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THE APPLICATION OF ENRICHED SOIL AMELIORANT FORMULATIONS ON FORMER SAND MINING SOIL ON THE GROWTH AND YIELD OF SHALLOT

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ABSTRACT

Soil degrading due to mining activities often requires improvement to support optimal plant growth. In this study, a soil ameliorant formulation enriched was applied to former sand mining areas. The soil ameliorant comprised a combination of water hyacinth compost, humic acid, and straw biochar. The research consisted of 7 treatments, including 1 control treatment, 1 treatment using N, P, K, and S fertilizers recommendation, 1 treatment using only the soil ameliorant, and 4 treatments combining the soil ameliorant with N, P, K, and S fertilizers. The results indicated that the combination of soil ameliorant significantly influenced the growth of shallot plants and the fresh bulb weight per plant. Overall, the combination of 1 dose of soil ameliorant (water hyacinth compost 25 tons/ha, humic acid 40 kg/ha, straw biochar 20 tons/ha) combined with ¾ dose of N, P, K, and S fertilizers showed the best results in terms of shallot fresh bulb weight per plant. This proves that adding organic soil ameliorant can enhance nutrient availability in former sand mining soil.

Keywords: Former Sand Mining Soil; Shallot; Water Hyacinth Compost; Humic Acid; Straw Biochar.

1. INTRODUCTION

Indonesia is endowed with abundant natural resources, particularly mineral resources, making the country possess vast mining areas [1]. The potential of Class C mining materials, such as sand mining, plays a strategic role in regional economic development, the industrial sector, and can serve as a source of livelihood for the community [2]. Class C mines like sand and gravel often leave behind degraded land with low water absorption, lack of nutrients, and susceptibility to erosion, making it challenging to use for agriculture [3]. Therefore, soil ameliorants are needed to enhance its quality, such as water hyacinth, biochar, and humic acid.

Water hyacinth can improve the soil by adding nutrients like nitrogen, phosphorus, and potassium, as well as increasing humus content, porosity, and soil water retention [4]. Humic acid, a derivative of organic matter, provides physical, chemical, and biological benefits to the soil, such as improving soil structure, increasing nutrient availability, and stimulating plant growth [5]. Biochar, a soil ameliorant made from rice straw, can also enhance soil quality by improving water and nutrient storage capacity, as well as reducing erosion and soil damage [6]. Former Class C mining areas can be utilized for cultivation, such as red onion (Allium cepa L.), with the addition of organic matter and other nutrients [7].

The combination of soil ameliorants, such as water hyacinth compost, biochar, and humic acid, is expected to meet the minimum technical requirements for organic fertilizers and soil ameliorants (Minister of Agriculture Decision Number 261/KPTS/SR.310/M/4/2-19). Based on the previous exposition, further research is needed regarding the combination of water hyacinth compost, rice straw biochar, and humic acid in their utility to enhance the quality of Class C mining areas.

2. MATERIALS AND METHODS

2.1 Materials

The materials used in the research consisted of soil from a former sand mining area in Citimun Village, Cimalaka District, Sumedang Regency, West Java, Indonesia; red onion seedlings of Batu Ijo variety; soil ameliorants derived from water hyacinth compost, humic acid, rice straw biochar, Orgadec decomposer, Urea fertilizer, SP-36, KCl, ZA with various doses according to treatments, as well as pesticides for pest and disease control using furadan with the active ingredient carbofuran.

2.2 Methodology

This study will apply a combination of several types of soil ameliorants, namely water hyacinth compost, rice straw biochar, and humic acid, to the soil in former Class C mining areas planted with shallot crops. The doses used for this combination of soil ameliorant are 25 tons/ha of water hyacinth compost [4], 40 kg/ha of humic acid [8], and 20 tons/ha of rice straw biochar [9]. The research will be conducted using a Randomized Block Design (RBD), consisting of one control treatment, one treatment with Urea and SP-36 fertilizers at recommended doses, one treatment with only soil ameliorant, and four treatments combining soil ameliorant with N, P, K, S fertilizers. Each treatment will be repeated four times with two experimental units, resulting in a total of 56 polybags (Table 1). The treatments provided are as follows:

Table 1 : Arrangement of Soil Ameliorant and N, P, K, S Fertilizer Treatments on Shallot

