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Effect of Induced Compost by Cellulolytic (*Aspergillus fumigatus*) and Ligninolytic (*Geotrichum* sp.) Fungi Inoculum Application on Vegetative Growth of Red Chili (*Capsicum annum* L.)

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8 Abstract

Green waste (GW) is an important fraction of municipal solid waste (MSW). The composting of lignocellulosic GW is challenging due to its low decomposition rate. Therefore the use of fungi inoculum as a decomposer inducer on GW composting needs to study. The purpose of this study was to explore the potential of the compost induced by cellulolytic (*Aspergillus fumigatus*) and ligninolytic fungi (*Geotrichum* sp.) inoculum application on vegetative growth of red chilly plants (*Capsicum annum* L.). This research was conducted in the green house of the Faculty of Agriculture the University of Lampung, Indonesia. Completely Randomized Design was adopted with five treatment dose of cellulolytic and ligninolytic compost amandmend of 0%, 10%, and 20% each (K= control, S1= Cellulose 10%, S2= cellulose 20%, L1= Ligninolytic 10% and L2= ligninolytic 20%). Parameters observed were plant height, dry weight, relative water content and chlorophyll of a, b and total. The results demonstrated that compost induced by cellulolytic fungi (*Aspergillus fumigatus*) and ligninolytic (*Geotrichum* sp) produced the optimal effect on growth parameters across all treatments. The compost application could increase significantly plant height, dry weight, relative water content. But not the chlorophyll content of a, b and total. The maximum measurements of plant height, dry weight, relative water content was achieved by S2, L2, L2, K and L2 treatments respectively. These results suggest that the inoculum induced compost has bene cial impacts for the use as organic fertilizer to enhance vegetative growth.

Keywords: Compost, *A. fumigatus*, *Geotrichum* sp., vegetative, *C. annum*.

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INTRODUCTION

Plant requires sufficient nutrients for normal growth. However recently, decreasing soil conditions due to the influence of global climate change and agricultural production makes soil conditions experiencing nutrient deficiencies.² As organic agricultural production grows in economic importance, there is an increased need to examine the efficacy of a variety of plant fertility sources. On the other hand, the growth of urban green areas worldwide has led to an increase of the amounts of green waste (GW) generated. This, in turn, has become an environmental problem in developing and developed countries.¹ This coincides with efforts in waste reduction, one strategy of which is composting municipal solid waste.² Besides, it increases the need for additional sources of fertilizers. The use of synthetic fertilizers on the soil can cause deterioration to the balance of the soil ecosystem. Fertilization carried out continuously may cause a decrease in the number of soil microorganism population. As a result, the decomposition process in the soil will run very slowly without the help of microfungi as decomposers of organic compounds, and there is a decrease in the process of plant growth and development.

Along with other biowaste (i.e. food waste), GW constitutes the highest fraction of municipal solid waste (MSW)³. One of the compost substrate potential for the future is the use of compost derived from yard litter. In addition, it is to avoid the threat of chemical residual residues using synthetic fertilizers can inhibit plant growth.¹⁴ Compost has been identified as an alternative chemical fertilizer to increase soil fertility and crop production.¹ Compost is a plant residue, animal residue or a mixture of both that has been decomposed and recycled as a fertilizer and soil amendment. Compost is a key ingredient in organic farming. At its most essential, the process of composting requires simply piling up waste outdoors and waiting a year or more.⁵

One reesearch has shown that application of selective saprophytic microfungi based on decomposition properties on soil was able to increase soil fertility in the term of Nitrogen, Phosporus and potassium soil content and plant growth of *Lycopersicum esculentum* Mill⁶. Based on this, the addition of selected fungi inoculums

during the composting process will cause the formation of inoculum enriched compost which is able to accelerate the process of decomposition of organic matter and produces plant nutrients⁷. One of the subjects that has the potential used as superior organic fertilizer is compost induced by cellulolytic and ligninolytic fungi which enables rapid addition of soil nutrients. Moreover the presence of fungal inoculum in the compost will help the continuous decomposition process in the soil so that it is potential to produce soil fertility nutrients

