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THE EFFECTIVENESS COMBINATION OF PALM KERNEL BIOCHAR AND TITHONIA COMPOST ON IMPROVING HYDROLOGICAL RESPONSE AND CORN YIELD IN ULTISOL

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ABSTRACT

The primary objective of this research was to investigate the efficacy of a combination of soil ameliorants, specifically oil palm shell biochar and tithonia compost, in enhancing the hydrological response of Ultisols and increasing corn yields. The study aimed to identify the optimal dosage combination that would significantly impact Ultisol hydrological response and maize yield. The randomized block design (RBD) was utilized to conduct the study. The ameliorant materials consisted of oil palm shell biochar and tithonia compost, which were divided into six treatments and four groups, including without Biochar and compost (p0), 10 tonnes/ha of Biochar (p1), 7.5 tonnes/ha of biochar & 2.5 tonnes/ha of compost (p2), 5 tonnes/ha of biochar & 5 tonnes/ha of compost (p3), 2.5 tonnes/ha of Biochar + 7.5 tonnes/ha (p4), and 10 tonnes/ha of compost (p5). Soil physical parameters, such as soil organic matter, soil bulk density, total pore space, soil texture, permeability, infiltration rate, and soil infiltration capacity, were monitored during the study. The BNJ test with a 95% confidence level was used to analyze the research data. The result of the study indicated that the p3 treatment (5 tonnes/ha of Biochar and 5 tonnes/ha of compost) and the p4 treatment (7.5 tonnes/ha of compost & 2.5 tonnes/ha of Biochar) demonstrated a more significant improvement in infiltration rate and capacity, as well as soil permeability, compared to the other treatments. Moreover, the p3 treatment (5 tonnes/ha of biochar & 5 tonnes/ha of compost) was shown to enhance corn yields by 80.53%, while the p4 treatment (2.5 tonnes/ha of biochar & 7.5 tonnes/ha of compost) resulted in an 80% increase in yields.

Keywords: Biochar; compost; infiltration; palm shells; tithonia; Ultisol

INTRODUCTION

Due to the limited availability of productive land in Indonesia, farmers are resorting to cultivating marginal lands for agricultural purposes, including Ultisol. In Jambi Province alone, Ultisol covers an area of 2.27 million hectares, which is equivalent to 42.53% of the province's total land area [1]. This suggests that Ultisol has excellent potential for developing dry-land agriculture. However, Ultisol's agricultural use is hindered by several challenges, such as low soil porosity, poor infiltration and permeability rates, and limited water holding capacity [2,3]. To address these issues and enhance Ultisol's infiltration and permeability, soil ameliorants like Biochar and compost can be applied.

Biochar is a type of biological charcoal produced through a pyrolysis process involving carbon-based raw materials (biomass). This process generates 50% carbon (C) and nutrients that can be used as a soil conditioner to enhance soil fertility and properties [4,5]. A study conducted [6] revealed that Biochar, as a soil ameliorant, effectively enhances soil properties by increasing the stability of soil aggregates, permeability, organic carbon content, and the ability to retain water and nutrients for plant growth. Furthermore, the combination of Biochar and compost can further enhance soil fertility by improving its physical, chemical, and biological properties [7].

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The application of compost in agricultural land has been a well-known and reliable way to enhance soil physical properties, specifically by increasing soil organic matter and improving infiltration rates, soil water content, porosity, and aggregate stability [8]. Tithonia diversifolia plant, an invasive weed that grows in the highlands of Sumatra, contains high levels of nutrients such as 0.95-1.55% nitrogen, 0.31-1.5% phosphorus, and 0.35-0.88% potassium [9, 10], which is used to produce Tithonia compost. Tithonia compost can improve soil physical properties by increasing soil organic matter and acting as a soil conditioner that helps in the formation of granules. This helps to loosen the soil structure and improve bulk density, porosity, permeability, and available pore water, thus providing sufficient water and air for plant growth [3, 12]. In South Labuhan Batu Ultisols, the results of a study [13] indicated that the application of Tithonia diversifolia compost had a significant effect on increasing phosphorus uptake and growth of corn plants.

