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Utilization of Soil Amandment to Optimize Growth and Yield of Pakcoy (Brassica rapa l.) on Degraded Soil

Ayu Nurfadilah[1], Dila Handayani[1], R. Eviyati[1], Ida Setya Wahyu Atmaja[1]*

[1]Faculty of Agriculture, Universitas Swadaya Gunung Jati, Cirebon,Indonesia

*Correspondence E-mail: idasetya@ugj.ac.id

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ABSTRACT

Slurry is by product of stone process, as cutting and polishing of natural stone. The consequence of the exixtence of slurry can be seen on irrigation water quality and degraded soil such sufficient nutrient and soil physics properties. The aims of this research was to analyse the effect of soil amandment on degraded soil to improve growth of Pakcoy (Brassica rapa L.). This research was conducted in June to August 2024 in Dukuhpuntang Cirebon using the Completely Randomized Design (CRD). The treatments are combination of the rice straw compost and soil affected by natural stone waste as planting media, including: A0 (control 100% soil affected by natural stone waste), A1 (25% soil affected by natural stone waste: 75% rice straw compost), A2 (50% soil affected by natural stone waste: 50% rice straw compost), A3 (75% soil affected by natural stone waste: 25% rice straw compost). Each combination treatment repeated 6 times. The research show that the utilization of rice straw compost in soil affected by natural stone waste as planting media increasing number of plant height, number of leaves, and fresh weight consumption by 41%, 39%, and 83%. Soil amendment improving the soil properties through ideal condition for plant growth, including reducing the soil compaction.

Keywords: Degraded soil, Dukuhpuntang, Natural Stone**,** Slurry**,** Waste

1. INTRODUCTION

Natural stone, one of the natural resources was found in Indonesia, including Cirebon regency. Natural stone utilized by industries such as construction, mining, and manufacture. Especially in Cirebon, natural stone was mined and used as decorative stone (floor and wall) and also cement industry. During the process, natural stone cut and polish uses large quantities water. In this process produce the waste, both solid and liquid waste, such as tailing, crushed stone, dust, and also chemical waste from stone extraction (Wahyuningsih et al., 2022) . Solid waste consists of crushed stone in irregular size, while liquid waste as a slurry is a mixture of water and dust.

Slurry is semi liquid waste, by product of stone process and contain some water. Slurry flows with irrigation, affect to water irrigation and water quality(Ozcelik, 2016), (Susanto et al., 2021). Slurry made an environmental problems, such air pollution, covering the soil pores and causing the crush on the soil surface. It makes the surface of soil hard and compact like a crush, and inhibits the growth of plant roots, root penetration, and also air flow in the soil. This condition accelerate the soil degradation. In line with Danish et al., (2021) that marble slurry contain dust

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that cover agriculture land and made infertile land. The major factor of soil degradation are land use change, deforestation, disposal waste and uncontrolled land management (

Amendments is natural sources or organic matter, have function to repair the soil properties (physic, chemical, and biological), contain some minerals to improve soil structure and inhibit soil degradation (Rembah & Novianti, 2021),(Surjaningsih, et al., 2023).Some organic matter as soil amendments such compost, manure, agriculture waste (rice straw, palm oil bare ash, biochar, etc). Compost is a kind of organic matter. It have direct and indirect function to soil. Increase nutrient availability is direct function, while improve soil structure, and increase microbial activity are indirect function of compost (Cahyono et al., 2020). Use of compost as soil amendment is an alternative to repair soil degradation, especially in soil with sufficient nutrient, compact soil or high bulk density. The aim of this research was to analyze how the effect of soil amendments on degraded soil to optimize the growth and yield of pakcoy (Brassica rapa L.).

2. RESEARCH METHOD

This research was conducted in Semplo Village, Cirebon Regency, Indonesia, with geographical at 6°43′13″,108°25′58″ in June to August 2024. The materials used in this research are Pakcoy (Brassica rapa L.) Nauli F1 varieties, soil affected by natural stone waste, EM4 (Effective Microorganisms-4), goat manure and rice straw. The tools used in this research are polybags, seed trays, shovels, plastic buckets, rulers/tape measures, handsprayers, stationery, cameras.