MATERIALS AND METHOD

Compost preparation-Composting using a mixed substrate was carried out using the modified Kumar *et al.* method⁸. The litter was dry mixed litter collected from the campus yard with the following mixed of litter: ketepeng (*Terminalia catappa*), walnuts (*Canarium vulgare* Leenh), keben (*Barringtonia asiatica*), Sonokeling (*Dalbergia latifolia* Roxb.), Jati belanda (*Guazuma ulmifolia* Lamk.), cantile (*Michelia alba*) and Puring(*Codiaeum variegatum*). Litter was used with evenly mixed with amounts of 10 kg each. The litter was mixed, chopped 3-5 cm in size, and aerated dry. The composition of compost materials follows the comparison of Ustuner *et al.* which is 2: 1 (w / w) for plant vegetation and animal manure⁹. The compost material used in this study intentionally did not use additional sources of sugar such as molasses because it was intended to suppress the growth of bacteria which would increase the composting temperature which would in fact kill the fungi inoculum.

Cellulolytic fungi (*Aspergillus fumigatus*) and ligninolytic fungi (*Geotrichum* sp) were obtained from previous studies. Litter composting process took place in aerobics, medium water content is 30-40%, and the temperature is around 30 - 50°C. A single culture inoculum and a 14-day-old consortium were given as much as 1.0% of the weight of the compost material substrate⁸. Composting was done using a modification of the Takakura Home Method (THM) method^{10, 11}.

This study was conducted in a completely randomized design experiment with the main factor being fertilization with 5 levels as follows:

1. K = Control
2. S1 = 10% of Cellulolytic compost

3. S2 = 20% of Cellulolytic compost
4. L1 = 10% of Ligninolytic compost
5. L2 = 20% of Ligninolytic compost

The variables of this study were plant height, dry weight, relative water content, and chlorophyll a and b. Fifteen, thirty and forty five days after planting (DAP), plant parameters were analyzed. Plants were cut 1 cm above the soil surface, then plant fresh weights were recorded, and dry weights were conducted by drying the plants at 60°C for 24 h. Chili red leaf chlorophyll content was assessed by crushing 1 gram of chili leaves crushed until smooth with mortar, then 20 ml of 96% ethanol was added. The extract is filtered and then put into a test tube. Chlorophyll extract measured the absorbance at wavelengths of 648 and 664 nm. Chlorophyll content was expressed in milligrams per gram (mg / g) of tissue and was calculated in the following equation¹²:

$$\begin{aligned} Chla &= 13.36 A_{664} - 5.19 A_{648} \\ Chlb &= 27.43 A_{648} - 8.12 A_{664} \end{aligned}$$

RESULTS AND DISCUSSION

Data presented in Table 1 show the effect of compost induced by cellulolytic and ligninolytic fungi treatments significantly affected plant height during 15, 30 and 45 day after planting (DAP). However, the highest value of plant height was obtained by the S2 treatment on 45 DAP. No apparent differences were detected on the trait concerning all induced compost treatments beside control.

Observations of 15 and 30 DAP on plant height show real differences of treatments compared to control, but there were no significance differences among treatments beside control.

Table 1. Plant height (cm) treated by induced compost of cellulolytic and ligninolytic fungi inoculum

No	Treatments	15 DAP	30 DAP	45 DAP
1	K	4.97 ^c	8.57 ^c	17.07 ^d
2	S1	7.77 ^b	19.90 ^b	52.70 ^c
3	S2	8.60 ^{ab}	24.90 ^{ab}	66.60 ^{ab}
4	L1	8.90 ^{ab}	21.77 ^{ab}	59.23 ^{bc}
5	L2	8.30 ^{ab}	26.57 ^{ab}	60.30 ^{bc}

Description: - K = control; S1 = Cellulolytic (10%); S2=Cellulolytic (20%); L1 = Ligninolytic (10%); L2 = Ligninolytic (20%). Numbers followed by different letters within columns are significantly different at $P < 0.05$.

On the 45 DAP observation the treatment S2 indicated that it was significantly highest among all treatments including control. Induced compost had a significant effect on the height of the large red chili plant on all observation days.