In tropical soils, the benefits of using compost are typically short-lived, lasting only one or two growing seasons due to the rapid oxidation and mineralization of organic matter in the soil. To address this issue, a solution is to combine compost with a soil enhancer that has a long-term effect on increasing and maintaining soil organic carbon stability, such as biochar [14]. According to Rezeki's study [15], the application of oil palm shell biochar resulted in increased nutrient uptake in sweet corn plants compared to no biochar application. Treatment with 10 tons/ha of palm shell biochar yielded the highest absorption of N, P, and K compared to other treatments.

The utilization of biochar and tithonia compost has been proven to be an effective method for enhancing food crop productivity, specifically corn. Corn plants necessitate high nutrients, predominantly nitrogen, making them suitable as test plants for fertilization, particularly in comparisons between organic fertilizers [16]. Thus, conducting research to determine the impact of the combination of biochar and tithonia compost on soil properties and plant growth is crucial. The objective of this study is to investigate the effectiveness of the combination of oil palm shell biochar and tithonia compost in improving soil hydrological conditions, such as soil permeability and infiltration, and corn yield in Ultisols.

MATERIALS AND METHODS

The study was conducted in Sungai Duren Village, Jambi Luar Kota sub-district, Muaro Jambi District, Jambi Province. The soil type at the research site was Ultisol. The duration of the study was approximately five months. The research utilized various instruments, such as pyrolysis drums, weighing scales, soil ovens, sample rings, double-ring infiltrometers, stopwatches, permeameters, furnaces, and wet sieve apparatus. The materials employed in the research comprised oil palm shell biochar, tithonia compost, urea, TSP and KCL fertilizers, *furadan* pesticide, and Bisi 1 hybrid corn variety.

This study was an experimental study using a randomized block design (RBD) with six treatments with four repetitions for each treatment to obtain 24 experimental units. The treatments were combinations of oil palm shell biochar and tithonia compost as described below:

p0: control (without Biochar and compost).
p1: biochar 10 tonnes/ha
p2: biochar 7.5 tonnes/ha & compost 2.5 tonnes/ha
p3: biochar 5 tonnes/ha & compost 5 tonnes/ha
p4: biochar 2.5 tonnes/ha & compost 7.5 tonnes/ha

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p5: compost 10 ton/ha

Research Stages

The Biochar used in this study was derived from oil palm shells that underwent pyrolysis and were subsequently sifted through 50 mesh (100% pass) and 80 mesh (50% pass) sieves. The compost used in the study was composed of fresh Tithonia diversifolia forage with Trichoderma decomposers and was subjected to a 4-week composting process. The experimental plots were sized at 3 x 4 meters and spaced at 75 x 40 cm to accommodate 40 plants per plot. Treatment was carried out by broadcasting the materials onto the soil surface and incorporating them to a depth of approximately 20 cm. Treatment was administered based on the dry weight dose of organic matter and subsequently incubated for one week following even distribution.

Planting was conducted one week after the treatment application. The corn seeds were carefully chosen beforehand, and three of them were placed in each planting hole. The standard fertilizers used in this research were 300 kg/ha Urea, 150 kg/ha TSP, and 150 kg/ha KCL. The plant maintenance procedures applied in this research included watering, thinning, pruning, replanting, and weeding, as well as pest and disease control. Harvesting was performed 106 days after planting.

Observational Variables

The plant variables observed in this study were: plant height and corn yields. Soil variables observed include:

a. Soil Organic Matter

The Loss on Ignition (LOI) method was employed to determine the material properties. Composite soil samples were subjected to baking at 105°C for 24 hours and subsequently heated to 600°C for 6 hours using a Furnace tool. Organic matter content was determined using the equation given below.

$$\%\,Organic\ Matter = \frac{sample\ dry\ weight - ash\ weight}{sample\ dry\ weight}\ x\ 100\%$$

b. Bulk Density

The gravimetric method was utilized to measure bulk density. Intact soil samples were subjected to a 2 x 24-hour oven-drying process at 105°C, after which bulk density was determined using the equation below.

$$Bulk\ Density = \frac{soil\ dry\ weight\ (gr)}{soil\ volume\ (cm^3)}$$

c. Total Pore Space

The gravimetric method was utilized to determine the total pore space. Intact soil samples baked in sample rings for 2 x 24 hours at 105°C were used for the analysis. Based on the organic matter content value, which was greater than 1%, the total pore space was calculated using the equation provided below.

