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The effect of spent mushroom compostand various composting starter combination on the growth and yield of kangkong (*Ipomoea reptans*)

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The effect of spent mushroom compostand various composting starter combination on the growth and yield of kangkong (*Ipomoea reptans*)

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Abstract. The objective of this study was to determine the effect of the compost of spent mushrooms that was composted with different starting materials on the growth and performance of kangkong. This study was performed using a randomized block design, consisting of two factors. The first factor was the compost starter combination that consists of three levels (effective microorganism + $CaCO_3$ effective microorganism + fertilizer of urea and phosphate). The second factor was the application dosages of compost that consists of 4 levels (5 tons/ha, 10 tons / ha, 15 tons/ha and 20 tons/ha). The results showed that the application of spent mushroom compost with diverse materials of initial compost starter showed a significant interaction in the width of the leaf at 10 days after planting (DAP), the height of the plant at 30 DAP, dry weight, and leaf area ratio at 20 DAP. In comparison with the controls, the significant influence occurred in plat height at 30 DAP, dry weight at 10 DAP, the width of the leaf at 10 and 20 DAP, and the ratio of the leaf area at 20 DAP. The combination of effective microorganisms + urea and effective microorganisms + phosphate fertilizer gave a good result in the growth and yield of kangkong.

1. Introduction

Kangkong is a favorite vegetable that is liked by the people of Indonesia. Kangkong is easily cultivated and contains high nutrients. This plant also has an extensive adaptation capability to various environmental conditions. It is also easy to maintain, and relatively inexpensive in the cost farming. Using a proper media will increase the productivity of kangkong [1].

Spent mushroom substrate, in a large scale is included to agricultural solid waste that will cause environmental problems [2]. According to a work by Garg and Gupta [3] spent mushroom waste is traditionally incenerated or deposited in the land area that will cause GHG effect and reduces the productivity olf agriculture land use area [4]. Esmaielpour et al.[5] and Polat et al.[6] stated that spent mushroom has a potential to be used as a soil conditioner, which will be able to improve the stability of the soil aggregate. The mushroom media commonly used among mushroom growers in Indonesia consists of three main components: sawdust, rice bran, and powdered corn. Each of these components has an organic content that can be useful for soil fertility, therefore the spent mushroom contains of abundant nutrients including organic substrate, sulfur, potassium, calcium, magnesium, nitrogen and phosphor [7].

The spent mushroom requires an adequate process of decomposition before it is ready for use. Therefore, it is necessary to provide a decomposition reinforcement (starter) to accelerate the decomposition process of the spent mushroom to be a high-quality compost. Composting is a very common applicable technology among the farmers in rural area to provide assesable nutrient in agriculture production. It is a process of biological decomposition and stabilize of organic waste to transform the organic matter into available nutrition for plants.

Spent mushrooms compost application into the soil can increase soil fertility by improving the physical, chemical, and biological soil [8]. Some microorganisms use spent mushroom compost as an energy source. Soil microorganisms can bind the grains of soil by mechanical bonding by the cell and filament microbodies [9]. The composition of the chemical element content of spent mushroom used in this research is presented in Table 1. The composition is similar to the spent mushroom substrate composition used by Lou et al. [2].

Table 1. The composition of spent mushroom.

Element	Content
C	31.7%
N	0.84%
P	0.65%
K	0.45%
C/N ratio	37
Organic Material	5410%
pH	5-6

The spent mushroom can be used as organic fertilizer after a decomposition process. Because of the C / N ratio of the spent mushroom is quite high, we need a material to lower the ratio. Materials used are starter containing microorganisms that can break down, and speed up the ripening process of the spent mushroom composting. The starter is a compound that provides energy so that nutrients are readily available for a limited number of microbial activity. The activity of microorganisms will accelerate the composting process. The process would result in nutrients bound of organic compounds by transforming poorly soluble compounds will be transformed into a soluble so that it is available for the plants.

