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Biochar and Biofertilizer Reduce the Use of Mineral Fertilizers, Increasing the Efficiency of Shallot Fertilization

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ABSTRACT

Although the inceptisol soil in Nawungan has good fertility, it is not very effective in fertilizing plants because a lot of the nutrients are lost due to evaporation or washing away. As a result, new and inventive methods of growing shallots in that region were needed. The purpose of this study was to improve the yield of shallot plants and the efficacy of NPK fertilization of shallot plants by applying biochar and biofertilizer. The study was place at Nawungan 1, Selopamioro Village, Imogiri District, Bantul Regency, Yogyakarta Province, from April to September of 2023. Its coordinates are 7° 53'03.36" S, 110° 24'37.58" E. In order to create 33 trials, this study used a completely random group design (CRGD) with two factorials of 5 by 2 and one control negative with three repeats. One factor is biochar (B0), followed by biochar rice husk 5 tons·ha^{-1} (B1), biochar rice husk 10 tons·ha^{-1} (B2), biochar shell coconut 5 tons·ha^{-1} (B3), and biochar shell coconut 10 tons.ha^{-1} (B4). The second element is that without biofertilizer (H0A), without biofertilizer + NPK 400 kg·ha^{-1} (H0B) and with biofertilizer + NPK 400 kg·ha^{-1} (H1B). The research result showed that treatment application biofertilizer + NPK 400 kg·ha^{-1} + biochar coconut shell capable increase C-organic, N-total, P-available, K-available, growth tall plants, quantity leaves, yield harvest, NPK uptake by plants and increase efficiency NPK fertilization on the Inceptisol.

Keywords: biofertilizer, biochar, Inceptisol, NPK, shallots.

INTRODUCTION

The place where organisms such as flora, macrofauna, mesofauna, and microfauna grow is in the soil. Indonesia is home to a variety of terrain types, including Inceptisols (USDA). Approximately 70.52 million hectares, or 40% of Indonesia's wide primary soil, are covered by inceptisols in the region that is flat until slopes (Puslittanah, 2003). Incepsols are immature soils that are quickly forming from parent materials that are deteriorating. According to Sudirja *et al.* (2027) and Barbosa *et al.* (2020), inceptisol soil has its own depth and is excellent at processing thin soil. Its nature physical development system roots and rooted limited land, and it has a heavier, more kind texture due to part of its pore filled with dust particles (Sudirja *et al.*, 2027 and Barbosa *et al*., 2020).

Shallot (*Allium ascalonicum L.*) is one plant horticulture shaped tubers layered with root fibrous and leafy cylindrical like needle. Shallot lots grown in Indonesia which is utilized as material spice kitchen main. Shallot has a tuber diameter range between 2–3 cm. Shallot have varying harvest periods start aged 60–90 days after planting (DAP). Shallot own potency harvest up to >12 ton·ha^{-1} in season dry and 25 ton·ha^{-1} in season rain (Muchjidin, 2010).

The *Allium ascalonicum L.,* commonly known as red shallot, is a horticultural tuber that is covered with fibrous roots. According to BPS (2022), production shallot in 2021 it will reach 2 million tons, an increase of 10.42% (189.15 thousand tons) from 2020. Consumption shallot sector House Indonesia's ladder in 2021 rose 8.33% compared 2020. Recorded consumption red shallot House in 2021 it will reach 790.63

thousand tons. That number increase amounting to 60.81 thousand tons if compared to with year previously. Consumption red shallot sector house ladder contribute amounting to 94.16% of total consumption shallot big in 2021. With increase amount Indonesia's population is estimated at total consumption shallot in Indonesian will keep going increase every the year so that opportunity cultivation red shallot will still promising. BPS (2022) projects that production of red shallot will reach 2 million tons.

Providing material repairer land in agricultural activities has been a long-standing practice among farmers who make use of nearby resources. Biochar is one of the many types of soil ameliorant materials that are accessible. Nevertheless, employ biochar at the farmer level. Still incredibly infrequently. Biochar is a carbon-rich substance that is produced by burning organic waste (biomass agriculture) without oxygen or with limited oxygen supply (pyrolysis) (Lehmann, 2009 and Weber and Quicker, 2018). The advantages of biochar include its wide, big surface area, stable structure, high cation exchange capacity, rich amount of carbon, and stability (Rizwan *et al.*, 2016). Biochar is given as an ameliorant on substandard soil repair characteristic chemistry soil, biology soil, and nature physique soil, according to Sriratmini *et al.* (2019), 2021, up 10.42% (189.15 thousand tons) from 2020. Restoring the soil's qualities will boost plant and land output. Additionally, according to Winarso (2005), providing land for repair will enhance the ability of the land to retain water, improve the biology of the land, and comply with Wigati *et al.* (2006), in order to improve stability, aggregate the land, and improve the humus content of the soil all circumstances that are desirable to the plant.

Farmers have long been aware of the benefits of using biofertilizer in agriculture since it can boost the number of bacteria in the soil. It is well recognized that biofertilizer can significantly increase the body's natural nutrient availability. In contrast, the pores in biochar can provide as a home for bacteria to remain in soil. The combination of biochar and biofertilizer has the potential to improve the quality of fertility in Inceptisol. Improvements in red shallot production can be achieved through repair technology, cultivation, and the use of biotechnology goods such as biochar and fertilizer in a climate-controlled, friendly environment. The addition of biochar and biofertilizer aims to improve soil health and NPK fertilization efficiency. Plants that thrive in good soil will yield high levels of productivity and health.

