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Effectiveness of *Aspergillus* sp.Induced Cocoa Husk Compost on the Growth of Pakcoy (*Brassica rapa* L.) in a Soilless Culture System

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Abstract:*Cocoa cultivation in Indonesia produces cocoa pod huskwaste,which poses a major challenge to the agricultural sector. Cocoa pod husk is rich in nutrients such as a Potassium and Nitrogen, giving it the potential to be used as organic compost. Decomposition which takes a long time in the composting process can be accelerated with the help of the fungus Aspergillus sp. which can produce enzymes to break down the complex compounds contained in cocoa husk into simple compounds that are easily absorbed by plants. The aim of this research was to study the effect of adding cocoa pod husk compost to induce Aspergillus sp. combined with the Soilless Culture System (SCS) on the growth of pakcoy (Brassica rapa L.) plants and to determine the most optimal composition. This research used a Completely Randomized Design (CRD) with the SCS media used consisting of rice husk compost, worm compost, leaf compost, coconut fiber compost and cocoa pod husk compost. There are four media composition treatments, namely P1 (2:1:2:1:2), P2 (2:1:2:1:3), P3 (2:1:2:1:4), and P0. (2:1:2:1:0) with 6 repetitions. The parameters observed included leaf area, number of leaves, leaf chlorophyll content, shoot-root ratio, wet weight and dry weight of the plant. The results showed that the addition of solid compost from cocoa pod shells induced Aspergillus sp. (BIOGGP 3) was able to increase the vegetative growth of pakcoy plants with the best composition P2 (2:1:2:1:3) and was significantly different from P0 (2:1:2:1:0).*

Keywords:*Cocoa pod husk, Aspergillus sp., Soilless Culture System; Pakcoy (Brassica rapa L.).*

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I. INTRODUCTION

Indonesia is one of the largest cocoa producers in the world. This high volume of cocoa production generates a significant amount of cocoa pod husk waste, which presents a major agricultural challenge as it can account for 70–80% of the total fruit weight. Cocoa pod husk compost offers an alternative solution to manage this abundant organic waste. This organic waste is naturally rich in essential macronutrients such as potassium and nitrogen, giving it great potential as an organic fertilizer that can enhance media nutrient availability and increase overall plant productivity(Juradi et al., 2019; Sutrisnawati et al., 2023).The utilization of cocoa pod husks as organic fertilizer has been proven to enhance plant growth and yield; for instance, previous studies reported an increase in eggplant production by up to19.48%(Yulianti & Aburdin, 2020).

Aspergillus sp. is a type of fungus capable of efficiently decomposing complex compounds like cellulose and xylan into simpler molecules. This biological process significantly helps accelerate composting and shortens the production period required to generate stable compost (Irawan et al., 2017). Inoculation with *Aspergillus* sp. not only speeds up the decomposition processbut also improves the structure and availability of nutrients in compost, making it easier for plants to absorb these nutrients. Research by (Harfiani et al., 2024) shows that compost inoculated with *Aspergillus* sp. can increase growth factors such as leaf area and chlorophyll content, thereby improving plant quality and productivity.

The Soilless Culture System (SCS) is an advanced agricultural method that does not utilize natural soil, relying instead on alternative organic growing media such as rice husks, vermicompost, cocopeat, and leaf compost. This method provides high water-use efficiency and supports optimal plant root development. The addition of dried cocoa pod husks and the biological action of *Aspergillus* sp. can enrich the growing medium and promote the growth of pakcoy, making this system highly suitable for sustainable agriculture applications(Aji & Widyawati, 2019;(Shafira et al., 2021).

This research utilizes cocoa pod husk waste decomposed by the cellulolytic fungus *Aspergillus* sp. as a core component of the growing medium. This biological intervention of *Aspergillus* sp. was conducted to accelerate the conversion of complex organic compounds into readily available plant nutrients. Therefore, this study evaluated the effectiveness of various SCS media compositions consisting of rice husks, vermicompost, cocopeat, and leaf compost, supplemented with cocoa pod husk compost, in stimulating the growth parameters of pakcoy plants.

II. EXPERIMENTAL PROCEDURE

This research was conducted from November 2025 to February 2026 at the Botany Laboratory and Microbiology Laboratory, Department of Biology, Faculty of Mathematics and Natural Sciences, University of Lampung. A quantitative method using a Completely Randomized Design (CRD) was adopted. The SCS media consisted of rice husks, vermicompost, cocopeat, leaf compost, and cocoa pod husk compostwith 4 variations in media composition P0 (2:1:2:1:0), P1 (2:1:2:1:2), P2 (2:1:2:1:3), and P3 (2:1:2:1:4). There were 6 repetitions of each treatment, resulting in 24 experimental plots.The obtained data were tested for normality and homogeneity. If the data were normally distributed and homogeneous, they were further subjected to Analysis of Variance (ANOVA). Significantly different treatments were further analyzed using Duncan's Multiple Range Test (DMRT) at a 5% significance level to determine the differences between treatments.