Fig. 1 reports the effect of induced compost treatments on the plant height. At 15 DAP the highest chili plants were plants given L1 compost (Ligninolytic 10%). At 30 DAP the highest plants were at L2 (ligninolytic 20%). At 45 DAP the highest plants were achieved at S2 (cellulolytic 20%) compost treatment. Moreover, in the whole compost application, both cellulolytic and ligninolytic gave a good influence compared to controls on the height of large red chili plants.

The results showed that the soils amended with induced compost had a significant effect on the height of chili plants from the three observation times compared to the control. The results comply with Schroth and Sinclair¹³ stating that plants can grow and develop optimally if the process of absorption of nutrients in large quantities occurs optimally. It is assumed that nutrients available in compost induced by cellulolytic and ligninolytic fungi with a combination of doses of 10% and 20% have been able to meet the needs of large red chili plants so that the growth of plant height can be optimal.

Induced compost stimulated the plant growth parameters through the improvement effect on the meristematic activity of tissues, where these compost are rich in N, P, K and other minerals which are required for propellant growth. As a result of these prospects, it may be concluded that compost improved the structure of sandy soil and consequently encouraged the plant to

Table 2. Dry weight of plants (g) treated by induced compost of cellulolytic and ligninolytic fungi inoculum

No	Treatments	15 DAP	30 DAP	45 DAP
1	K	0.002 ^d	0.041 ^b	0.124 ^f
2	S1	0.010 ^{bcd}	0.152 ^b	5.081 ^{cde}
3	S2	0.021 ^{ab}	0.103 ^b	4.091 ^{de}
4	L1	0.011 ^{bcd}	0.427 ^a	3.175 ^e
5	L2	0.013 ^{bcd}	0.420 ^a	5.789 ^{bcd}

Description: - K = control; S1 = Cellulolytic (10%); S2=Cellulolytic (20%); L1 = Ligninolytic (10%); L2 = Ligninolytic (20%). Numbers followed by different letters within columns are significantly different at $P < 0.05$.

1 achieve good growth. Moreover, the slow released nutrients from compost permit the plants to get benefit of them, and thus improved plant growth⁵.
 7 Several studies have been done related to organic amendments on improving soil physical, chemical, and biological properties, providing essential plant nutrients to stimulate plant growth and yield¹⁴⁻¹⁷.

Table 2 presented the effect of compost induced by cellulolytic and ligninolytic fungi¹⁵ on the dry weight of large red chili plants. Treatments significantly affected dry weight of plants during 15, 30 and 45 DAP. Observations of 15 and 30 DAP on dry weight show significant differences of treatments compared to control, but there were no significance differences among treatments (exclude control). On the 30 DAP the highest dry weight value was achieved by L1 . On the 45 DAP observation the treatment L2 indicated that it

Table 3. Relative moisture content of plants (g). treated by induced compost of cellulolytic and ligninolytic fungi inoculum

No	Treatments	15 DAP	30 D AP	45 DAP
1	K	0.05 ^a	0.15 ^c	0.63 ^d
2	S1	0.13 ^a	1.28 ^{abc}	21.87 ^{bcd}
3	S2	0.10 ^a	1.20 ^{bc}	16.77 ^{cd}
4	L1	0.15 ^a	4.41 ^{ab}	20.57 ^{bcd}
5	L2	0.14 ^a	4.06 ^{ab}	30.39 ^{abc}

Description: - K = control; S1 = Cellulolytic (10%); S2=Cellulolytic (20%); L1 = Ligninolytic (10%); L2 = Ligninolytic (20%). Numbers followed by different letters within columns are signi cantly different at $P < 0.05$.

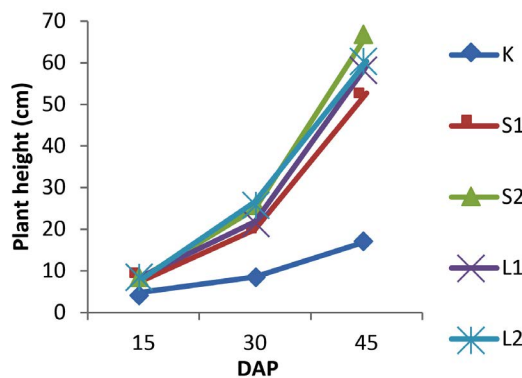


Fig. 1. Induced compost effect on the plant height . K = control; S1 = Cellulolytic (10%); S2=Cellulolytic (20%); L1 = Ligninolytic (10%); L2 = Ligninolytic (20%).

was significantly highest among all treatments including control.