METHODS

Place and time of research

The study was conducted from April to September of 2023. Inceptisol in Nawungan 1, Selopamioro Village, Imogiri District, Bantul Regency, Yogyakarta Province was the land used for the study. This area, which is situated at 7° 53'03.36" S, 110° 24'37.58" E, is 298 meters above sea level. It experiences a typical tropical monsoon climate, with an average annual temperature of 21.9–31 °C and 3234 mm of bulk rain (BPS, 2023). The Soil Physics, General Soil, Soil Chemistry and Fertility Laboratory, Soil Department, Faculty of Agriculture, Gadjah Mada University conducts characteristic chemical and physical analyses.

Based on the analysis results of the soil's beginning, the Inceptisol site study own level fertility is very soil fertile. This matter can influenced exists activity culture influencing the humans characteristic soil. This horizon called the anthropogenic horizon. Activity culture humans carried out by residents is cultivation red shallot start 80s. Culture the has influence characteristic soil on land agriculture in the area study so the soil own hortic horizon. Hortic horizon has characteristic soil colored dark, content material organic and high P, activity animal high, saturation base high, as well generated from planting, fertilizing, and application period long from residue organic (IUSS, 2022).

Design study

Look over in this use of the randomized complite block design (RCBD), there were 33 trials consisting of one control negative with three repetitions and two factorials of size 5×2. The first factor treatment uses two types of biochar: coconut shell and rice husk biochar. Each treatment comes in two doses: a biochar-free one (B0), one that uses five tons of rice husk biochar per hectare (B1), ten tons of rice husk biochar per hectare (B2), five tons of coconut shell biochar per hectare (B3), and ten tons of coconut shell biochar per hectare (B4) (Yurika, *et al.,* 2022 and Panjukang, *et al.,* 2023). The second element is the

Table 1. Physical and chemical properties of the studied soil

No.	Soil properties	Unit	Value	Harkat
Soil physics				
1.	Texsture			*Clay*
	Sand	%	25	
	Dust	%	21	
	Clay	%	54	
2.	Structure	-	-	Loose
3.	Consistency	-	-	Crumb
4.	Volume weight	$g \cdot cm^{-3}$	0.95	Low
	Specific gravity	$g \cdot cm^{-3}$	2.12	Currently
5.	Porosity	%	55.24	Very high
6.	Moisture level	%	11.11	Low
Soil chemistry				
7.	Actual pH (H_20)		7.01	Neutral
8.	Organic ingredients	%	8.42	Very high
9.	C-organic	%	4.88	Very high
10.	N-total	%	0.46	Currently
11.	P-total	$mg \cdot kg^{-1}$	52.21	High
12.	K-total	$mg \cdot kg^{-1}$	56.42	Tall
13.	P-available	$mg \cdot kg^{-1}$	238.88	Very high
14.	K-available	$mg \cdot kg^{-1}$	68.36	Very high
15.	Na-available	$mg \cdot kg^{-1}$	25.40	Very high
16.	Ca-available	$mg \cdot kg^{-1}$	1,084.97	Very high
17.	Mg-available	$mg \cdot kg^{-1}$	40.31	Tall
18.	CEC	$cmol(+) \cdot kg^{-1}$	56.00	Very high

use of fertilizer life. provided in two distinct treatments, one (H0) devoid of biological fertilizer and the other (H1) containing biological fertilizer. Look over One control group that is positive and one that is negative. Control positive use NPK fertilizer while negative control without use NPK fertilizer. The size plot 1×3 m with distance between plot 80 cm with distance plant 15×20 cm. Channel drainage and irrigation with 60 cm wide and deep 30 cm for land Inceptisol. Variety seeds red shallot used was Bima Brebes (*Allium ascalonicum* L. var. *bima brebes*). One application of biofertilizer was made using a leaky use comparison method, dilution of a 10 ml dose with two liters of water yielding a 20 liter dose per hectare. The dose is determined according to the instructions for using biofertilizer. Fertilize with basic fertilizer for one second. Days after planting, or DAP, were 15 for the second fertilization and 25 for the third. Apply 150 kg of NPK, 100 kg of TSP, and 100 kg of KCl to the second fertilizer base. Fertilize the base again at 15 HST with 150 kg of NPK, 100 kg of TSP, and 100 kg of KCl. The second fertilization was done at 15 HST, and the third fertilization was done at 25 DAP with 100 kg of NPK, 100 kg of TSP, and 100 kg of KCl.

Observation parameters

Observed soil parameters are total N, available P, available K, COC, pH and organic C. Network parameters plants taken total N, total P, and total K. Measured agronomic parameters were plants height, quantity offspring, quantity leaf. When harvest, observed parameters is heavy wet tubers, heavy dry tubers, tuber diameter, yield harvest wet, and results harvest dry.

Analysis land and network plant

Three soil samples were taken: one at 0 days after planting (ground incubation), one at 17 DAP (soil after fertilization stage 2), and one at 31 DAP phase vegetative maximum down to 20 cm depth for soil physicochemical analysis.