The soil amendments used is rice straw compost. Compost is mixture of rice straw, goat manure, EM-4 then incubation for 30 days. Soil affected by natural stone waste as degraded soil taken from rice field in 0-20 cm depth. This research method was use Completely Randomized Design (CRD). This research comparise the composition of rice straw compost and soil affected by natural stone waste as planting media. The treathment including A0 (100% soil affected by waste), A1 (25% soil affected by waste : 75% compost), A2 (50% soil affected by waste : 50% compost), A3 (75% soil affected by waste : 25% compost) and each treathment repeated six times. Then planting media was incubated for one week.

Pakcoy was planted at 14 Days After Sowing (DAS) and harvest at 30 Days After Planting (DAP). None of inorganic fertilizers were added in plant media. The variables observed include initial soil analysis, plant height, number of leaves, root length, root volume, and fresh consumption weight. Plant height and number of leaves were measured at 7 DAP, 14 DAP, and

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21 DAP. Root length, root volume, root morphology, and fresh consumption at 30 DAP. Fresh consumption weight measured by weighing the weight of biomass without root.

3. RESULTS AND DISCUSSION

Soil Analysis

The laboratory analyse show that the soil affected by natural stone waste have silt loam texture with proportion of sand 6%, silt 69%, clay 25%. The content of N is 0.10% (very low), P_2O_5 14.8 ppm (medium), K_2O 20.72 mg/100g (medium), pH 7.4 (high), and CEC 13.99 (low). The criteria for the soil properties refer to (Widiatmaka,Suryono, 2001).

Plant Height

The application of rice straw compost as soil amandment on soil affected by natural stone waste has a significant impact on plant height at all observation stages. The average plant height for each treatment presented in Table 1.

Tabel 1. Average Plant Height

Treatment	Plant Height (cm)					
	7 DAP		14 DAP		21 DAP	
A0 (100%)	9,41	a	9,70	a	9,41	a
A1 (25%:75%)	16,36	b	10,71	ab	16,36	b
A2 (50%:50%)	15,68	b	12,95	b	15,68	b
A3 (75%:25%)	15,98	b	11,86	ab	15,98	b

Note: Numbers followed by the similar letter not significantly different at 5% Duncan test level

Table 1 shows that all treatments which have rice straw compost in planting media had different significantly than A0 treatment. Although at 21 DAP the application of rice straw compost had same effect on A1, A2 and A3 treatments, with an average plant height of 16.01 cm. This number increase 41% than control (9.41 cm).

The increasing of soil productivity can be done by adding organic matter to the soil (Triadiawarman, et al., 2022). Rice straw compost as soil amandment repair the soil properties including physical, chemical and biology properties. The increasing of plant height, stem diameter, and fresh weight is due to the stability of soil properties, then plants can absorp the nutrient in the soil (Sukasih, 2016). Rice straw compost contains macro nutrients such N-total (N) 0.97%, Phosphorus 1.54%, Potasium (K) 1.42%, carbon organic 16.55%, and C/N ratio 17.06 (Harahap et al., 2020).

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Number of Leaves

Leaves, have an important role in plant metabolism. Leaves, as a potential source, responsible to the photosyntetic process that produces assimilates and can be utilized by other plant organs. The average number of leaves for all treatments was presented in Table 2.

At the early growth, the application of rice straw compost did not have a significant effect on the number of leaves for all treatments. However, at 21 DAP all treatments with rice straw compost added had a significantly effect on the number of leaves than control

Tabel 2. Average Number of Leaves

Treatment	Number of Leaves (leaves)					
	7 DAP		14 DAP		21 DAP	
A0 (100%)	5,00	a	5,66	a	6,83	a
A1 (25%:75%)	5,00	a	6,16	a	11,16	b
A2 (50%:50%)	5,00	a	7,00	b	12,00	b
A3 (75%:25%)	5,00	a	6,33	ab	10,67	b

Note: Numbers followed by the similar letter not significantly different at 5% Duncan test level

The increasing number of leaves in A1, A2, and A3 treatments compared to the control said that rice straw compost can effectively minimize the negative impact of natural stone waste to the soil. The initial soil analysis shows that the soil affected by natural stone waste contains a lack of nitrogen. While nitrogen is one of the essential nutrients to form chlorophyll that needed for photosynthetic. Rice straw compost release a number of nutrients, including nitrogen, phosphorus, and potassium, so it increases the nutrient availability in the soil affected by the natural stone waste. Nitrogen and phosporus play an important role in the formation of new cells and are also main organic compounds in plants, such as amino acids, nucleic acids, ADP, and ATP (Mayani et al., 2015).

