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The Effect of Compost and Biochar Fertilizers on The Growth and Yield of Shallots

Robinson Ama Dangu Ngindi, I Gusti Bagus Udayana, Yohanes Parlindungan Situmeang

Agrotechnology Study Program, Faculty of Agriculture, Warmadewa University
*Corresponding author: robyngindi0501@gmail.com

Abstract
This study aims to determine the effect of compost and biochar doses and their interactions on the growth and yield of shallots. This research was conducted at the Local Waste Processing Site (TOSS), Kusamba Village, Dawan District, Klungkung Regency, Bali Province. The design used in this study was a factorial randomized block design (RAK) consisting of 2 factors. The first factor is the treatment of compost dose (K) which consists of 3 levels, namely: K1 = 5 tons ha^{-1}, K2 = 10 tons ha^{-1}, and K3 = 15 tons ha^{-1}. While the second factor is the dose of biochar (B) which consists of 3 levels, namely: B1 = 5 tons ha^{-1}, B2 = 10 tons ha^{-1}, and B3 = 15 tons ha^{-1}. The interaction between compost treatment with biochar had a significant ($P<0.05$) effect on the fresh weight of tubers per clump and fresh weight of rhizomes per clump, and a very significant effect ($P<0.01$) on the number of tubers per clump, but not significant ($P\geq0.05$) to other variables. The compost dose treatment had no significant effect ($P\geq0.05$) on all observed variables except for the maximum number of leaves. Biochar dose treatment had a significant to a very significant effect on the variables of maximum leaf number, fresh weight of tubers per clump, the oven-dry weight of tubers per clump, and oven-dry weight of tubers per clump, and had no significant effect ($P\geq0.05$) on other variables. The interaction between compost 5 tons ha^{-1} and biochar 10 tons ha^{-1} (K1B2) gave the highest fresh weight of tubers per clump of 100.00 g which was significantly different or increased by 38.60% compared to the lowest fresh weight of tubers per clump at the interaction of compost 5 tons ha-1 with biochar 15 tons ha^{-1} (K1B3) is 72.15 g.

Keywords: *Rice husk; household waste; compost; biochar; red onion.*

1. Introduction

Shallots (*Allium ascalonium L.*) are one of the leading commodities in several regions in Indonesia which is used as a cooking spice and contains several substances that are beneficial to health, its properties are as anti-cancer and substitute for antibiotics, lowering blood pressure, cholesterol and lowering blood sugar levels [1]. Shallots are also one of the national priority and superior vegetable commodities that can be developed through increasing planting area, productivity, production stability, and quality. Based on [2] the production of shallots in Indonesia in the last 5 years (2017 - 2021) has seen an increase seen every year since 2017, at which time Indonesia only produced 1.47 million tons. The number continues to increase with an average increase of 8% per year. Indonesia's shallot production will reach 2 million tons in 2021.

The need for shallots in the last 5 years in Bali is very large, reaching 20,336 tons per year. This is in line with the increasing number of people who increase every year, while the production of shallots decreases. Shallot production in Bali in 5 years (2017-2021) has experienced ups and downs every year. Shallot production in 2017 reached 20,306 tons and the following year 2018 increased to 24,267 tons, while in 2019 it decreased by 19,687 tons, while in 2020 it decreased by 14,207 tons. However, in 2021 there will be a drastic increase of 23,215 tons. Onion producers in Bali are located in Songan Village, Kintamani District, Bangli Regency, and there are scattered in several districts such as Karangasem, Buleleng, Klungkung, and a little bit in Jemberana [3].

One of the efforts to get good growth and yield of shallot plants is to fertilize. Fertilization is the act of providing additional nutrients to the soil either directly or indirectly so that it can provide nutrients for plants. Plant growth and development are strongly influenced by the availability of nutrients in the soil. Organic fertilizers come from plants and animals that have undergone a decomposition process and contain nutrients needed by plants. The use of fertilizers is applied to increase the growth and yield of shallots so that there is an improvement in the physical and chemical properties of the soil [4].

Compost is an organic fertilizer resulting from the decomposition of various livestock manure, plant waste, and waste from urban waste [5]. Compost fertilizer brings many benefits because it contains carbon (C) which can help the soil become loose, besides that compost also contains nitrogen (N) which in plants plays a role in stimulating the growth of stems, branches, and roots [6]. Urban waste that can have an impact on public health, can also be used as material for making organic fertilizer or compost. City waste is easy to obtain in large quantities and if it is managed in the compost it can overcome the waste problem in the region [7].