A soil sample was collected using a bucket at a depth of 0–20 cm from each plot at five different points during the plot test. Every example land is gathered and homogeneously mixed, and one example land composite is made for each plot. Example of a composite land that has been ground, dried, and filtered using a filter that is passable to 2 and 0.5 mm. It is then stored in a container and used for physicochemical characteristics soil analysis.

Soil pH parameters using H_2O (distilled water) with ratio 1:2.5 and measured using a pH meter, soil C organic used Muffel furnace method. Soil N total used Kjeldahl destruction method with H_2SO_4 and H_2O_2 concentrated. P is available land use Olsen method and read use UV-VIS spectrophotometer at ƛ 693 nm. K-available used destruction method with 25% HCl and read use flamephotometer. The CEC uses extract NH_4Oac 1 M pH 7 and KCl. Whereas total N plants used ashing wet method with H_2SO_4, P total used destruction method with a mixture of $HClO_4$ and HNO_3 concentrated (2:1) read by UV-VIS spectrophotometer at ƛ 889 nm. K total used destruction method with HNO_3 and $HClO_4$ and be read with using a flamephotometer.

Measurement plant growth and yield

Plants are measured for height, number of leaves, and number of saplings every week starting at 7 days old and continuing until harvest. Seven plant observations are taken for each treatment (3 fixed observations and 4 destructive observations), for a total of 60×7 = 420 plant units observation. 1×1 m tiles are weighed and made $ton \cdot ha^{-1}$ in order to determine the heavy wet harvest results obtained from sample. Dry weight measured using a heavy, wet red shallot sample that was exposed to the sun for one week before being dried and allowed to air out for two days. The weight was then converted to tons per hour.

Analysis NPK nutrient uptake and efficiency

Determination nutrient uptake using equation, namely:

$$uptake\ NPK = NPK\ of\ shallots\ (\%) \times \times\ dry\ weight\ of\ shallots\ (g)$$

Efficiency nutrient uptake (RE) is comparison between the amount of nutrients absorbed by the plant with the amount of nutrients provided past fertilizer. Efficiency NPK nutrient uptake can be achieved calculated with formula equality as following (Mengel and Kirkby, 1987):

$$Nutrient\ uptake\ efficiency = \\ = \frac{uptake\ NPK - uptake\ control\ \times\ 100\ \%}{G\ fertilizers\ added}$$

Statistics analysis

Data analyzed with fingerprint variance (ANOVA) for know exists Anya treatments that interact and influence different real. Data analysis uses the F test at the α = 5% level for see influence different real in the treatment and continued with Duncan multiple range test (DMRT) at the 5% level of the indicated parameters exists significant influence. For find out the soil parameters that have the most influence (highest r) on yield and uptake of NPK in plants done analysis regression correlation multiple.

RESULTS

Analysis results the content biochar is presented in Table 2. Content biofertilizer used in study presented in Table 3.

Chemical properties of inceptisol

Based on results analysis fingerprint variety Figure 1 at 0 DAP, 17 DAP and 31 DAP, showed that giving biofertilizer, biochar, and interaction both of them influential real against soil C-organic Inceptisol. Soil C-organic content showed increase in a way gradually starting 0, 17, 31 DAP. The soil C-organic content is <5% classified very high.

Based on results statistics analysis the variety of Figure 2 at 0 DAP, 17 DAP and 31 DAP, showed that addition of biofertilizer, biochar, and interaction both of them influential real (-) on soil CEC Inceptisol. The CEC highest was reaching 57.7 $cmol(+) \cdot kg^{-1}$ and the lowest 53 $cmol(+) \cdot kg^{-1}$. From value the Inceptisol have a very high CEC.

The soil N-total content Inceptisol study red shallot 0 DAP revealed that addition treatment had no a real influence on N-Total based on results of statistical analysis variety Figure 3. The total N content of the soil Inceptisol is significantly influenced by the biological and biochar treatments given to red shallot plants

Table 2. Content rice husk biochar (RHB) and coconut shell biochar (CSB)

No.	Parameter	RHB		BBK	
		Rate	Honor	Rate	Honor
1.	pH	7.92	Base	8.61	Base
2.	Moisture content (%)	9.13	Low	6.78	Low
3.	C (%)	34.41	Very high	68.64	Very high
4.	N-Total (%)	4.13	Very high	6.04	Very high
5.	P-Total (%)	5.93	Low	3.64	Low
6.	K-Total (%)	0.90	Very high	0.61	Very high
7	CEC	26.42	Currently	33.37	Currently

* Data analysis laboratory chemistry UGM land.

Table 3. Content biofertiliser

No	Composition	Content
1.	Bacteria N- docking (cfu·ml^{-1})	≥ 1 x 10^7
2.	Bacteria P and K solvents (cfu·ml^{-1})	≥ 1 x 10^7
3.	Bacteria IAA Generator (cfu·ml^{-1})	≥ 1 x 10^7
4.	Auxin (ppm)	≥ 65
5.	Gibberellin (ppm)	≥ 82
6.	Cytokinins (ppm)	≥ 34

* Content data fertilizer life of PPKS Medan.

at ages 17 and 31 during the vegetative period; however, there is no interaction between the second treatment and the first.

