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The production of pak choy (*Brassica rapa* L) based on cleaner coffee production

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Abstract: The environmental damage that is happening in Indonesia is getting bigger. Industrial activity waste is becoming more and more and creates pollution. The waste reduction process strategy can be done by collaborating, between agronomic technical applications and clean production. The purpose of this writing shows that the clean production process in the coffee industry can be collaborated through the development of healthy vegetables through the use of coffee waste after processing it into by-products (compost and liquid fertilizer). Hope can provide knowledge and an overview for the coffee farming community on how to apply this clean production concept to their industry. The production process is clean through energy efficiency and will ultimately result in minimization of useful waste again. The experiment used a randomized design. Treatment groups consisted of: the first composition (NPK compound fertilizer + Nasa liquid fertilizer + coffee compost); The second composition (NPK compound fertilizer + coffee waste liquid fertilizer + coffee compost); The third composition (liquid Nasa fertilizer + coffee waste liquid fertilizer + coffee compost). Growth variables consisted of plant height, number of leaves and leaf width; Production variables consist of weight / plant and weight / plot. The results obtained by the utilization of coffee production waste (coffee husk compost and coffee waste liquid fertilizer) are recommended to support clean coffee production, able to increase Pak Choy's (*Brassica rapa* L) production per sample and area.

1. Introduction

Cleaner production, is one of the preventive measures against pollution, is the sustainable implementation of an integrated preventive environmental strategy for processes, products and services in increasing overall efficiency and reducing risks to people and the environment [1]. Indonesia is an agricultural country, most of its people depend on agriculture. The agricultural production process goes hand in hand with the value of needs, so that the main problem is generally the result of the community's lack of understanding of environmental management, the need for consumption is not in line with a sustainable production process. Understanding of clean production means being able to carry out environmental development in a sustainable manner; development that meets the needs of the present without compromising the ability of future generations to meet their own needs. This concept has three virtues, namely: economic sustainability, environmental and social protection and ethical acceptance [2]. Preventing the emergence of pollution is the same as minimizing waste, and cannot be done immediately but with gradual reduction. The concept of waste minimization can be explained as prevention and reduction activities as well as efforts to improve the quality of the final waste resulting from various processes that take place [3] [4].

Jember coffee is well known among the public and is one of the leading products to be reckoned with. Like most cases, the condition of smallholder coffee farmers in the Jember area, especially the Panti area, can be used as a parameter to illustrate the problem of understanding the level of farming management in order to be sustainable with the application of clean production techniques [2]. There are two kinds of waste produced during the coffee harvest, namely the skin of the fruit and liquid waste during the fermentation process and the washing process. The two wastes, if left alone for a long time, will have an impact on the environment. A new pollution prevention concept, based on the goal of reducing environmental impacts through a product life cycle (life cycle analysis), with a focus on design for environmentally friendly products (design for the environment) or on a new approach based on added value, namely eco-efficiency. Eco-efficiency is more aimed at efficient management strategies that have a positive impact on the environment while clean production is on the operational or production side by preventing and reducing landfills by handling it so that it has a positive impact on increasing efficiency and productivity. The by-products that can be utilized from post-coffee processing are coffee compost and coffee liquid organic fertilizer [2].

Pak Choy's (*Brassica rapa* L) type of mustard is one of the horticultural plant products which is one of the short-lived green vagetables, can be harvested from the age of 25 - 35 days after planting is the optimal character stage for the product. Apart from having quite a lot of enthusiasts, it is also easy to maintain, so there is enough potential for producer farmers because of the short turnover rate of the market chain, providing a bright business prospect. The use of coffee waste has also been tried on Lettuce (Lactuca Sativa), giving good results [5]. Based on these various studies, it is necessary to discuss the potential green vagetable problem in the relationship of waste management based on Eco-efficiency management of clean coffee-based production. This method is proven to be the right action to implement sustainable agriculture [6].

2. Material and methods

The experiment was conducted on farmer's land in Panti village, Jember Regency in Jember (80 m above sea level). The experiment was started by collecting coffee husk waste and composting it for 1-2 months, until the compost was ripe. The liquid waste resulting from post-harvest processing fermentation is fermented to become coffee waste liquid fertilizer, then testing the production of healthy vegetables (green vegetable) by planting a short-lived Pak Choy (*Brassica rapa* L)as a test sample. Planting was carried out in experimental demonstration plots measuring (1 x 2) m with a spacing (20 x 20) cm, planting material for Pak Choy's seed (*Brassica rapa* L), compost of coffee husk waste (10 tonnes / ha), liquid fertilizer coffee processing waste (2 ml / L), liquid Nasa fertilizer (2 ml / L), NPK Mutiara compound fertilizer (half the recommended dose, 2 gr / plant).