Code	Treatments	Fertilizer Dosage (kg/ha)			
		Urea	SP-36	KCl	ZA
A	Control	0	0	0	0
B	N, P, K, S recommendation	150	185	100	150
C	Soil Ameliorant	0	0	0	0
D	Soil Ameliorant + ¼ dose N, P, K, S	37,5	46,25	25	37,5
E	Soil Ameliorant + ½ dose N, P, K, S	75	92,5	50	75
F	Soil Ameliorant + ¾ dose N, P, K, S	112,5	138,75	75	112,5
G	Soil Ameliorant + 1 dose N, P, K, S	150	150	100	150

3. RESULT AND DISCUSSION

3.1 Initial Soil Characteristics

The soil in the research location has a neutral pH, low C-organic content, low total N, medium C/N, very high P_2O_5 content both potential and available P, and medium K_2O potential. In addition, low extractable cation content (K, Na, Ca. Mg), low CEC with low base saturation, and sandy loam texture (table 2).

Table 2 : Results of Analysis of Former Sand Mining Soil In Citimun Village, Sumedang Regency, 2023

No	Parameter	Unit	Value	Criteria
1	pH : H_2O	-	7,32	Neutral
2	pH : KCl 1 N	-	5,42	-
3	C-Organic	%	0,90	Low
4	N-Total	%	0,15	Low
5	C/N	-	12	Medium
6	P_2O_5 (Bray I)	ppm P	19,37	Very High
7	P_2O_5 HCl 25%	mg/100 g	59,23	Very High
8	K_2O HCl 25 %	mg/100 g	37,60	Medium
9	CEC	$cmol.kg^{-1}$	12,59	Low
10	Extractable Cation :			
	K-dd	$cmol.kg^{-1}$	0,26	Low
	Na-dd	$cmol.kg^{-1}$	0,28	Low
	Ca-dd	$cmol.kg^{-1}$	4,12	Low
	Mg-dd	$cmol.kg^{-1}$	1,85	Low
11	Base Saturation	%	26,93	Low
12	Texture:			
	Sand	%	70	
	Loam	%	22	Sandy Loam
	Clay	%	8	

3.2 Plant Height of Shallot

Plant height is indicative of a growth characteristic related to other factors and components of plant development. The height growth, following its genetic traits, is highly relevant to the productivity of the crop. The growth of plant height, based on observational data, can be seen in Table 3. The application of organic soil ameliorant combined with ¾ dose of N, P, K, S fertilizer (F) shows the tallest plant height compared to other treatments (Fig. 1). From day 7 to day 35 after planting (Fig. 2), it can be observed that the application of organic soil ameliorant enhances plant height as it positively influences the physical, chemical, and biological conditions of the soil. Organic soil ameliorant, such as water hyacinth compost or biochar, improve the availability of nutrients required by plants. Additionally, they also enhance soil structure, water absorption capacity, and nutrient retention, ultimately supporting root growth and overall plant development. With improved soil conditions, plants can efficiently absorb nutrients, stimulate vegetative growth, and consequently, significantly increase plant height.

Table 3 : Plant Height (cm) of Shallot

Code	Treatments	Days After Planting				
		7	14	21	28	35
A	Control	3,24 a	10,60 a	27,95 a	31,91 a	32,36 a
B	N, P, K, S recommendation	7,33 cd	15,05 bc	33,29 ab	41,41 cd	43,90 bc
C	Soil Ameliorant	6,53 b	14,24 ab	27,78 a	31,04 a	31,75 a
D	Soil Ameliorant + ¼ dose N, P, K, S	7,21 c	14,25 ab	28,71 a	35,54 ab	39,86 b
E	Soil Ameliorant + ½ dose N, P, K, S	7,75 cd	17,05 bc	32,95 ab	38,15 bc	41,91 bc
F	Soil Ameliorant + ¾ dose N, P, K, S	7,98 d	19,11 c	36,20 b	43,50 d	45,70 c
G	Soil Ameliorant + 1 dose N, P, K, S	7,83 cd	15,39 ab	31,84 ab	41,88 cd	45,78 c

Explanation: Mean values followed by the same letter are not significantly different based on the Duncan's Multiple Range Test at the 5% significance level.