$$Total\ Pore\ Space = \left(1 - \frac{BD}{BJ - (0{,}02\ x\ \%\,BO)}\right)\ x\ 100\%$$

Description:

BD = bulk density (gr/cm3)

BO = organic matter (%)

BJ = weight of soil per unit volume of soil particles (gr/cm3)

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d. Soil texture

In this study, soil texture was determined using the Hydrometer method. This was done to obtain the percentage of sand, silt, and clay present in the soil. Subsequently, the soil texture classification was determined using the soil texture triangle, as per the guidelines outlined by the USDA.

e. Permeability

The permeability measurement is carried out by implementing Darcy's Law method. According to Darcy's Law, the permeability of soil is determined by its permeability coefficient. This coefficient depends on several factors, including liquid viscosity, pore size distribution, grain size distribution, void ratio, mineral particle roughness, and degree of soil saturation. The Law can be expressed in the following manner:

$$K = \frac{Q\ x\ L}{t\ x\ h\ x\ A}$$

Descriptions:

K = Permeability (cm/hour)
Q = Volume of water
L = Height of soil sample (cm)
t = Measurement time (hours)
h = Height of water above the surface
A = Land surface area (cm2)

f. Infiltration rate

The process of infiltration measurement was conducted in this study by means of direct field measurements utilizing a double-ring infiltrometer. The data obtained from the infiltration rate measurements in the field can be analyzed through the utilization of the equation provided below:

$$f = \frac{\Delta H}{t} x60\ (cm/jam)$$

Descriptions:

f = infiltration rate
ΔH = height of water drops in a specific time interval (cm)
t = time required by water at ΔH to penetrate the soil (minutes).

The Horton model is recognized as one of the widely used infiltration models in hydrology. It is observed that the infiltration capacity decreases over time, eventually reaching a constant value. The mathematical representation of the Horton model can be described through the utilization of the equation provided below:

$$f = fc + (f0 - fc)e^{-kt}$$

Descriptions:

f = infiltration capacity of water into the soil (cm/hour)
fc = constant infiltration rate (cm/min)
fo = initial infiltration rate (cm/min)
e = 2.71828
k = soil constant (infiltration coefficient)
t = time (minutes)

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Data Analysis

In this study, a range of observational data was collected and analyzed. This included variables such as infiltration rate, bulk density, total pore space, permeability, organic matter, plant height, and corn yield. The analysis was conducted using ANOVA at a 95% confidence level (α = 5%). Subsequently, the BNJ test was conducted to evaluate the average effect of treatment.

RESULT AND DISCUSSION

Soil Physical Properties Before Treatment

The physical characteristics of the soil, as observed prior to treatment, indicated the presence of several physical properties that were not conducive to plant growth. The relevant physical properties of the soil prior to the completion of total treatment have been documented in Table 1.

Table 1: Physical Soil Properties Before Treatment

No.	Soil parameters	Measurement Results	Criteria
1.	Organic matter (%)	2,73	Low*
2.	*Bulk density* (gr/cm^3)	1,98	High*
3.	Total Pore Space(%)	48,38	Low*
4.	Soil texture:		
	a. Sand (%)	72,09	Loamy sand*
	b. Dust (%)	23,92	
	c. Clay (%)	3,99	
5.	Permeability (cm/jam)	2,81	Slow*
6.	Infiltration rate (cm/jam)	0,90	Rather slow**

Note: * criteria based on Bogor Soil Research Center (1994); ** criteria based on Kohnke (1968); Arshad (2010)

Table 1 indicates that the soil in the low category contains 2.73% organic matter. This low organic matter leads to a high bulk density value, which can reach 1.98 in the high category. Such a combination of low organic matter and high bulk density results in soil compaction and a low soil pore number, which can be as low as 48.38% in the low category. The analysis further reveals that the initial soil permeability is in the slow category at 2.81 cm/hour, and the infiltration rate is relatively slow at 0.90 cm/hour. These soil conditions, characterized by low organic matter, high bulk density, low porosity, and slow infiltration rates, lead to insufficient soil pore space, making the soil more prone to compaction and hampering the inflow of water into the soil, which, in turn, reduces its ability to transmit water to the lower layers [17]. Therefore, it is essential to enhance soil physical properties to improve soil quality, which, in turn, will support the development and growth of corn plants. One practical approach to this goal is adding organic matter and soil amendments, such as oil palm shell biochar and tithonia compost.

