochar dose factor, there an increase in total N (Mateus et al., 2017) explained that in the treatment of a combination of organic fertilizers and rice husk biochar, the highest average Base Saturation (KB) was B5. The results of the base saturation analysis stated that each treatment had significantly different results from the control. In the treatment of organic fertilizer and rice husk biochar, the highest available N average was found in the B2 treatment. From the results of the study that the available N is not real it is influenced by environmental factors such as high rainfall.

CONCLUSION AND RECOMMENDATION

Based on the research that has been done, it can be concluded that the combination treatment of cow organic fertilizer and rice husk biochar has a significant effect on

plant height, number of branches, root nodules, pod wet weight, pod dry weight, soil pH, base saturation (KB), and N absorbed, but has no significant effect on the number of filled pods, number of empty pods, cation exchange capacity (CEC), and N available. The average number of filled pods was highest in treatment B4 (36.67%) and lowest in treatment B1 (1.33%). The highest average cation exchange capacity (CEC) was found in treatment B2 (18.76m3/100g), and the lowest average was found in treatment B6 (10.79me/100g). The highest average available N was found in treatment B2 (4.13%) and the lowest was found in treatment B8 (3.15%).

SUGGESTION

Further research is needed to determine the effect of the combination of organic fertilizer and rice husk biochar on available N, N uptake on the growth and production of soybean plants, on ultisol soil using higher treatment doses.

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