A starter can be made from inorganic fertilizers. According to Rinsema [10], the addition of phosphate and calcium can help the process of making good compost. At this time a lot of substances starter and the decomposition of plant growth promoters on the market, all of which are the development of biotechnology applied by utilizing various types of natural organisms. Effective Microorganisms are mixed cultures of microorganisms that are beneficial for plant growth. The effective microorganism used in this research is contained of photosynthetic bacteria, Lactobacillus sp, Streptomyces sp, yeast (yeast), and actinomycetes. The dosage of spent mushroom application is also an important factor to support plant growth and yield. Polat et al. [6] reported that there significantly differences among different level of spent mushroom compost application on total yield of lettuce. The objective of this study was to determine the effect of the compost of spent mushrooms that was composted with different starting materials on the growth and performance of kangkong.

2. Materials and methods

2.1. Materials

The main materials used in this research were spent mushroom, local commercial effective microorganis, $CaCO_3$, urea, SP-36. The spent mushroom was taken from the mushroom house of Agriculture Faculty, University of Islam Malang. This research was conducted in the experimental field of Agriculture Faculty, University of Islam Malang which located at the altitude of 500m above the sea and having Alluvial soil type. The research was done from June to September.

2.2. Experimental set up

This study used randomized block design which consists of 2 factors. The first factor was the type of compost initiator that consists of 3 levels: (Effective microorganisms + $CaCO_3$ (S1)), (Effective microorganisms + Urea (S2)) and (Effective microorganisms + SP-36 (S3)). The second factor was the dosage of the spent mushroom compost application that consists of 4 levels: (5 tons/ha (D1)), (10 tons/ha (D2)), (15 tons/ha (D3)) and (20 tons (D4)). There were 12 combinations and 1 control treatment wasa dded at the dose of 0 ton/ha (without spent mushroom compost but using inorganic fertilizer NPK 52 g / plot). Each treatment combination was repeated 3 times.

2.3. Experimental procedure

The spent mushroom was dried under the sun, divided according to the treatment and weighed. A total of 2 ml Effective microorganisms was dissolved in 0.5 liters of water for every 5 kg of spent mushroom. The solution then was poured slowly into the spent mushroom and added with CaCO3 70 g / 5 kg spent mushroom, urea 50 g / 5 kg of spent mushroom, and SP-36 as much as 50 g / 5 kg of spent mushroom. It was then blended until the moisture content reached 30%. The mixture spent mushroom media was filled into the plastic bags according to the treatment, After the C / N ratio reached 15-20, the spent mushroom compost was be applied in the field.

Three kangkong's seeds were planted with a space of 10 cm x 20 cm. Spent mushroom applications were done one week before planting according to the treatment. As a follow-up, the NPK fertilizer (52 g / plot) was applied at the time of planting.The observations were carried out destructively. Observation began at ten days after planting, and the continuing observations were done at intervals of 5 days until the plant was 35 days after planting. Sampling was done randomly,3 samples per plot. The observations were included: height of plants (cm), number of leaves (leaf), number of branches (fruit), leaf area (cm2) Weight of fresh total per plant (g) Dry weight of total per plant (g), total root length (cm), Relative Growth Rate (RGR), and Leaf Area Ratio (LAR).

$$\text{RGR} = \frac{LnW_2 - LnW_1}{(t_2 - t_1)} \;\; (\text{ g.g}^{-1}\text{days}^{-1}) \qquad (1)$$

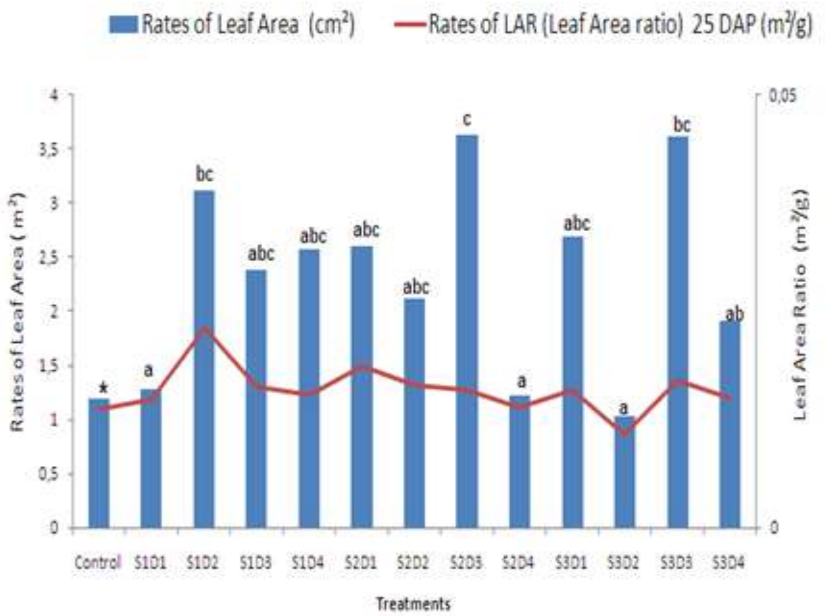
Where:
W_2-W_1= total plant dry weight in the 1 and 2 observation.
t_2 - t_1 = plant age in the 1st and 2nd observations.