Characteristics of Tithonia Compost

Table 2 displays the complete analysis results of tithonia compost before its application to the soil. The analysis reveals that the compost adheres to the Indonesian National Standard (SNI) 19-7030-2005, indicating its high quality. Furthermore, the compost has undergone complete decomposition, making it appropriate for application with a C/N value of 12.56%. It is worth noting that the C/N ratio of the compost has also reached 12.56.

Table 2. Tithonia Compost Analysis

No.	Compost Parameter	Measurements Results	Quality Standards
1.	Water Content (%)	20,67	≤ 50

No.	Compost Parameter	Measurements Results	Quality Standards
2.	C-Organic	18,97	9,80 - 32
3.	N-Total (%)	1,51	≥ 0,4
4.	C/N (%)	12,56	10 - 20

Soil Physical Properties After Treatment

Soil Organic Matter

According to Table 3, applying either 10 tons/ha of Biochar (p1) or 10 tons/ha of compost (p5) alone significantly impacted increasing soil organic matter. Furthermore, treatments p1, p3 (5 tonnes/ha of biochar & 5 tonnes/ha of compost), p4 (2.5 tonnes/ha of biochar & 7.5 tonnes/ha of compost), and p5 (10 tonnes/ha of compost) all resulted in a comparable increase in soil organic matter. The use of tithonia compost as a means of enhancing soil organic matter can lead to increased soil C content through the release of C-organic from the compost [18]. Additionally, oil palm shell biochar was found to substantially impact increasing soil organic matter, with Biochar serving as a long-lasting source of carbon in the soil. As the dose of Biochar applied to the soil improves, the carbon stock in the soil also increases [19]. These findings align with previous research, which demonstrated that the application of 10 tons/ha of palm shell biochar increased the soil organic matter content by 4.73% compared to a control group where no biochar was used, which resulted in a soil organic matter content of 2.87% [20].

Table 3: Effect of Treatment Doses on Soil Organic Matter, Bulk Density and Total Soil Pore Space

Treatments	Organic matter (%)	Bulk Density (gr/cm^3)	Total Pore Space (%)
P0 (Control)	2,87 c	1,38 a	18,01 ba
p1: biochar 10 tonnes/ha	4,45 ab	1,23 ab	53,73 ab
p2: biochar 7.5 tonnes/ha & compost 2.5 tonnes/ha	3,57 bc	1,28 ab	51,55 ab
p3: biochar 5 tonnes/ha & compost 5 tonnes/ha	5,67 a	1,15 b	56,49 a
p4: biochar 2.5 tonnes/ha & compost 7.5 tonnes/ha	5,50 a	1,18 b	55,48 a
p4: biochar 2.5 tonnes/ha & compost 7.5 tonnes/ha	5,38 a	1,20 b	54,80 a

Bulk Density

Table 3 illustrates that the application of 10 tonnes/ha of Biochar (p1) and 10 tonnes/ha of compost (p5) alone did not result in a significant decrease in bulk density when compared to the control treatment (p0). However, p3 (5 tonnes/ha of biochar & 5 tonnes/ha of compost), p4 (2.5 tonnes/ha of biochar & 7.5 tonnes/ha of compost), and p5 (10 tonnes/ha of compost) had a significant impact in reducing soil bulk density. These treatments were found to have the same effect on soil bulk density. The reduction in bulk density was observed to be related to the dosage of each treatment administered to the soil. High organic matter content in the soil leads to lower bulk density than low organic matter content [21]. Incorporating tithonia compost into the soil enhances soil organic matter content, which is decomposed into organic acids that bind soil particles, resulting in stable soil aggregates. The study demonstrated that a combination of Biochar and compost provides an alternative approach to improving soil density. As a soil conditioner, Biochar exhibits more stable properties and is less susceptible to oxidation. This is consistent with previous research [22], which reported that applying 10 tonnes/ha of compost and 10 tonnes/ha of Biochar significantly reduced bulk density by up to 7.5%.