Compost fertilizer can improve nutrient availability, soil fertility, and agricultural crop yields. The results of [8, 9], stated that the best growth response and maize yield were obtained with the application of 20-ton ha^{-1} compost. Furthermore [10] in their research, a compost dose of 7.5-15 tons ha^{-1} can increase plant height, fresh weight of cobs, and fresh weight of corn plants. The use of compost 20 tons ha^{-1} gave the highest yield of fresh weight for pakchoy vegetable plants or an increase of 44% compared to no compost [11]. The application of compost sourced from municipal waste at a dose of 10 tons ha^{-1} can increase the growth and yield of chili plants [12, 13].

Biochar is a solid material formed from the pyrolysis process of ordinary biomass called activated charcoal which is environmentally friendly, economical, and can be used for various purposes, such as soil remediation, waste management, greenhouse gas reduction, and energy production [14]. Biochar functions as a soil enhancer from agricultural, livestock, and forestry wastes such as rice husks, straw, coconut shells, sawn wood, tree branches, wood chips, corn cobs, and various livestock wastes. The use of biochar helps to improve the physical properties of the soil, especially by increasing the porosity of the soil and its ability to absorb nutrients and water. As a soil enhancer, biochar can slow down the decomposition process, and slowly mineralize into carbon dioxide and other nutrients needed by plants [15]. Research comparing treatments of different levels of biochar with varying degrees of fineness on soil pH, CEC, C-organic, and P is available [16]. The results of this study showed that after incubation for 21 days at room temperature, the best interaction was shown by biochar at a rate of 15 tons ha^{-1} lower soil pH, increase soil CEC, increase soil organic C, and increase soil phosphorus availability. The results of [17], giving 5 tons ha^{-1} of biochar is more effective in increasing total pore space, fast drainage pores, and water pores, as well as reducing slow drainage pores compared to other treatments to increase soybean yields. Research on giving biochar and compost from animal manure at a dose of 15 tons ha^{-1} also showed a significant effect on the number of fruits and fruit weight in red chili [18]. The application of compost from municipal waste and chicken biochar from rice husks can improve the growth and yield of shallots. Based on the above, it is necessary to research the utilization of various urban wastes that are processed into compost and biochar from rice husks to increase the yield of shallots.

2. Materials and Methods

This research was conducted at the TOSS (Local Garbage Processing Site) experimental area, Jl. Kusumba, Kusumba Village, Dawan District, Klungkung Regency, Bali Province. The research implementation time starts from August – December 2021. The results of soil analysis at the research site can be seen in Table 1.

The research design used was a factorial randomized block design (RBD) consisting of 2 treatment factors. The first factor is compost (K) which consists of 3 levels, namely: K1= 5 tons ha^{-1}, K2= 10 tons ha^{-1}, and K3= 15 tons ha^{-1}. The second factor is biochar (B) which consists of 3 levels, namely: B1= ton ha^{-1}, B2= ton ha^{-1}, and B3= ton ha^{-1}. Thus, there were 9 treatments repeated 3 times, so 27 experimental plots were obtained.

The materials used in this study were the local variety Bima red onion seeds, TOSS compost organic fertilizer which is a source of Klungkung municipal waste-based waste, biochar from rice husk, NPK basic fertilizer (16-16-16), silver black plastic. mulch, bovine biourin, pesticides, and round-up herbicides.

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Table 1. Soil Analysis Results of Research Site

No	Analysis Type	Unit	Mark	Information
1	Texture			
	Sand	%	41.27	
	Dust	%	38.33	loamy sand
	Clay	%	20.41	
2	Water content			
	Air Dry	%	3.49	
	Dry Field	%	43.86	
3	pH H_2O		7.2	neutral
4	Electrical Conductivity	mmhos/cm	1.89	low
5	N-total	%	2.02	very high
6	C-organic	%	0.1	low
7	P-available	ppm	119.16	very high
8	K-available	ppm	250.34	high

Source = Laboratory of Soil Science, Faculty of Agriculture, Udayana University (2021).

The content of compost derived from the processing of Klungkung urban organic waste is shown in the Table below.