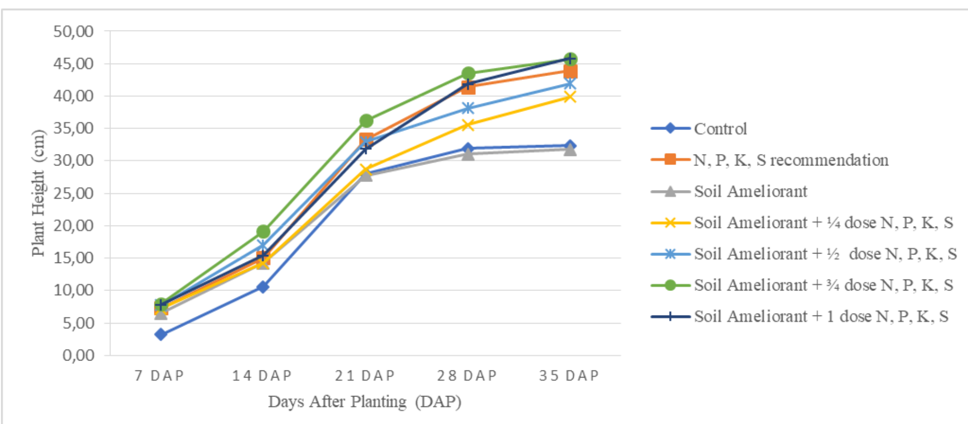

Figure 1: Graph of plant height of shallot

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7 Days After Planting

14 Days After Planting

21 Days After Planting

28 Days After Planting

35 Days After Planting

Figure 2: The growth of shallot from 7 days after planting until 35 days after planting

3.3 Number of Leaves of Shallots

The number of leaves on a plant is closely related to the overall growth of the plant. The quantity of leaves is a crucial indicator of the health and productivity of the plant. Leaves play a vital role in producing the energy and nutrients necessary for the plant. Through photosynthesis, the plant generates glucose, used as a source of energy and building material for cell and tissue growth. Sufficient leaf count supports optimal production [10]. The developmental height of the plant based on observational data can be seen in Table 4.

Table 4 : Number of Leaves of Shallots

Code	Treatments	Days After Planting				
		7	14	21	28	35
A	Control	2,88 a	9,13 a	12,63 a	15,75 a	18,88 a
B	N, P, K, S recommendation	3,00 a	10,25 a	16,25 c	21,63 b	25,38 b
C	Soil Ameliorant	3,25 ab	10,00 a	14,00 b	15,88 a	21,25 ab
D	Soil Ameliorant + ¼ dose N, P, K, S	3,63 b	10,00 a	13,38 ab	19,00 ab	23,63 ab
E	Soil Ameliorant + ½ dose N, P, K, S	4,25 bc	10,13 a	15,63 bc	19,63 ab	25,25 b
F	Soil Ameliorant + ¾ dose N, P, K, S	4,38 c	10,00 a	13,63 ab	19,13 ab	22,63 ab
G	Soil Ameliorant + 1 dose N, P, K, S	4,13 bc	10,00 a	13,75 ab	19,50 ab	23,13 ab

Explanation: Mean values followed by the same letter are not significantly different based on the Duncan's Multiple Range Test at the 5% significance level.

In general, the number of leaves on shallot plants from 7 days after planting (DAP) to 35 DAP shows different values (Fig. 3). The control treatment has the lowest leaf count among the treatments. Meanwhile, the treatment with only soil ameliorant has a leaf count that is not significantly different from the control. This is because the added soil ameliorant lacks sufficient nutrient content to supply the required nutrients for shallot plants. In the treatment combining N, P, K, and S fertilizers with the soil ameliorant, the leaf count has values almost the same or even higher than the treatment with N, P, K, and S fertilizers.