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Total Pore Space

Table 3 indicates that p3 treatment (5 tonnes/ha of biochar & 5 tonnes/ha of compost), p4 (2.5 tonnes/ha of biochar & 7.5 tonnes/ha of compost), and p5 (10 tonnes/ha of compost) significantly increased the total soil pore space, with all three treatments having a similar effect on the total soil pore space. The combination of oil palm shell biochar and tithonia compost, combined or separately, resulted in an increase in the total pore space of the soil. The p1 treatment showed an increase of 11.91%, p2 showed 7.37%, p3 showed 17.66%, p4 showed 15.55%, and p5 showed 14.14% in total pore space. The p3 treatment had the highest total pore space of 56.49%.

The use of tithonia compost can affect soil aggregation through the activity of soil microorganisms. High organic matter content can lead to low bulk density and increase total soil pore space, and vice versa [23]. The combination of Biochar and compost can also contribute to the increase in soil porosity by providing a new habitat for soil microbes, which can influence the formation of soil pores [24]. The research findings demonstrate that a lower bulk density value is associated with a higher total pore space in the soil.

Rate and Capacity of Infiltration

The pore distribution of soil is affected by the organic matter content, bulk density, and total pore space, which subsequently impacts the rate and capacity of soil infiltration. Analysis results demonstrate that the application of a combination of Biochar and compost significantly affects the rate and capacity of soil infiltration. According to the Horton model, the infiltration rate decreases as time progresses, eventually reaching a constant value, as depicted in Figure 1.

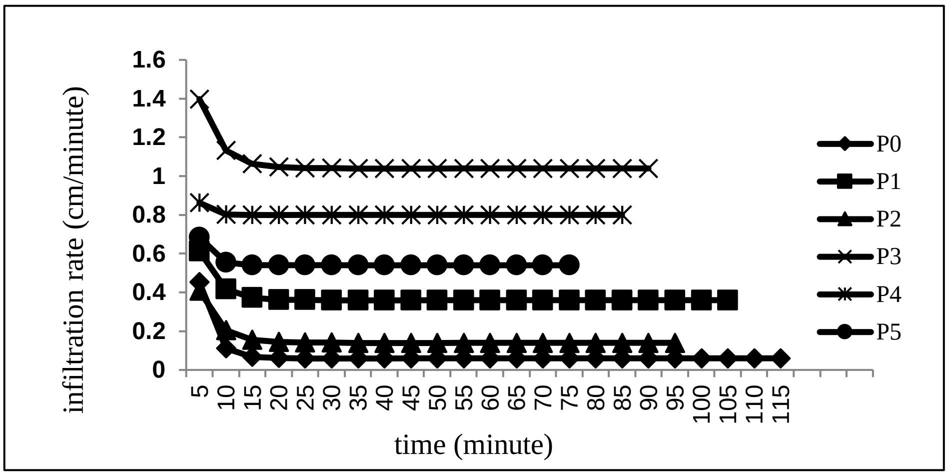

Figure 1. Infiltration Rate Curve for Each Treatment

Based on Figure 1, the infiltration rate is observed to be lower in the control group, whereas the p3, p4, and p5 treatments exhibited the highest infiltration rates. This trend aligns with the findings of the study, which demonstrated that the p3, p4, and p5 treatments had the lowest volume weight and the highest total pore space. Furthermore, the outcomes of the analysis of variance, as presented in Table 4, indicate that the application of a combination of tithonia compost and Biochar significantly influenced the rate and capacity of soil infiltration.