The experiment used a randomized block design. The treatments consisted of three fertilizer compositions: The first composition (K0 = NPK compound fertilizer + Nasa liquid fertilizer + coffee compost); The second composition (K1 = NPK compound fertilizer + coffee waste liquid fertilizer + coffee compost); The third composition (K2 = liquid Nasa fertilizer + coffee waste liquid fertilizer + coffee compost). Growth measurement variables consisted of plant height, number of leaves and leaf width; production variable: crop weight / sample weight crop / bed. Data were analyzed using the F test at 5% with the LSD test at 5%.

3. Result and discussion

The growth and development of Pak Choy's (*Brassica rapa* L) depend on the ability of these plants to respond to the treatment of media composition. The composition using NPK compound fertilizer and Nasa fertilizer is a treatment control to measure the response of the plant to the media composition treatment using post-harvest coffee processing waste (compost of coffee husk waste and coffee processing waste liquid fertilizer)

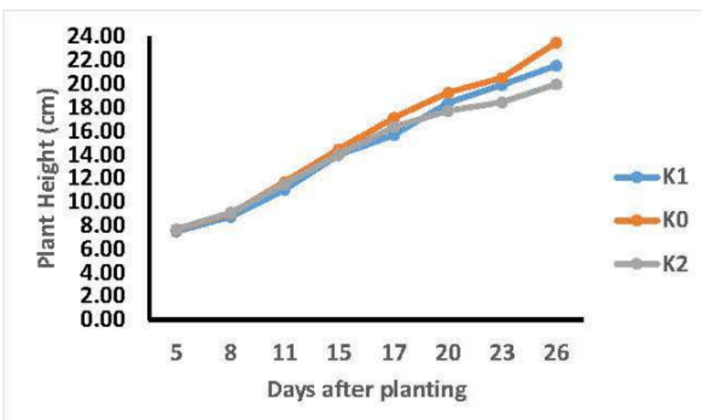
3.1 Plant height

Pak Choy's (*Brassica rapa* L) plant height growth variable at the beginning of the plant observation had not shown a response, the data was not significantly different (Table 1), because the conditions of the plant at the beginning of growth were still in the seedling stage, plants were still adapting to their environment, food intake was dependent on cotyledons. The increasing age of the plants was 17-20 DAP (Day after planting), the roots were more perfect, plants began to respond to the environment, plant height growth showed a significant difference, plants treated with K2 waste material composition (= Nasa liquid fertilizer + coffee waste liquid fertilizer + compost coffee) growth lags behind plants using the composition of K0 (= NPK compound fertilizer + Nasa liquid fertilizer + coffee compost) and K1 (= NPK compound fertilizer + coffee waste liquid fertilizer + coffee compost) (Table 1). The condition at the end of harvest 26 DAP (Figure 1) plant height K0 and K1 in a higher growth position than K2 (= Nasa liquid fertilizer + coffee waste liquid fertilizer + coffee compost), but statistically proven that the plant height of the three treatments was not significantly different (Table 1), it means that coffee waste fertilizer is able to support the growth and development of plant height along with the treatment using NPK compound fertilizer and Nasa fertilizer.

Table 1. Response to growth and height development of the Pak Choy (*Brassica rapa* L) to the treatment medium

Treatment	Plant height, cm (Days after planting)															
	5		8		11		15		17		20		23		26	
K0	7.628	a	9.000	a	11.682	a	14.452	a	17.115	a	19.250	a	20.518	a	23.512	a
K1	7.472	a	8.737	a	11.032	a	13.978	a	15.668	b	18.372	ab	19.912	a	21.550	a
K2	7.695	a	9.059	a	11.500	a	14.029	a	16.341	ab	17.703	b	18.444	b	19.980	a

Note: Numbers followed by the same letters on the same column show no significant difference in the LSD test 5%; K0 NPK + liquid Nasa fertilizer + coffee compost; K1 NPK + coffee liquid organic fertilizer + coffee compost; K2 liquid Nasa fertilizer + coffee liquid organic fertilizer + coffee compost.



Note: K0 NPK + liquid Nasa fertilizer + coffee compost; K1 NPK + coffee liquid organic fertilizer + coffee compost; K2 liquid Nasa fertilizer + coffee liquid organic fertilizer + coffee compost.