Table 2. Elemental Content in Compost Processed from Klungkung Urban Organic Waste

No	Analysis Type	Mark
1	pH	7.3
2	Electrical Conductivity (mmhos/cm)	1.21
3	C-organic(%)	20.63
4	N-total (%)	0.62
5	P-available (ppm)	350.81
6	K-available (ppm)	426.17
7	C/N Ratio	33.27
8	Air dry content	5.88

Source = Laboratory of Soil Science, Faculty of Agriculture, Udayana University (2021).

Table 3. Elemental content in biochar from rice husk cages mixed with broiler chicken manure

No	Analysis Type	Mark
1	pH	7.0
2	C-organic (%)	39.53
3	N-total (%)	0.8
4	P-available (ppm)	0.18
5	K-available (ppm)	0.56
6	KTK (Cmol/kg)	18.3
7	Ca (%)	0.09
8	Mg (%)	0.09
9	Ratio C/N	58.13
10	Water content (%)	28.2
11	Ash content (%)	36.8
12	Biochar yield (%)	32.3

3. Results and Discussion

3.1. Results

The results of the analysis of variance on the effect of compost and biochar doses and their interactions with the shallot growth and yield variables can be seen in Table 3. Table 3 shows that the interaction between compost treatment and biochar (KB) had a significant effect ($P<0.05$) on the fresh weight of tubers per clump and fresh weight of tubers per clump, and had a very significant effect ($P<0.01$) on the number of tubers. per family, but had no significant effect ($P\geq0.05$) on other variables. The compost dose treatment had no significant effect ($P\geq0.05$) on all observed variables except for the maximum number of leaves. Biochar dose treatment had a significant to a very significant effect on the variables of a maximum number of leaves, fresh weight of tubers per clump,

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oven-dry weight of tubers per clump, and oven-dry weight of tubers per clump, and had no significant effect (P≥0.05) on other variables.

Table 3. Significant effect of dose of compost fertilizer and dose of biochar and their interactions on growth and yield variables of shallots.

No	Variable	Treatment		
		Compost (K)	Biochar (B)	Interaction (KB)
1	Plant height (cm)	ns	ns	ns
2	Number of leaves (strands)	**	*	ns
3	Number of tubers per clump (tubers)	ns	ns	**
4	Fresh weight of tubers per clump (g)	ns	**	*
5	Fresh weight per clump (g)	ns	ns	*
6	Oven dry weight of tubers per clump (g)	ns	*	ns
7	Oven dry weight per clump (g)	ns	*	ns
8	Harvest index (%)	ns	ns	ns

ns : not significant (P≥0.05), ** : Very influential (P<0.01), * : significant effect (P<0.05)

Table 4. Effect of compost and biochar doses and their interactions on all observed variables.

Treatment	Plant height	Number of leaves	Number of tubers per clump	Fresh weight of tubers per clump	Fresh weight per clump	Oven dry weight of tubers per clump	Oven dry weight per clump	Harvest index
Compost	(cm)	(strands_	(tubers)	(g)	(g)	(g)	(g)	(%)
K1	37.63 a	51.17 b	15.96 a	83.26 a	103.33 a	14.20 a	33.36 a	29.79 a
K2	38.14 a	51.35 b	15.82 a	84.68 a	106.73 a	15.03 a	36.31 a	29.39 a
K3	38.51 a	53.57 a	16.39 a	81.57 a	98.94 a	13.07 a	33.27 a	28.36 a
LSD 5%	-	1.60	-	-	-	-	-	-
Biochar								
B1	38.11 a	53.30 a	15.29 b	78.07 b	95.23 a	13.14 b	32.05 b	29.14 a
B2	38.18 a	51.78 a	16.71 a	90.93 a	107.62 a	15.84 a	38.00 a	29.39 a
B3	37.99 a	51.02 b	16.17 a	80.51 b	106.14 a	13.32 b	32.89 b	29.02 a
LSD 5%	-	1.60	1.26	7.25	-	2.08	4.92	-

Numbers followed by the same letter on the same factor are not significantly different in the LSD 5% test.

3.2 Discussion

The results of this study showed that the interaction between compost 5 tons ha^{-1} and biochar 10 tons ha^{-1} (K1B2) gave the highest fresh weight of tubers per clump, namely 100.00 g, which was significantly different or increased by 38.60% compared to fresh weight. The lowest tuber per clump was at the interaction of compost 5 tons ha^{-1} with biochar 15 tons ha^{-1} (K1B3), which was 72.15 g. (Table 4 and Figure 1).