Fig. 2 reports the effect of induced compost treatments on the dry weight of the plant. On the 45 DAP chili plants that had the highest dry weight value were plants given L2 compost (ligninolytic 20%) treatments. Moreover, overall fertilizer application, both cellulolytic, and ligninolytic compost gave a good effect compared to the control on the dry weight of large red chili plants.

The data also indicated that the induced compost affects the dry weight of large red chili plants. The existence of a significant effect is thought to be due to the adequacy of plant nutrients provided by induced compost fertilizer. The addition of compost can improve soil quality as well as providing nutrients for plants, so that it is good for plant growth. The application of GW compost is very promising because of the physicochemical diversity of the material so that the strategy of adding a consortium of fungi inoculums greatly help the decomposition process¹⁸. The compost contains several macro and micro-nutrients that can improve¹³ soil physical, chemical, and biological properties, providing essential plant nutrients to stimulate plant growth and yield¹⁵⁻¹⁷.

Table 3 shows that induced compost application had a significant effect on the relative moisture content of large red chili

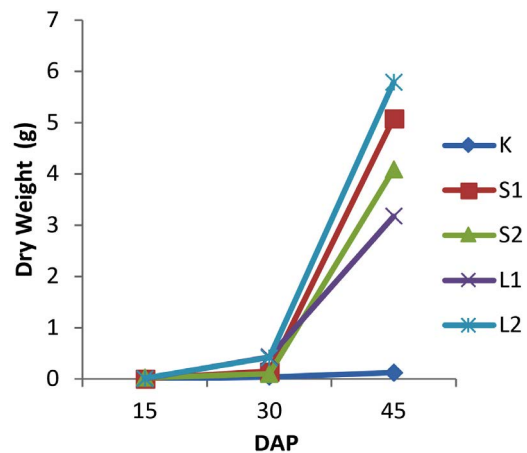


Fig. 2. Induced compost effect on the dry weight. K = control; S1 = Cellulolytic (10%); S2=Cellulolytic (20%); L1 = Ligninolytic (10%); L2 = Ligninolytic (20%).

plants on observation days except on the 15 DAP. Observations of 30 and 45 DAP on relative moisture content show significant differences of treatments. On the 30 DAP the highest relative moisture content value was achieved by L1. On the 45 DAP observation the treatment L2 indicated that it was significantly highest among all treatments.

Fig 3. reports the effect of induced compost treatments on the relative moisture content of the plants. On the 15, 30 and 45 DAP the plants that have the highest relative water content were plants given compost L2 (ligninolytic 20%).

The relative water content of a large red chili plant has increased over time. The water content of plants is resulted from absorption of plant roots and with the addition of compost can increase the absorption of roots of nutrients so that it can increase water content of plants. This

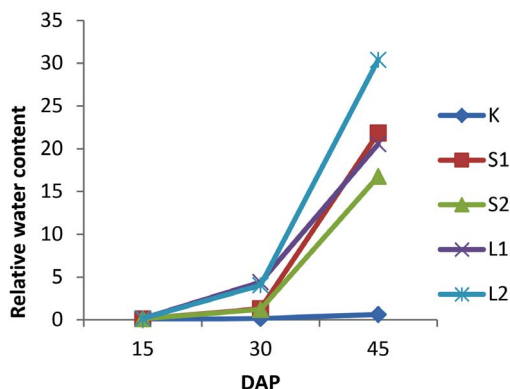


Fig. 3. Induced compost effect on the relative moisture content. K = control; S1 = Cellulolytic (10%); S2=Cellulolytic (20%); L1 = Ligninolytic (10%); L2 = Ligninolytic (20%).