Based on statistical analysis of the outcomes Figure 4 at 0 DAP, 17 DAP, and 31 DAP illustrates that applying biochar and biological fertilizer has a significant impact on P-available land Inceptisol; however, no interaction occurs between the second treatment. Olsen's method analysis results

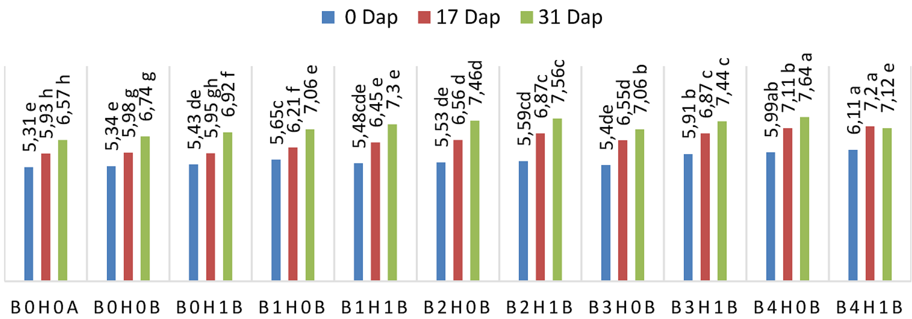

Figure 1. C-organic (%): 0 DAT – incubation period; 17 HST – 3 days after fertilization follow-up 1; 31 HST – 3 days after fertilization follow-up 2/vegetative maximum; without biochar (B0); rice husk biochar 5 tons·ha^{-1} (B1); rice husk biochar 10 tons·ha^{-1} (B2); coconut shell biochar 5 tons·ha^{-1} (B3); coconut shell biochar 10 tons·ha^{-1} (B4); without biofertilizer (H0), and with biofertilizer (H1). Numbers in columns followed by the same letter showing there is no different real between treatment with the DMRT test at the 5% level.

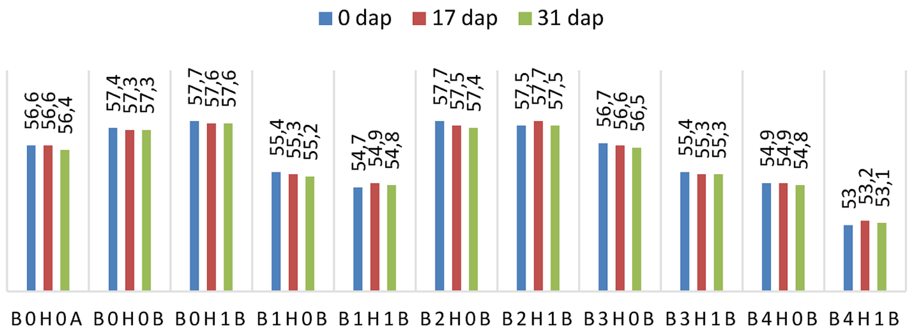

Figure 2. KPK: CEC (cmol(+).kg^{-1}) 0 DAP – incubation period; 17 DAP – 3 days after fertilization follow-up 1; 31 DAP – 3 days after fertilization follow-up 2 vegetative maximum; without biochar (B0); rice husk biochar 5 tons·ha^{-1} (B1); rice husk biochar 10 tons·ha^{-1} (B2); coconut shell biochar 5 tons·ha^{-1} (B3); coconut shell biochar 10 tons·ha^{-1} (B4); without biofertilizer (H0), and with biofertilizer (H1). Numbers in columns followed by the same letter showing there is no different real between treatment with the DMRT test at the 5% level.

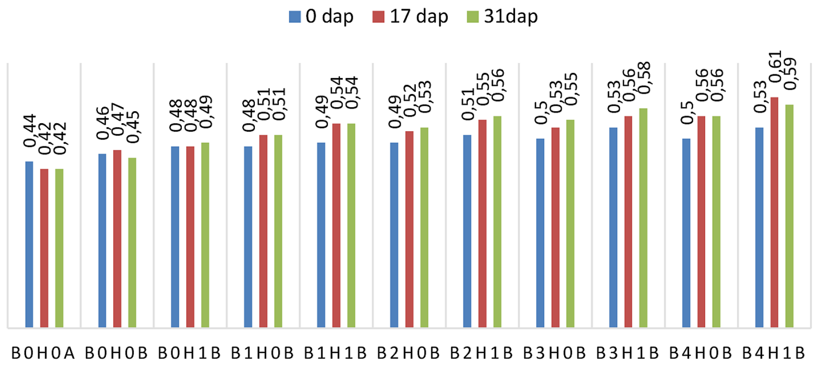

Figure 3. N-total: 0 DAT – incubation period; 17 DAP – 3 days after fertilization follow-up 1; 31 DAP – 3 days after fertilization follow-up 2/vegetative maximum; without biochar (B0); Rice husk biochar 5 tons·ha^{-1} (B1); rice husk biochar 10 tons·ha^{-1} (B2); coconut shell biochar 5 tons·ha^{-1} (B3); coconut shell biochar 10 tons·ha^{-1} (B4); without biofertilizer (H0), and with biofertilizer (H1). Numbers in columns followed by the same letter showing there is no different real between treatment with the DMRT test at the 5% level.