The results of this study showed that the highest fresh weight of tubers per clump was obtained from the interaction between compost 5 tons ha^{-1} and biochar 10 tons ha^{-1} (K1B2) 100.00 g, which was significantly different or increased by 38.60%. Compared with the interaction dose of compost 5 tons ha^{-1} and biochar 15 tons ha^{-1} (KIB3), which is 11.63 g (Table 4 and Figure 1). The high fresh weight of tubers per clump occurred in the treatment of compost with biochar (KxB) supported by a significant and positive correlation between observed variables such as fresh weight per clump (r = 0.84*), and oven-dry weight per clump (r = 0.84*).

The high fresh weight of tubers per clump occurred in the treatment of 5 tons of ha^{-1} compost with 10 tons of ha^{-1} biochar (K1B2). This was due to the ability of compost and biochar to improve soil physical properties such as increasing soil porosity, and the ability to retain water and nutrients in the soil.

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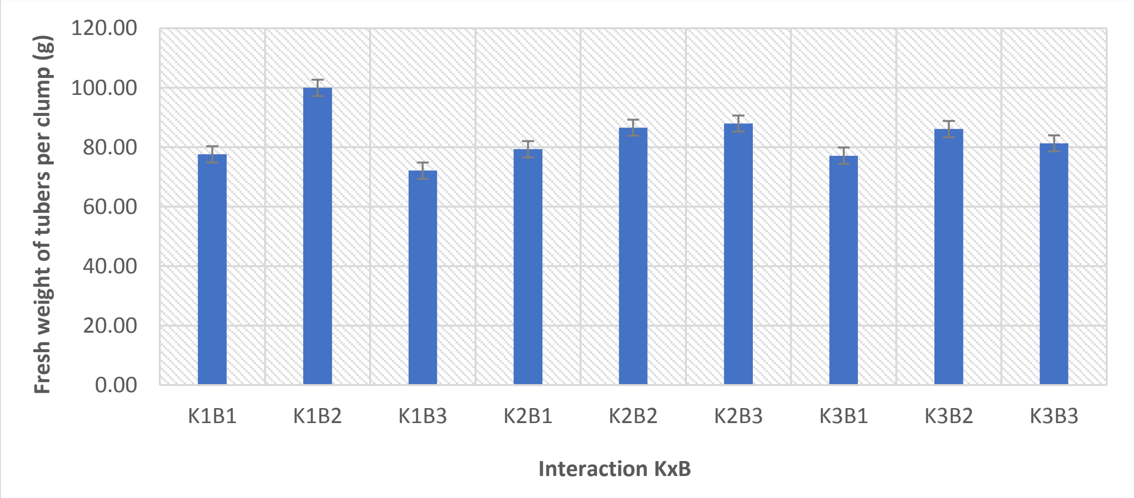

Figure 1. Fresh weight of tubers per clump on the interaction of compost and biochar

Table 5. The correlation coefficient between variables (r) due to the interaction effect of compost and biochar doses

	1	2	3	4	5	6	7	8
1	1							
2	0.69ns	1						
3	0.05ns	-0.40ns	1					
4	0.32ns	-0.23ns	0.68ns	1				
5	0.34ns	-0.29ns	0.55ns	0.84*	1			
6	-0.05ns	-0.45ns	0.47ns	0.84*	0.62ns	1		
7	0.09ns	-0.27ns	0.41ns	0.76ns	0.56ns	0.93**	1	
8	-0.40ns	-0.62ns	0.34ns	0.47ns	0.39ns	0.52ns	0.17ns	1

r (0.05; 6; 1) = 0.811 r (0.01; 6; 1) = 0.917

1. Plant height (cm)
2. Number of leaves (strands)
3. Number of tubers per clump (tubers)
4. Fresh weight of tubers per clump (g)
5. Fresh weight per clump (g)
6. Oven dry weight of tubers per clump (g)
7. Oven dry weight per clump (g)
8. Harvest index (%)

ns: not significant ($P \geq 0.05$)
**: Very significant ($P < 0.01$)
* : Significant ($P < 0.05$)