Table 4. Effect of Treatment Dosage on Infiltration Rate, Capacity, and Soil Permeability

Treatments	Infiltration Rate (cm/jam)	Infiltration Capacity (cm/jam)	Permeability (cm/jam)
P0 (Control)	1,55 e	7,00 c	17,33 b
p1: biochar 10 tonnes/ha	4,59 cd	21,32 bc	18,38 ab

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Treatments	Infiltration Rate (cm/jam)	Infiltration Capacity (cm/jam)	Permeability (cm/jam)
p2: biochar 7.5 tonnes/ha & compost 2.5 tonnes/ha	2,84 de	13,17 c	18,01 b
p3: biochar 5 tonnes/ha & compost 5 tonnes/ha	11,48 a	54,06 a	21,33 ab
p4: biochar 2.5 tonnes/ha & compost 7.5 tonnes/ha	8,99 ab	41,92 ab	22,53 a
p4: biochar 2.5 tonnes/ha & compost 7.5 tonnes/ha	6,50 bc	30,44 abc	20,45 ab

Table 4 illustrates that treatment p2, consisting of 7.5 tonnes/ha of Biochar and 2.5 tonnes/ha of compost, had no significant effect on increasing the infiltration rate in comparison to the control group (no treatment). Conversely, treatments p1 (10 tonnes/ha of Biochar), p3 (5 tonnes/ha of Biochar and 5 tonnes/ha of compost), p4 (2.5 tonnes/ha of Biochar and 7.5 tonnes/ha of compost), and p5 (10 tonnes/ha of compost) were able to significantly increase the infiltration rate relative to the control group. The treatment with the highest rate and capacity values was p3 (5 tonnes/ha of Biochar and 5 tonnes/ha of compost), exhibiting an 11.48 cm/hour increase in infiltration rate and a 54.06 cm/hour infiltration capacity and meeting the relatively fast criteria. The addition of tithonia compost and Biochar to the soil can enhance the physical properties of the soil and stimulate the growth of soil microorganisms, given their organic matter content. Besides providing nutrients for plants, organic matter can also augment the holding capacity of groundwater.

The incorporation of Biochar and compost into the soil can increase biomass and consequently enhance the organic matter content, leading to a reduction in bulk density. The study found that there is an inverse relationship between bulk density and infiltration rate, indicating that a lower bulk density results in a higher infiltration rate and vice versa. Bulk density plays a crucial role in regulating the infiltration rate, as lower bulk density suggests higher total pore space and organic matter content in the soil, resulting in increased water penetration and a higher infiltration rate. It was observed that a lower bulk density value leads to a higher infiltration rate [25].

Soil Permeability

Table 4 displays the soil permeability outcomes, indicating that treatment p0 (control) did not differ significantly from treatment p1 (10 tonnes/ha biochar), p2 (7.5 tonnes/ha biochar & 2.5 tonnes/ha compost), p3 (5 tonnes/ha of biochar & 5 tonnes/ha of compost), and p5 (10 tonnes/ha of compost). However, the control exhibited a significant difference from the p2 treatment (2.5 tonnes/ha of biochar & 7.5 tonnes/ha of compost). The results suggest that most treatments had a similar effect on increasing soil permeability compared to the control. This could be due to the comparable friability and porosity of the soil resulting from a decrease in bulk density and an increase in total pore space, which were relatively consistent across all plots with the same texture. Consequently, favorable pore conditions were created, resulting in comparable water flow capabilities and, therefore, an insignificant effect on increasing soil permeability.

The treatment with the highest soil permeability was observed in p4, which consisted of 2.5 tonnes/ha of Biochar and 7.5 tonnes/ha of compost, with a value of 22.53 cm/hour. On the other hand, the control treatment (p0) had the lowest permeability with a value of 17.33 cm/hour. The increase in permeability was attributed to the addition of both compost and Biochar, which led to a decrease in bulk density and an increase in total soil pore space, ultimately resulting in higher permeability values.

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Corn Growth and Yield

According to the findings presented in Figure 2, the growth of corn plants differed in terms of plant height, depending on the application of Tithonia, Biochar compost, or a combination of both. However, there was no significant difference observed in the height of corn plants among the various treatments.