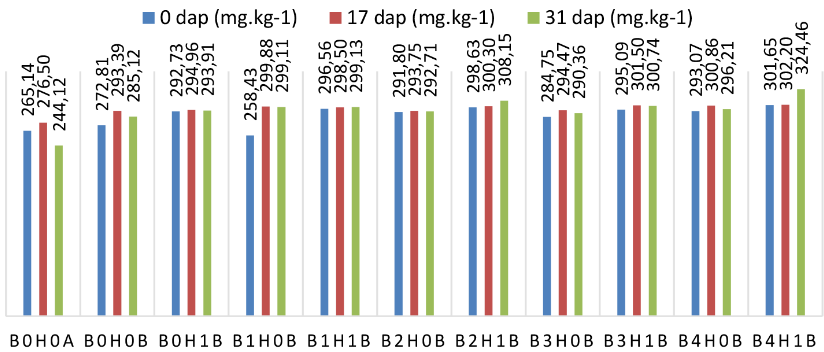

Figure 4. P-available: 0 DAT – incubation period; 17 DAP – 3 days after fertilization follow-up 1; 31 DAP – 3 days after fertilization follow-up 2/vegetative maximum; Without biochar (B0); rice husk biochar 5 tons·ha^{-1} (B1); rice husk biochar 10 tons·ha^{-1} (B2); coconut shell biochar 5 tons·ha^{-1} (B3); coconut shell biochar 10 tons·ha^{-1} (B4); without biofertilizer (H0), and with biofertilizer (H1). Numbers in columns followed by the same letter showing there is no different real between treatment with the DMRT test at the 5% level.

indicate that the land under study, Inceptisol, has a very high available P content. The combination B4H1B treatment exhibits the best treatment results, with 0 DAP = 301.65 mg.kg^{-1}, 17 DAP = 302.20 mg·kg^{-1}, and 31 DAP = 324.46 mg·kg^{-1}. Biofertilizer + coconut shell biochar + NPK400 kg·ha^{-1} is the treatment for B4H1B.

Based on the statistical analysis of the results, the variation in Figure 5 moment red shallot aged 0 DAP and 17 DAP demonstrated the influence of fertilizer biology, biochar, and interactions on real against K-available. In the meantime, treatment with biofertilizer and biochar affects the availability of nutrients for red shallots that are 31 days old (vegetative maximum); there is no interaction with second treatment. The treatment plot (biofertilizer + coconut shell biochar + NPK400 kg·ha^{-1}) has the maximum K-available in B4H1B.

Growth and productivity of red shallot

The tallest plant in the B4H1B treatment is shown in Figure 6. Tall is the shortest plant represented by the B0H0A treatment. Every day, tall plants grow to a height of 0.5 to 1 cm. Red shallot plants reach the maximum vegetative period on the sixth week, at which point they start to clearly resemble flowers. Even after reaching the vegetative maximum phase, the red shallot plant continues to grow tall until the eighth week. Red shallot shrinks on the ninth week of the plant because harvest time has arrived. The shallot plant has entered the phase of cook physiological harvest, as indicated by yellowing leaves, plant fall, and slight withering of the plant.

Application of biofertilizer biochar and interactions (biofertilizer × biochar) showed influence different real in numbers leaf plant red shallot 9

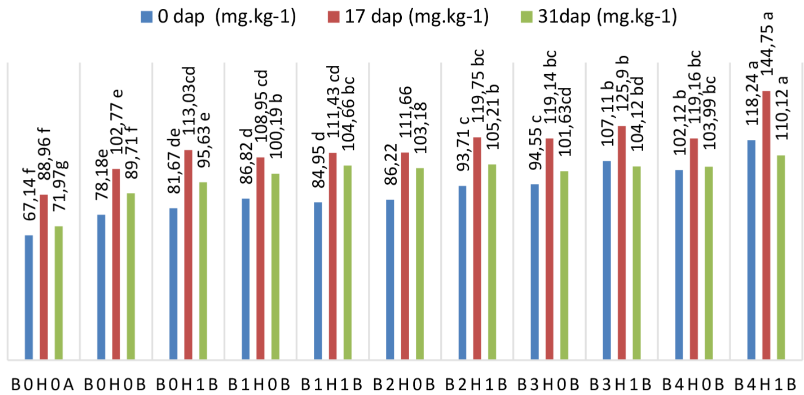

Figure 5. K-avalaible: 0 DAT – incubation period; 17 HST – 3 days after fertilization follow-up 1; 31 HST – 3 days after fertilization follow-up 2/vegetative maximum; without biochar (B0); biochar husk rice 5 tons·ha^{-1} (B1); biochar husk rice 10 tons·ha^{-1} (B2); biochar shell coconut 5 tonsvha^{-1} (B3); biochar batok coconut 10 tons·ha^{-1} (B4); without biological fertilizer (H0), and with biological fertilizer (H1). Numbers in columns followed by the same letter showing no there is different real between treatment with the DMRT test at the 5% level.