Figure 1. The response of the Pak Choy (*Brassica rapa* L) plant height to the compotition of the treatment medium

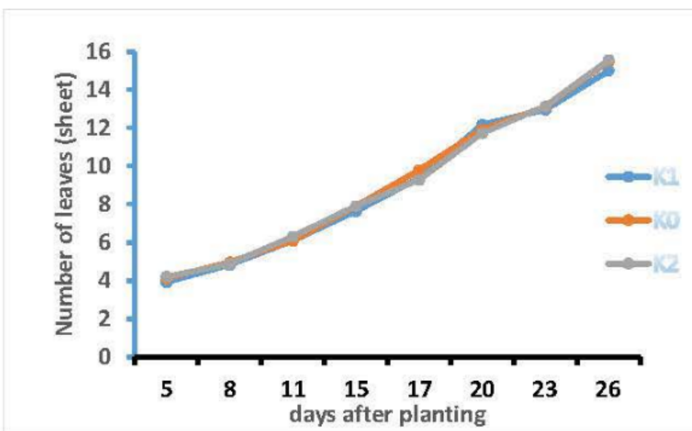
3.2 Number of Leaves

The results of the analysis showed that the response of growth in the number of leaves of Pak Choy (*Brassica rapa* L) to the types of compotition media did not show any significant difference (**Table** 2) and **Figure** 2). The composition of the type of fertilizer used did not change the character of the number of leaves, as evidenced by the end of the observation at harvest time the plants showed the same number of leaves K1 (= NPK compound fertilizer + coffee waste liquid fertilizer + coffee compost) and K2 (= Nasa liquid fertilizer + coffee waste liquid fertilizer + compost coffee) was not significantly different from K0 (= compound NPK fertilizer + Nasa liquid fertilizer + coffee compost) (15,000 -15,559 leaves), meaning that fertilizer from coffee waste is recommended in terms of maintaining the number of leaves.

Table 2. Response to growth and number of leafs development of the Pak Choy (*Brassica rapa* L) to the treatment medium

Treatment	Number of leaf, sheet (Days after plant)															
	5		8		11		15		17		20		23		26	
K0	4.117	ab	4.950	a	6.083	a	7.883	a	9.783	a	11.917	a	13.100	a	15.500	a
K1	3.917	b	4.817	a	6.083	a	7.633	a	9.350	a	12.167	a	12.950	a	15.000	a
K2	4.203	a	4.881	a	6.305	a	7.898	a	9.271	a	11.729	a	13.136	a	15.559	a

Note: Numbers followed by the same letters on the same column show no significant difference in the LSD test 5%; K0 – NPK + liquid Nasa fertilizer + coffee compost; K1– NPK + coffee liquid organic fertilizer + coffee compost; K2 – liquid Nasa fertilizer + coffee liquid organic fertilizer + coffee compost



Note: K0 – NPK + liquid Nasa fertilizer + coffee compost; K1– NPK + coffee liquid organic fertilizer + coffee compost; K2 – liquid Nasa fertilizer + coffee liquid organic fertilizer + coffee compost

Figure 2. The response of the Pak Choy (*Brassica rapa* L) number of leaves to the compotition of the treatment medium

IOP Conf. Series: Earth and Environmental Science 672 (2021) 012094 doi:10.1088/1755-1315/672/1/012094

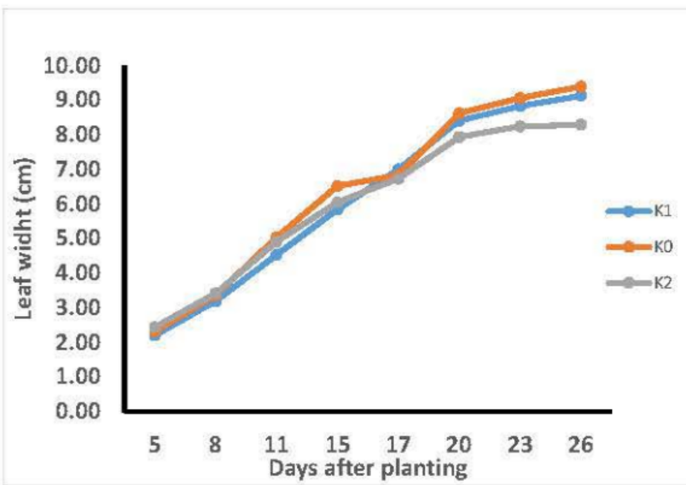
3.3 *Leaf Width*

The leaf width growth of Pak Choy's plant (*Brassica rapa* L) was in line with the growth of plant height, at the beginning of the observation the plants had not shown a response, at the end of the harvest period the K0 and K1 treatments were significantly different from those of K2 treatment (**Table** 3 and **Figure** 3). Plant growth and development based on the results of the analysis of the three measuring variables, can be illustrated that the plant vigor of K0 (− NPK compound fertilizer + Nasa liquid fertilizer + coffee compost) (15,000 -15,559 leaves) and K1 (− NPK compound fertilizer + coffee waste liquid fertilizer + coffee compost) is better than K2 plant vigor (− liquid Nasa fertilizer + coffee waste liquid fertilizer + coffee compost), but K1 is not significantly different from K0, meaning that the presence of compound fertilizers (half the recommended dose) as a companion to growth and leaf width development is still needed.