A higher number of leaves promote the photosynthetic process. Total soil nitrogen affects the fresh weight of pakcoy, stimulating the growth of stems, branches, and leaves of the plant, and is important for the formation of chlorophyll (Prayoga, et al., 2018).

Root Length, Root Volume, and Fresh Weight Consumption

Roots are plant organs that play an important role to absorp the nutrients and water from the soil. The growth and development of roots are influenced by the soil properties in the plant media. Laboratory analysis results show that the soil affected by natural stone waste have

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texture that dominate by silt. The liquid waste of natural stone as a mixture of water and fine size of stone. The existence of silt on the soil surface made the crusting and soil compaction. This condition inhibit the growth of root and root penetration. The average of root length, root volume, and fresh weight consumption are presented in Table 3.

Table 3 shows that the application of soil amandment has a significant effect on root length. A2 treatment has the longest root length than other treatments. In line with root length, root volume is also influenced by the application of rice straw compost as a soil amandment. All treatments with soil amandment added had more root volumes and significantly different than control. An average root volume was 3.59 cm^3, which is three times higher than control (1,67 cm^3).

Table 3. Average Root Length, Root Volume, and Fresh Weight Consumption

Treatment	Parameter					
	Root Length (cm)		Root Volume (cm^3)		Fresh Weight Consumption (g)	
A0 (100%)	27,88	a	1,67	a	197,74	a
A1 (25%:75%)	35,13	ab	3,67	b	1.325,32	b
A2 (50%:50%)	43,53	b	3,67	b	1.226,41	b
A3 (75%:25%)	35,33	ab	3,43	b	904,02	b

Note: Numbers followed by the similar letter not significantly different at 5% Duncan test level

Rice straw compost is one of the sources of organic matter to improving soil properties. Organic matter contains slow release nutrient minerals, improve soil aggregation, soil moisture, reduce the soil crusting and bulk density (Gurmu, 2019.). The ideal conditions in the planting media provide an optimal balance between water, air, and soil solids, then roots can be reach the deeper soil layers to found water and nutrients. the Comparison of root morphology under A0 and A2 treatments presented in Figure 1

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(a) (b)

Figure 1. Morphology of Pakcoy Plant Roots in (a) A0 Treatment and (b) A2 Treatment.

Based on Figure 1, A0 have fewer and shorter of roots than A2. This condition caused by physical properties of A0 that it more compact plant media, so it inhibit the growt of root. A0 also lack of nutrient in plant media. Suboptimal planting media inhibit the air and nutrient absorption (Pranata et al., 2019) and also root growth. The utilization of compost reduce the soil compaction, increasing the soil pores, and promote the nutrient absorption (Sukasih, 2016). The growth of root depend on soil structure and also proportion of air and water in soil solum. Bio-physical proceses refers to soil structure influence to mineral dissolution (Dejong et al., 2013), root access to water and nutrient in soil (Djajadi et al., 2012)

Compost as soil amandment improving the soil degraded properties, especially in soil affected by natural stone waste. Compost reduces the soil compaction, improving the balance of soil agregat, and contributes some nutrient to the soil. The increasing of plant height, number of leaves and also the growth of root result the higher of plant weight. The addition of rice straw compost increase the fresh consumption weight approximately 83% than control. As a source, the increasing number of leaves enhance the plants fresh weight.

4. CONCLUSION

The application of soil amendments in degraded soil influences the growth and yield of Pakcoy (Brassica rapa L.). The utilization of rice straw compost in soil affected by natural stone waste as planting media increase plant height, number of leaves, and fresh weight consumption by

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41%, 39%, and 83%, respectively than control. Rice straw compost improves soil properties through ideal conditions for plant growth

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