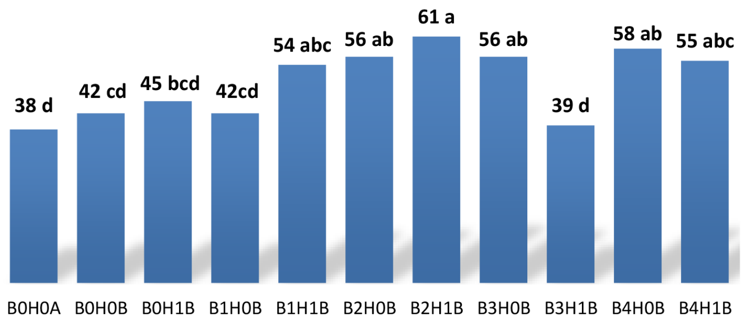

Figure 6. Red shallot plant height: without biochar (B0); rice husk biochar 5 tons·ha^{-1} (B1); rice husk biochar 10 tons·ha^{-1} (B2); coconut shell biochar 5 tons·ha^{-1} (B3); coconut shell biochar 10 tons·ha^{-1} (B4); without biofertilizer (H0A), without biofertilizer + NPK 400 kg·ha^{-1} (H0B), and with biofertilizer + NPK 400 kg·ha^{-1} (H1B). Numbers in columns followed by the same letter showing there is no different real between treatment with the DMRT test at the 5% level.

weeks after plant despite treatment biofertilizer, according to results statistical analysis variety Figure 7 not a real influential one. The B2H1B treatment exhibited the highest response growth amount leaf (61 pieces), whereas the B0H0A treatment displayed the lowest amount leaf (38 pieces).

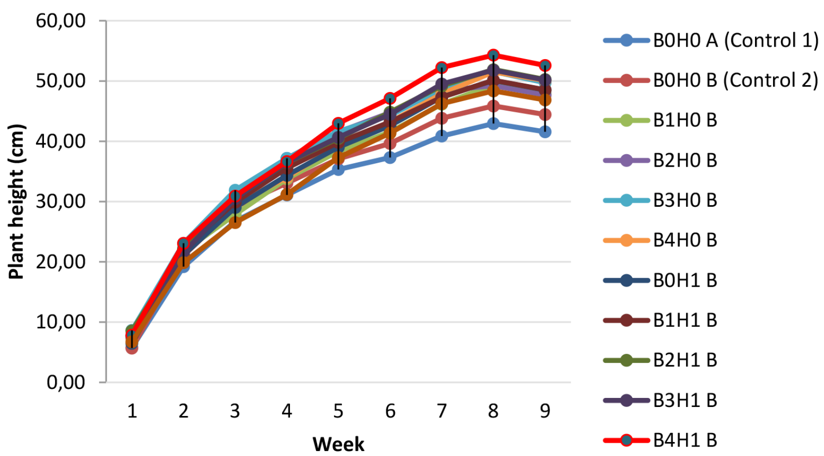

Figure 7. Dynamics growth tall plant red shallot with treatment fertilizer biological and biochar

Shallot harvest results

Calculation data variable tiling results fresh and dry harvest tubers red shallot with treatment biofertilizer and biochar presented in Table 4. Resulting from the statistic analysis Table 4 illustrates how the application of biochar, biofertilizer, and the combination of the two (biochar biofertilizer) have varying real effects on the harvest plant's red shallot. Harvest of red shallot results the wet (14.2 ton·ha^{-1}) and dry (12.9 ton·ha^{-1}) B4H1B treatments exhibited the highest. In the meantime, the lowest harvest red shallot results in the code H0B0 treatment are 7.1 tons·ha^{-1} dry and 8 tons·ha^{-1} fresh red shallots.

NPK nutrient uptake and efficiency NPK fertilization

Based on the statistical analysis results, Table 5 demonstrates that the application of biochar and fertilizer has a distinct real impact on the NPK nutrient uptake by red shallot plants, but that there is also interaction between the two. The B4H1B treatment showed the highest NPK nutrient uptake, with 400 kg·ha^{-1} of NPK fertilizer added along with biochar and coconut shell biochar. The uptake of N, P, and K was 90.75, 92.33, and 370.82 mg·plant^{-1}, respectively.

The treatment without biofertilizer, without biochar, and without NPK fertilizer 400 kg·ha^{-1} with details had the lowest NPK nutrient uptake. The uptake of N, P, and K was 23.44, 35.18, and 201.53 mg·plant^{-1}, respectively. N participation in studies. This is categorized as minor. This issue is said to have contributed to the number of N in the currently classified soil, while the availability of P and K included very high. Lowest NPK nutrient uptake seen in B0H0A is treatment without biofertilizer, without biochar and without NPK fertilizer 400 kg·ha^{-1} with details N uptake was 23.44 mg·plant^{-1}, P uptake was 35.18 mg·plant^{-1}, and K uptake was 201.53 mg·plant^{-1}. N uptake in research this classified small. This matter allegedly caused number of N in land classified currently whereas P and K availability included very tall.

Efficiency NPK fertilization against plant red shallot

The effectiveness of NPK nutrient uptake was calculated by comparing control samples without fertilization as the lower limit of uptake and treatments that used NPK fertilization. Based on the findings of statistical analysis Tables 6 demonstrate how biochar and biological fertilizer treatments interact to maximize the effectiveness of NPK fertilization of red shallot plants. The biological treatment fertilizer and biochar have a real impact on the effectiveness of NPK fertilization of red shallot plants. The B4H1B treatment exhibits the most efficient fertilization when compared to other treatments. Handling this can boost the effectiveness of fertilizers by 7.63% for N, 6.57% for P, and 19.91% for K. Water availability, timing of fertilization, CEC, soil pH, nutrient availability, climate, and type of land all affect fertilization efficiency.