$$\text{LAR} = \frac{LA}{W} \;\; (\text{m}^2/\text{g}) \qquad (2)$$

Where :
LD = Leaf Area (m^2)
W = Dry Weight (g).

2.3. Data analysis
The data obtained from the observations were analysed using an analysis of variance of 5% to determine the effect of treatment. If there was a significant effect on these variables, it will be followed by LSD test at 5% level. Dunnet test (at 5% level) was done to observe the difference between the treatments and control.

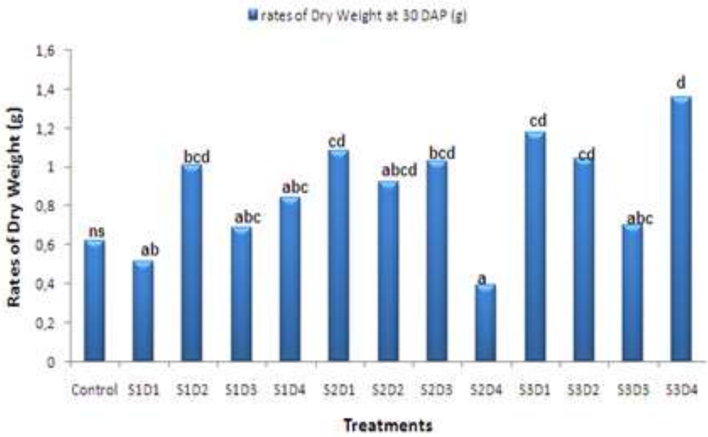
3. Results and discussion
The results of this study indicated a significant interaction between the kind of compost starter and the compos dosage application on leaf area at the age of 10 DAP (Figure 1). The combination of composting with effective microorganisms + Urea 15 ton/ha (S2D3) produces the best leaf area of kangkong, although it was not significantly different from some other treatments. It showed that spent mushroom compost using effective microorganisms + urea have a good quality because of its nitrogen content which supports the vegetative growth of kangkong. This result was in collinearity the opinion of Fog [11] who said that in early to mid-age of the plant, nutrients found in organic fertilizers could be used optimally by the plant for cell renewal. According to Lou et al. [2] spent mushroom compost was regarded as a better fertilizer due to its ability to hold 65% of Nitrogen. Nitrogen is the most important nutrient needed in a vegetative phase og plants. The result of this research also showed a significant interaction of the dry weight of the total fresh weight at 30 DAP. Composting treatment with effective microorganism + SP-36 (phosphate) starter at a dose of 20 ton/ha (S3D4) shows a higher result , but not significantly different from other treatments.



Notes : The different letterson thedifferent bars are significantly different on Duncant test (P<0.05).
* refers to significantly different with control on Dunnet test (P<0.05)

Figure 1. Leaf area of kangkong and leaf area ratio.

The value leaf area ratio (LAR) showed a significant interaction between the two treatments at 25 days after planting. The best LAR obtained in kangkong treated with effective microorganisms + ureacompost starter with a dose of 10 tons/haspent mushroom compost. According to Sitompul and Guritno [12], the magnitude of the LAR in the growing period is in making a significant contribution to the distribution, translocation, and efficiency of the synthesis process leaves. Ginting [13] said that the ratio of leaf area shows the ability of the leaves in to produce dry matters of plants. Figure 2 showed the effect of the two treatments on plant dry weight at 30 DAP. It showed that the combination of effective microorganism_+ fertilizers ($CaCO_3$, urea and phosphate) gave good result but it did not significantly different with the control. The combination of effective microorganisms + phosphate as strater and the application of 20 kg spent mushroom compost gave the best dry weight, although it was not significantly different with some other treatments.