Table 3. Response to growth and leaf width development of the Pak Choy (*Brassica rapa* L) to the treatment medium

Treatment	Leaf weight, cm (Days after planting)															
	5		8		11		15		17		20		23		26	
K0	2.323	ab	3.367	a	5.033	a	6.517	a	6.830	a	8.620	a	9.060	a	9.392	a
K1	2.208	b	3.197	a	4.523	a	5.838	b	7.005	a	8.405	a	8.825	a	9.132	a
K2	2.442	a	3.417	a	4.908	a	6.049	ab	6.727	a	7.934	a	8.247	b	8.286	b

Note: Numbers followed by the same letters on the same column show no significant difference in the LSD test 5%; K0 = NPK + liquid Nasa fertilizer + coffee compost; K1= NPK + coffee liquid organic fertilizer + coffee compost; K2 = liquid Nasa fertilizer + coffee liquid organic fertilizer + coffee compost

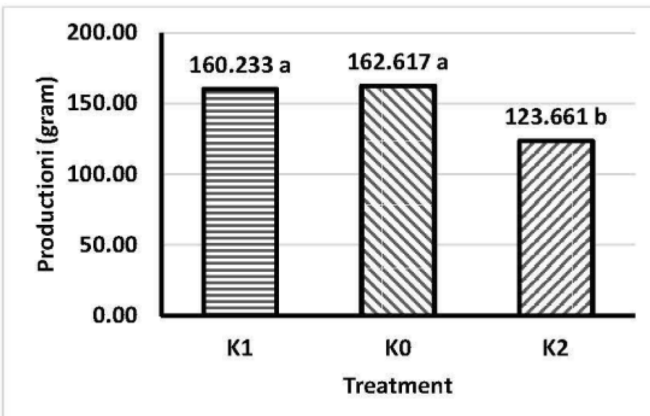


Note: K0 = NPK + liquid Nasa fertilizer + coffee compost; K1= NPK + coffee liquid organic fertilizer + coffee compost; K2 = liquid Nasa fertilizer + coffee liquid organic fertilizer + coffee compost

Figure 3. The response of the Pak Choy (*Brassica rapa L*) leaf widht to the compotition of the treatment medium

3.4 Crop / sample weight

Pak Choy (*Brassica rapa* L) is a green vegetable that is usually harvested during the vegetative active stage (age 25-40 after planting), all parts of the plant are still fit for consumption. The crop / sample weight is a variable measure to estimate the response of the end result of plant growth and development according to the production character of the treatment. The results of the crop / sample weight follow the previous plant growth and development data (height, number and width of leaves). Based on the data (see Figure 4), the weight of the crop / sample from the K1 treatment (= NPK compound fertilizer + coffee waste liquid fertilizer + coffee compost) was not significantly different from the K0 treatment (= NPK compound fertilizer + Nasa liquid fertilizer + coffee compost) equivalent to the experimental results on lectuce [5] and tomato [6]. The use of coffee compost and coffee waste liquid fertilizer for the production of Green Vegetable (Pak Choy) should be recommended as a solution to implementing Sustainable Agriculture through clean coffee production techniques. The composition of the coffee skin is rich in nutrients; crude protein (10.4%), crude fiber (17.2%), crude fat including lignin (2.13%), ash (7.34%), calcium (0.48%), phosphorus (0.04 %), caffeine (1.3%), tannins (8.5%), and metabolic energy (14.43%), which of course will increase their capacity through the composting process [7]. Production weight of the crop / bed matches the result with the weight of the crop / sample (data not shown)



Note: K0 = NPK + liquid Nasa fertilizer + coffee compost; K1= NPK + coffee liquid organic fertilizer + coffee compost; K2 = liquid Nasa fertilizer + coffee liquid organic fertilizer + coffee compost

Figure 4. The response of crop per sample of Pak Choy (*Brassica rapa L*) to the compotition of the treatment medium

4. Conclusion

The use of coffee husk compost and coffee waste liquid fertilizer is recommended as a solution to the application of clean coffee-based production techniques, which can increase Pak Choy's production (crop / sample weight and crop / bed weight). Suggestion: in the future it is necessary to develop experiments with more extensive treatment of composition, dosage, concentration and other types of green vegetables so as to broaden farmers' insights besides helping to achieve the implementation of clean production programs, it is also able to improve farmer welfare outside the coffee harvest season by producing side products the benefits.

5. Acknowledgment

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