Judging from the interaction of compost fertilizer on shallot plants, analysis of variance showed that the yield of shallots on the interaction of 5 tons ha^{-1} compost with 10 tons ha^{-1} biochar (K1B2) gave a significant effect (P<0.05) on the weight variable. fresh tuber per clump, and was supported by the variable fresh weight of tuber per clump and oven dry weight of tuber per clump which gave significantly significant results (P<0.05). It is presumed that the compost dose treatment of 5 tons ha^{-1} with biochar 10 tons ha^{-1} (K1B2) contains organic matter as a nutrient that is sufficient to meet the needs of shallot plants. The role of organic matter from the plant aspect from the weathering of organic matter can contain organic acids that can increase the availability of nutrients for plants and can be absorbed by plants immediately [19]. The availability of nutrients (N, P, K) contained in the compost gives a positive response to the growth of tubers, which will be absorbed and carried to the leaves to be assimilated in the process of photosynthesis. One of the products of this photosynthesis is fructans, where fructans are needed for tuber formation [20].

The interaction of the tested compost dose has a very significant effect on the variable number of leaves on shallot plants. This is presumably because the onion plant is a pseudo-trunked plant with very thin stems called discs. In this part of the disc, some buds can become new plants called lateral shoots or tillers, this will form a new disc to form a new tuber [20]. So that the formation of the disc until the formation of tubers needs nutrients, where the nutrients that are needed in the preparation of tissues are phosphorus and potassium which play a role in activating growth enzymes.

Compost is processed organic material residues from plants, animals, and organic waste that has undergone a decomposition or fermentation process, which can be accelerated with human assistance with the addition of microorganisms that can accelerate fermentation [21]. Where is the manufacture of compost in this study with the help of microbes which are used as compost bio activators? So it is suspected that the treatment of compost can provide sufficient nutrients for plants to carry out plant growth. Compost is obtained from the weathering of plant materials or organic waste such as straw, husks, leaves, grasses, organic waste, and organic waste. The composting process can be accelerated through the addition of decomposer microorganisms [22]. The decomposition of organic matter into compost can provide macro and micronutrients, and produce humic acid (humus) which can increase soil cation exchange capacity, and increase soil microorganism activity. In acid soils, the addition of organic matter that has been turned into compost can help increase soil pH, and improve soil fertility and crop yields [23]. The size and type of compost raw materials affect the decomposition process sooner or later. In addition, the combination of organic waste materials is also an important factor in the decomposition process. The more variations of the organic waste mixture, the better the quality of the compost that will be produced [24].

Biochar is a soil enhancer that can retain nutrients and water in the soil to support the provision of nutrients and water for each plant. This ability is caused by improved aeration and soil drainage due to increasing soil porosity so that soil compaction decreases. Research [25], reported that the application of biochar can increase soil pH, increase soil aggregate to increase soil water content, increase the ability of the soil to provide Ca, Mg, P, and K, increase soil microbial respiration, increase soil microbial biomass, increase cation exchange capacity and increase crop yields.

In this study, the interaction of biochar doses tested gave significantly to very significant results on the number of leaves, tuber fresh per clump, oven-dry weight per clump, and oven-dry weight per clump. This is because the increase in biochar derived from rice husks is known to contain nutrients that plants can need, has a high surface area, high porosity, and ash content in biochar which can indirectly dissolve adsorbed compounds such as Ca, K, and N needed by plants. The use of rice husk biochar and rice straw compost can provide nutrients to the soil as indicated by the increase in pH, N, P, K Ca, Mg, and S [26]. The benefits of biochar can last in the soil for a relatively long time, the application of biochar to agricultural land (dry and wetland) can increase the ability of the soil to store water and nutrients, improve soil friability, reduce evaporation of water from the soil and suppress the development of certain plant diseases and create habitats. good for symbiotic microorganisms [27].

4. Conclusion

Compost dose treatment had no significant effect on all observed variables except for the maximum number of leaves. Biochar dose treatment had a significant to a very significant effect on the variables of maximum leaf number, fresh weight of tubers per clump, the oven-dry weight of tubers per clump, and oven-dry weight of tubers per clump, and had no significant effect on other variables. The interaction between compost and biochar treatment had a significant effect on the fresh weight of tubers per clump and fresh weight of tubers per clump, and had a very significant effect on the number of tubers per clump, but had no significant effect on other variables. The interaction between compost 5 tons ha^{-1} with biochar 10 tons ha^{-1} gave the highest fresh weight of tubers per clump of 100.00 g which was significantly different or increased by 38.60% compared to the lowest fresh weight of tubers per clump in the interaction of compost 5-ton ha^{-1} with biochar 15 tons ha^{-1} which is 72.15 g.

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