Notes :ns) not significantly different with control on Dunnet test (P<0.05);
The different letters on the different bars are significantly different on Duncant test (P P<0.05)

Figure 2. Rates of dry weight of kangkong at 30 dap

Separately, the results of ANOVA are shown in Table 2. The treatment combination of composting starter significantly affect the plant height of kangkong at 30 days after planting, leaf area, number of branches, total fresh weight at 10 and 30 days, dry weight of the plant at 10 DAPand relative growth rate at 30-35 HST. The combination of effective microorganism and urea gave good results although it was not significantly different with the combination of effective microorganisms and SP 36. The two types of combination can be applied to produce good quality produce spent mushroom compost. Table 2 also shows that up to a dose of 20 tons/ha, spent mushroom did not deliver maximum results on the productivity of kangkong. It shows that the optimum dose of spent mushroom compost has not been reached.

Table 2. Plant height, leaf area, total branch, fresh weight, dry weight and RGR of kangkong of the two factors of application.

Treatment	Plant Height cm	Leaf Area (cm^2) 30 DAP	Total Branch 20 DAP	Fresh Weight (g)		Dry Weight 10 DAP (g)	Relative Growth Rates ($g.g^{-1}day^{-1}$) 30-35 DAP
				10 DAP	30 DAP		
Control	20.67 *	10.64 *	3.56	0.39	5.63	0.02 *	0.23
Starter							
Effective Microorganis+ $CaCO_3$	22.89 a	16.18 a	3.75 a	0.41 a	7.13 a	0,03 a	0.23 b
Effective Microorganism + Urea	23.83 ab	24.31 b	5.03 ab	0.50 b	8.61 a	0.04 b	0.21 b
Effective Microorganism + (phosphate)	26.07 b	26.04 b	5.72 b	0.43 a	10.57 b	0.03 a	0.15 a
LSD 5%	2.37	4.17	1.36	0.08	2.62	0.0051	0.028
SMS Dosage							
5 ton/ha	25.13	19.45 a	4.89	0.,45	9.08	0.03	0.17
10 ton/ha	25.23	21.22 a	5.22	0.42	9.44	0.03	0.18
15 ton/ha	22.41	26.34 b	4.67	0.48	7.39	0.04	0.23
20 ton/ha	24.18	21.70 ab	4.56	0.44	9.16	0.03	0.21
LSD 5%	ns	4.81	ns	ns	ns	ns	ns

*) Significantly different with control on Dunnet test ($P<0.05$); The different letterson thedifferent bars are significantly different on Duncant test (P $P<0.05$)

The results of orthogonal contrasts test showed significant differences between the control with the treatment on plant height (20 and 30 days after planting), leaf area age (10 and 20 days after planting), total dry matter (10 DAP), and Leaf Area Ratio (20 DAP) (Figure 1 and Table 2). The control plants have a lower value for all vegetative variables compared to the plants with spent mushroom compost treatments. It showed that the spent mushroom compost gave a better influence on the growth of kangkong. It is also proved that the spent mushroom produced in this research using effective microorganism and fertilizers have a good quality and suitable to support the vegetative growth of kangkong.

4. Conclusion

The application of spent mushroom compost with diverse materials of initial compost starter showed a significant interaction in the width of the leaf at 10 days after sowing (DAP), the height of the plant at 30 DAP, dry weight, and leaf area ratio at 20 DAP. The combination of effective microorganisms + urea and effective microorganisms + phosphate fertilizer gave a good result in the growth and yield of kangkong.In comparison with the controls, the significant influence occurred in plat height at 30 DAP, dry weight at 10 DAP, the width of the leaf at 10 and 20 DAP, and the ratio of the leaf area at 20 DAP. The result of this research proved that the spent mushroom using effective microorganism and fertilizers as compost starter have a good quality and suitable to support the vegetative growth of kangkong.

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