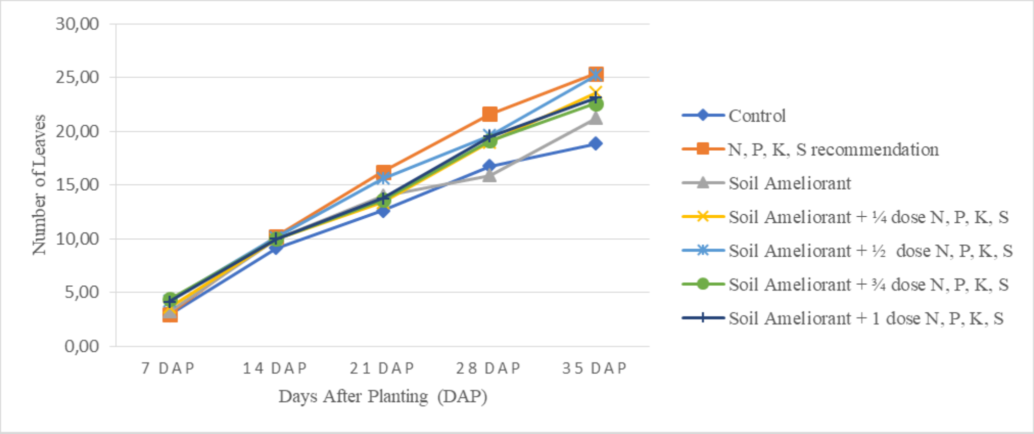

Figure 3: Graph of the number of leaves of shallot

3.4 Number of Bulbs and Bulb Weight per Shallot Plant

The application of soil ameliorant to former sand mining areas has a significant effect on the number and weight of shallot bulbs. In Table 5, it can be observed that the use of organic soil ameliorant enhances the productivity of shallot plants.

Table 5 : Number of Bulbs and Bulb Weight per Shallot Plant

Code	Treatments	Number of Bulbs	Bulb Weight (g)
A	Control	5 a	14,00 a
B	N, P, K, S recommendation	5 a	58,75 bc
C	Soil Ameliorant	5 a	27,00 a
D	Soil Ameliorant + ¼ dose N, P, K, S	4 a	48,00 b
E	Soil Ameliorant + ½ dose N, P, K, S	5 a	65,00 cd
F	Soil Ameliorant + ¾ dose N, P, K, S	4 a	93,25 e
G	Soil Ameliorant + 1 dose N, P, K, S	5 a	78,50 d

Explanation: Mean values followed by the same letter are not significantly different based on the Duncan's Multiple Range Test at the 5% significance level.

The number of shallot bulbs in each treatment did not show a significant difference. This is because the shallot bulb seedlings planted originated from the same variety. According to the description of the Batu Ijo shallot variety, the number of bulbs per clump ranges from 2 to 5 bulbs. Even though they were planted in former sand mining soil with low nutrient content, the number of bulbs per plant clump was not influenced by the type of planting medium. This indicates that the characteristic of the number of shallot bulbs is influenced by genetic factors and is only slightly affected by the growing environment.

The weight of shallot bulbs is influenced by nutrient availability and the conditions of the growing medium. Former sand mining soil with a dominant sandy texture facilitates the penetration of shallot bulbs. The treatment with 1 dose of soil ameliorant combined with ¾ dose of N, P, K, and S fertilizer (F) showed the highest results compared to the treatment using only 1 dose of N, P, K, and S recommended fertilizers. This occurred because the combination of water hyacinth compost, rice straw biochar, and humic acid functions as an organic soil ameliorant. Water hyacinth compost converted into compost plays a crucial role in improving soil quality. Compost contains humus, essential for increasing the content of macro and micro-nutrients, which are crucial for plant growth. For example, humus has a greater cation exchange capacity (CEC) than clay micelles (3-10 times), providing macro and micro-mineral nutrients for a longer period [11]. The addition of organic matter in the form of compost will also increase the number of micro-pores, which are pores used by the soil to retain water [12]. Indirectly, adding organic matter to the soil will affect soil aggregation and pore distribution, causing changes in the soil's ability to retain water [13].

Humic acid also contributes to providing nutrients by forming chelates with metal compounds, making nutrients more available to plants. Humic acid can form stable organometallic complex compounds with metals, releasing nutrients that are easily absorbed by plants. Additionally, humic acid acts as a root growth stimulant, enhancing plant growth by accelerating cell division and increasing plant dry weight [14].

The use of biochar also plays a role in increasing the soil's capacity to retain water, which is very useful for improving water availability in sandy textured soils and dry lands in regions with dry climates [15]

4. CONCLUSION

The application of soil ameliorant consisting of a combination of water hyacinth compost, rice straw biochar, and humic acid can enhance the growth of shallots as well as the wet bulb weight of shallots per plant. The combination of 25 tons/ha of water hyacinth compost, 20 tons/ha of rice straw biochar, and 40 kg/ha of humic acid is capable of reducing ¼ of the recommended dose of N, P, K, and S fertilizers by the Ministry of Agriculture's soil research institute. Therefore, the application of this soil ameliorant is expected to optimize the utilization of natural resources to improve and enhance the quality of former sand mining soils.

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