Table 4. Influence application biofertilizer and biochar to results tiling plant red shallot harvest

No.	Treatment code	Weight wet (ton·ha^{-1})	Dry weight (ton·ha^{-1})
1	B0H0A	8.0 h	7.1 h
2	B0H0B	9.9 g	8.8 g
3	B0H1B	11.1 ef	9.8 ef
4	B1H0B	12.1 de	10.7 de
5	B1H1B	12.3 cd	10.9 cd
6	B2H0B	13.0 bcd	11.5 bcd
7	B2H1B	10.8 fg	9.5 fg
8	B3H0B	12.6 bcd	11.2 cd
9	B3H1B	13.5 abc	11.9 bc
10	B4H0B	13.7 ab	12.5 ab
11	B4H1B	14.2 a	12.9 a

Note: without biochar (B0); rice husk biochar 5 tons·ha^{-1} (B1); rice husk biochar 10 tons·ha^{-1} (B2); coconut shell biochar 5 tons·ha^{-1} (B3); coconut shell biochar 10 tons·ha^{-1} (B4); without biofertilizer (H0A), without biofertilizer + NPK 400 kg·ha^{-1} (H0B), and with biofertilizer + NPK 400 kg·ha $^{-1}$ (H1B). Numbers in columns followed by the same letter showing. There is no different real between treatment with the DMRT test at the 5% level.

Table 5. Influence application fertilizer biological and *biochar* to plant NPK uptake red shallot

No.	Treatment code	N uptake (mg·plant^{-1})	P uptake (mg·plant^{-1})	K uptake (mg·plant^{-1})
1	B0H0A	23.44	35.18	201.53
2	B0H0B	38.20	40.97	219.61
3	B0H1B	49.47	45.95	241.17
4	B1H0B	57.26	54.87	256.20
5	B1H1B	68.27	61.71	282.27
6	B2H0B	54.15	56.86	269.44
7	B2H1B	60.09	62.05	299.72
8	B3H0B	53.58	60.78	274.81
9	B3H1B	75.92	82.40	334.58
10	B4H0B	61.97	77.68	329.32
11	B4H1B	90.75	92.33	370.82

Note: Without biochar (B0); rice husk biochar 5 ton·ha $^{-1}$ (B1); rice husk biochar 10 tons·ha^{-1} (B2); coconut shell biochar 5 ton·ha^{-1} (B3); Coconut shell biochar 10 ton·ha^{-1} (B4); without biofertilizer (H0A), without biofertilizer + NPK 400 kg·ha^{-1} (H0B), and with biofertilizer + NPK 400 kg·ha^{-1} (H1B). Numbers in columns followed by the same letter showing there is no different real between treatment with the DMRT test at the 5% level.

Table 6. Influence application fertilizer biological and biochar to efficiency NPK fertilization of plants red shallot

No.	Treatment code	N (%)	P (%)	K (%)
1	B0H0A	0.00 f	0.00 h	0.00 g
2	B0H0B	3.49 e	3.52 g	6.05 f
3	B0H1B	5.43 de	4.77 g	8.68 efg
4	B1H0B	6.50 cde	7.86 f	9.21 efg
5	B1H1B	8.19 bc	9.73 efg	12.44 de
6	B2H0B	6.15 cde	9.46 efg	14.09 de
7	B2H1B	8.44 bc	14.41 d	27.99 c
8	B3H0B	6.34 cde	12.16 de	17.44 d
9	B3H1B	9.99 b	19.96 c	27.40 c
10	B4H0B	9.09 b	23.20 b	37.98 b
11	B4H1B	15.90 a	31.25 a	49.91 a

Note: Without biochar (B0); rice husk biochar 5 ton·ha $^{-1}$ (B1); rice husk biochar 10 tons·ha^{-1} (B2); coconut shell biochar 5 ton·ha^{-1} (B3); coconut shell biochar 10 ton·ha^{-1} (B4); without biofertilizer (H0A), without biofertilizer + npk 400 kg·ha^{-1} (H0B), and with biofertilizer + NPK 400 kg·ha^{-1} (H1B). Numbers in columns followed by the same letter showing there is no different real between treatment with the DMRT test at the 5% level.

DISCUSSION

Biochar is material carbon-rich solid results conversion from waste organic (biomass agriculture) through burning no perfect or supply oxygen limited (pyrolysis) at temperatures of 250–700 °C (Lehmann, 2009; Weber and Quicker, 2018). Characteristics biochar own fraction different carbon and nutrient contents, increasingly high in lignin and compounds polyphenol so the more tall carbon so that causing the decomposition process the more slow (Saidy, 2018). Carbon inside shaped biochar cellulose, hemicellulose, and lignin. Pyrolysis process result cellulose and hemicellulose decompose produce substance volatile so that can form group function carboxyl, oxygen and carbonate on the surface biochar which increases the pH of biochar (Cheng *et al.,* 2006; Yuan *et al.,* 2011). Apart from that, the pyrolysis process can result loss of N and P nutrients in biochar (Edwin et al., 2023). Biochar can also be done binds soil organic C for reduce soil degradation and make availability carbon more stable inside soil (Putri *et al*., 2017). Carbon in biochar nature stable so that slow release because decomposed in a way slow. Besides that N, P, and K contents in biochar are also estimated will nature slow release because its structure each other bonded with carbon. Biochar has many pores and a large surface area so that inorganic nutrient absorption is better and microorganisms have a good place to grow and reproduce, especially bacteria, actinomycetes and arbuscular mycorrhiza fungi (Thies and Rillig, 2009).