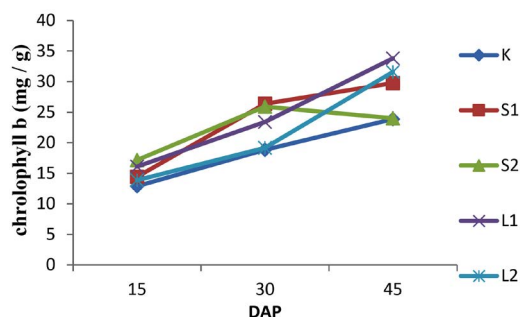


Fig. 5. Induced compost effect on chlorophyll b content. K = control; S1 = Cellulolytic (10%); S2=Cellulolytic (20%); L1 = Ligninolytic (10%); L2 = Ligninolytic (20%).

is in accordance with Sepwanti *et al.*¹⁹ stated that fungi-induced compost (*Trichoderma harzianum*) can increase the growth of red chili plants including the fresh weight and moisture content of a plant.

Fig. 4 reports that the effect of compost induced by cellulolytic and ligninolytic fungi on the leaf chlorophyll a of the leaves on 15 DAP, 30 DAP, and 45 DAP indicated no significant difference of all treatments. On the 15 and 30 DAP the highest effect of induced compost on chlorophyll a content was on S2 (cellulolytic 20%), whereas on the 45 DAP the highest chlorophyll a content was on L1 (ligninolytic 10%). Fig. 5 shows the effect of compost induced by cellulolytic and ligninolytic fungi on the leaf chlorophyll b content. The applications indicate that there were no significant difference of all treatments.

On the 15 and 30 DAP the highest effect of induced compost on leaf chlorophyll b content was on S2 (cellulolytic 20%), and on the 45 DAP highest leaf chlorophyll b content was at L1 (ligninolytic

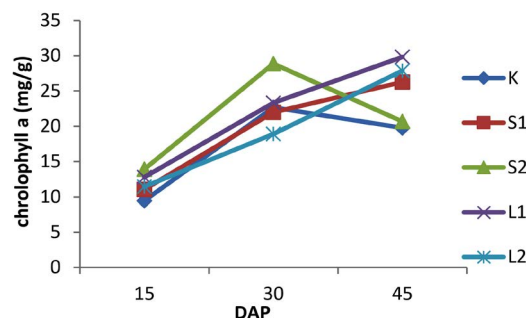


Fig. 4. Induced compost effect on chlorophyll a of the leaves. K = control; S1 = Cellulolytic (10%); S2=Cellulolytic (20%); L1 = Ligninolytic (10%); L2 = Ligninolytic (20%).

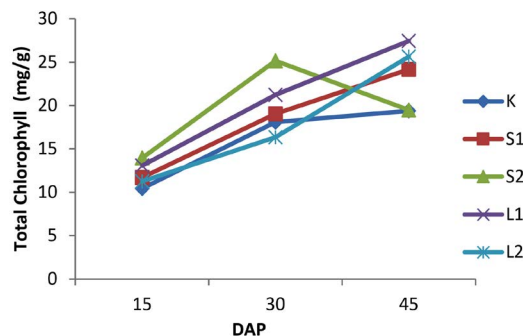


Fig. 6. Induced compost effect on total chlorophyll content. K = control; S1 = Cellulolytic (10%); S2=Cellulolytic (20%); L1 = Ligninolytic (10%); L2 = Ligninolytic (20%).

10%). However, the overall treatment of compost addition gave the best effect compared to the control on chlorophyll b of large red chili leaves (Fig. 5).

There were no significant differences in total chlorophyll content among treatments. However, induced compost led to an increase in total chlorophyll content in plant tissues more than control except when plant treated with S2 which tend to decrease on 45 DAP (Fig. 6)

The results indicate that the compost treatments did not have a significant effect on the chlorophyll a, b and total. Although the compost treatment has no significant effect on chlorophyll content but there is a tendency that treatments can increase the chlorophyll content in large red chili plants.

CONCLUSION

The application of compost induced cellulolytic fungi (*Aspergillus fumigatus*) and ligninolytic (*Geotrichum* sp) can increase vegetative growth of large red chili plants (*Capsicum annum* L.) including plant height, dry weight, relative water content, but no significant for chlorophyll a, b, and total.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

AUTHORS' CONTRIBUTION

All authors have made substantial, direct and intellectual contribution to the work and approved it for publication.

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DATA AVAILABILITY

All datasets generated or analyzed during this study are included in the manuscript.

ETHICS STATEMENT

This article does not contain any studies with human participants or animals performed by any of the authors.

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