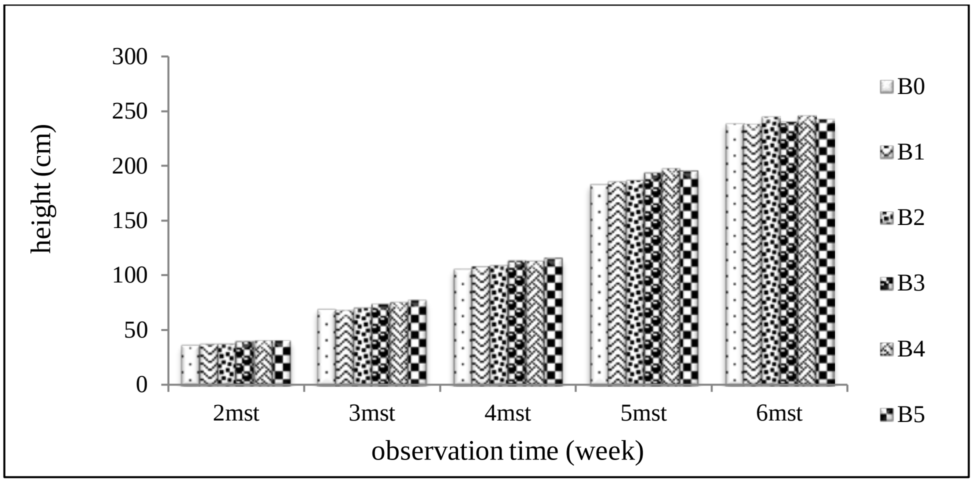

Figure 2. Growth Rate of Corn Plants

During weeks 2 to 4 after planting, there was no significant response in the growth of corn plants due to the application of compost and Biochar. However, in weeks 5 to 6, there was a noticeable increase in corn plant height as a result of applying compost, Biochar, or a combination of both. This increase in plant growth is likely attributed to the enhancement of soil physical properties such as infiltration rate and soil permeability, leading to an increase in soil water content. In fact, soil water content has been found to have a significant impact on plant height during the third week of planting [26]. The analysis showed that the application of oil palm shell biochar and tithonia compost did not have a significant effect on plant height but did have a significant effect on plant yields. The average values of plant height and corn yield were further subjected to the Honest Significant Difference Test, as presented in Table 5.

Table 5. Effect of Treatment Dosage on Growth and Yield of Corn Plants

Treatments	Plant Height (cm)	Plant Yield (kg/slot)
P0 (Control)	238,42 a	3,75 c
p1: biochar 10 tonnes/ha	237,79 a	5,42 b
p2: biochar 7.5 tonnes/ha & compost 2.5 tonnes/ha	244,51 a	6,01 b
p3: biochar 5 tonnes/ha & compost 5 tonnes/ha	240,01 a	6,77 a
p4: biochar 2.5 tonnes/ha & compost 7.5 tonnes/ha	245,79 a	6,75 a
p4: biochar 2.5 tonnes/ha & compost 7.5 tonnes/ha	242,58 a	6,08 b

Table 5 shows that the application of Biochar, compost, or a combination of both was not significantly different in all treatments in plant height growth. This condition is due to the same tillage in each treatment. This study also used basic fertilizers, namely Urea, TSP, and KCL. The use of basic fertilizers is used to help increase plant growth. Fertilizers play an important role in increasing crop yields, especially on soils with low nutrient content [27]. In addition, basic fertilizers can also nourish chlorophyll, increase protein levels in plant bodies, and improve the quality of plants in producing leaves. In addition, the condition of the land used is open land so that the plants get the same light intensity.

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The most effective treatments were observed in the p3 treatment (5 tonnes/ha of biochar & 5 tonnes/ha of compost) and the p4 treatment (2.5 tonnes/ha of biochar & 7.5 tonnes/ha of compost). Each treatment resulted in an increase in corn yields by 6.77 kg/plot or 5.64 tons/ha and 6.75 kg/plot or 5.62 tons/ha, respectively, compared to the control treatment of 3.75 kg/plot or 3.12 tonnes/ha. This represents an increase in corn crop yields ranging from 80.00% to 80.53%.

CONCLUSIONS

The application of treatments p3 and p4, which consist of various ratios of palm shell biochar and tithonia compost, resulted in a more effective improvement in soil infiltration rate and capacity compared to the other treatments. Additionally, the p3 treatment, with an application rate of 5 tonnes/ha of palm kernel shell biochar and 5 tonnes/ha of compost, showed the highest increase in corn yield at 80.53%. Similarly, the p4 treatment, with an application rate of 2.5 tonnes/ha of palm shell biochar and 7.5 tonnes/ha of tithonia compost, also increased corn yield by 80%. Both treatments were found to be the most effective in improving corn yield.

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