Bacteria N-mooring is bacteria that can fixing N of air become ammonium or nitrate, so can absorbed by plants. Bacteria solvents P and K are bacteria that can produce sour organic so that can increase availability of nutrients P and K. Bacteria IAA producers are bacteria that produce hormone growth. Hormones produced will spur growth roots, stems and shoots plant so that performance plant increase in context plant nutrient absorption (Sriwahyuni and Parmila, 2019).

An increase in soil C–O This resulted from the presence of biochar and biological fertilizer. Priambodo *et al*. (2019) state that adding biological fertilizer can raise the C-content of organic land. According to Astuti (2008) and Widayanti (2007), the microbes that cause sour organs are present in fertilizer biological. Acids organic are necessary for the breakdown of organic material. In addition to dissolving the nutrients P and K, the decomposition process releases C from neither organic nor biochar-containing material. Land's C-organic levels rise as a result of the decomposition process's release of carbon. C: Microorganisms need organic matter as a source of energy (Hardjowigeno, 2010). Giving treatment Biofertilizer and biochar is known own ability influencing the CEC (Jaya, *et al.,* 1986). This matter allegedly because biochar have ability in absorb cations (Liang *et al.,* 2006). Decomposition process by activity microbes can let go cations become available. Increasing amount soil cations can increase the soil CEC, CEC very important in physics soil, chemistry soil, fertility soil, deep nutrient retention soil, nutrient uptake by plants, fertilization and liming (Maas, Azwar, 1996).

Application biofertilizer and biochar can increase nutrient availability for plant. Biofertilizer contain microbes IAA producer. Besides that biofertilizer also contains hormone growth, including: auxin, gibberellin and cytokinin. The Hormone can stimulate growth roots, leaves and plants. Application biochar can increase NPK nutrient availability for plants, so nutrient uptake increases. According to research by Sumarni *et al.* (2012), the availability of NPK boosts plants' ability to absorb nutrients, which in turn causes plants' metabolism to increase and yield higher crops. Plant metabolism and photosynthesis are enhanced by adequate nutrient absorption. That factor affects the quantity of leaves, the height of the plants, and the quality of the red shallot harvest. The quantity of leaves that a red shallot plant produces can serve as an indicator of the quantity of tubers that are produced; the more leaves that a red shallot plant produces, the more tubers are produced (Anang and Bhermana, 2019). It can also increase the size of the tubers that a red shallot plant produces (Buda *et al*., 2018). Thus, harvesting shallots also produces more red color because assimilation of the results of photosynthesis builds up as reserve food in the tubers (Superior Giving fertilizer biological besides contains BPN which can fixate Nitrogen free, BPF and BPK can dissolve P and K to form available. Apart from that, fertilizer biologicals also contain growth hormone which can expand range root so that can increase NP and K nutrient uptake (Astuti, 2008). Giving *biochar* to in land can increase ability microbes in dissolves and releases P- available and K- Available so that can absorbed by plants (Zhang *et al*., 2016), can reduce loss of N, P, and K as a result washing and evaporation (Schnug and Haneklaus, 2016), so can increase efficiency fertilization of N, P, and K (Arif et al., 2017). NPK absorption is influenced by dose fertilization, soil pH, soil nutrient availability, COC, and water availability. Nutrient absorption by plants red shallot Keep going happen during plant Still need nutrients for growth and development plants (Dubey *et al*., 2016).

Rice husk biochar treatment with a dose of 10 $tons.ha^{-1}$ and coconut shell biochar 5 $tons.ha^{-1}$ showed almost the same results, while coconut shell biochar treatment with 10 $tons.ha^{-1}$ showed better NPK nutrient uptake effectiveness than the other treatments. The application of biological fertilizer increases the effectiveness of NPK nutrient uptake and shallot yields. The B4H1B treatment demonstrated a lower level of N fertilizer efficiency when compared to P and K fertilizer. This is said to be caused by existing lose N that is not absorbed by plants. Temperature, volatilization, water washing processes, and plant or microorganism absorption are factors that affect lost nitrogen in land. Excessive heat can accelerate the processes of nitrification (NH_4^- to NO_3^-) and denitrification (NO_3^- to N_2O and N_2 in the atmosphere), leading to an increase in N loss. Additionally, NO_3^- in the soil is easily washed by water, and momentarily low temperatures can slow down the rate of nitrification (Hardjowigeno, 2003).

CONCLUSION

The application of biochar and biofertilizer can promote plant height, leaf quantity, and NPK nutrient uptake, increasing harvest red shallot results and improving NPK fertilization efficiency on Inceptisol soil. The a pplication of biofertilizer and coconut shell biochar 10 ton·ha^{-1} and NPK fertilizer 400 kg·kg^{-1} (B4H1B) can increase shallot crop yields and efficiency of NPK fertilization uptake by shallot plants in Inceptisols.

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