2.1 Purification of *Aspergillus* sp Isolates

Potato Dextrose Agar (PDA) media was prepared by dissolving 5.85 g of PDA powder in 150 ml of distilled water (concentration 39/1000), and heated to a boil. After being transferred to an Erlenmeyer flask, the medium was sterilized in an autoclave at 121°C and 1 atm for 20 minutes. Once the temperature decreased post-sterilization, chloramphenicol was added and homogenized. A total of 10–20 ml of media was poured into a petri dish and left to solidify. Isolate *Aspergillus* sp. inoculated into a cup using a sterile tube needle, then the cup is wrapped in plastic wrap and paper, then stored in an incubator for one week (Qolbi et al., 2024).

2.2 Inoculum Preparation of *Aspergillus* sp.

The fungal inoculum was produced using a modified methodfrom Harfiani et al., (2024). A total of 300 g of corn kernels were placed into a heat-resistant plastic ziplock bag. Then sterilized in an autoclave for 15 minutes. Separately, 4 g of $CaSO4$ and 2 g of $CaCO3$ were added to 100 mL of distilled water; 75 mL of this mixture was added to a plastic ziplock containing sterile corn and homogenized. Inoculated isolates of *Aspergillus* sp. into a plastic ziplock containing corn, then homogenize and close with a stopper. Inoculum of *Aspergillus* sp. Incubate on corn media for 14 days with periodic shaking every 3 days.

2.3 Application of *Aspergillus* sp. Inoculum on Cocoa Pod Husks

The composting process was carried out in perforated baskets lined with cardboard. Organic materials consisting of 20 kg of dried, chopped cocoa pod husks and 10 kg of cattle manure were layered alternately in the basket alongside the addition of 300 g of *Aspergillus* sp. inoculum. The mixture was sprayed with water to attain a 60% moisture content, covered with newspaper, and kept in a shaded area. The compost was turned every 5 days to prevent water accumulation at the bottom.

2.4 Preparation of Media as a Planting Medium for Pakcoy

The soilless culture system planting medium is made using husks, vermicompost, leaf compost, cocopeat, and solid compost from cocoa pod husks that have been induced by the cellulolytic fungus *Aspergillus* sp. in 4 compositional variations.The growing medium for each treatment variation was thoroughly homogenized and placed into polybags measuring 35 cm x 35 cm, with 6 replications per treatment. The sowing process began by soaking the seeds for 2 hours to separate viable seeds from non-viable ones. Subsequently, the seeds were sown in a seedling tray filled with cocopeat, watered using a hand sprayer, and placed in an area sheltered from direct sunlight.After 7 days of age, marked by the growth of 2-4 leaves and being free from disease, the pakcoy seedlings are transferred to polybags containing Soilless Culture System media and maintained by watering every morning and afternoon, and replanted if any plants die(Siregar et al., 2023).

III. RESULTS AND DISCUSSIONS

3.1. Number of Leaves

The effect of cocoa hull compost on *Aspergillus* sp. (BIOGGP 3) on the number of leaves of pakcoy plants (*Brassica rapa* L.) in Soilles Culture System media.

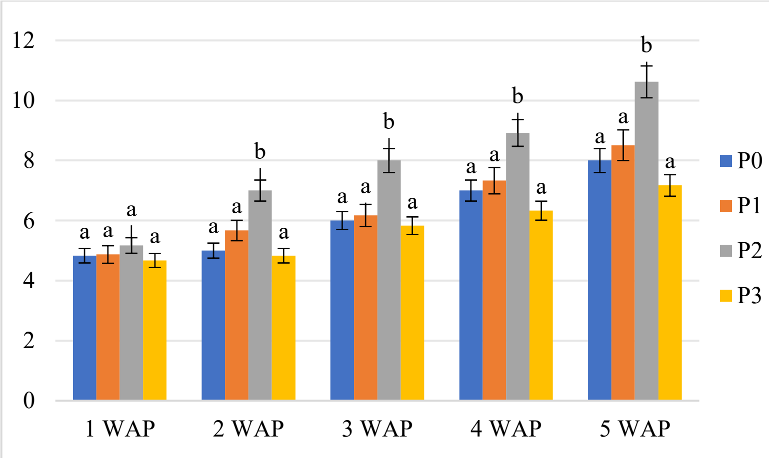

Figure1. Response of the number of pakcoy leaves to cocoa pod husk compost inoculated with Aspergillus sp.

Figure 1 shows the growth pattern in the number of leaves of pakcoy plants from week 1 to week 5. There was an increase with the highest number of leaves in week 5 being P2. These optimal results are obtained because this composition can provide ideal pore space and a stable nutrient supply for plants. Manurung et al. (2020) stated that cocoa pod husk compost induced by *Aspergillus* sp contains the elements Nitrogen (N), Phosphate (P), and Potassium (K). Nitrogen plays an important role as the main constituent of chlorophyll and an enzyme protein that regulates cell division in the apical medulla for the formation of leaf primordia. The role of *Aspergillus* sp. in SCS media is to accelerate the mineralization of complex organic materials through the secretion of phosphatase and cellulase enzymes, so that macronutrients are available more quickly to plants (Alribowo et al., 2016). SCS media supplemented with solid cocoa pod husk compost accelerates the release of complex organic nutrients into forms that are more easily absorbed by plants. This statement is supported by Nurmayanti et al., (2025)who confirmed that cocoa pod husks contain essential macronutrients.

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3.2 Leaf Area

The effect of cocoa pod husk compost inoculated with *Aspergillus* sp. (BIOGGP 3) on the leaf area ofpakcoy plantson Soilles Culture System media.

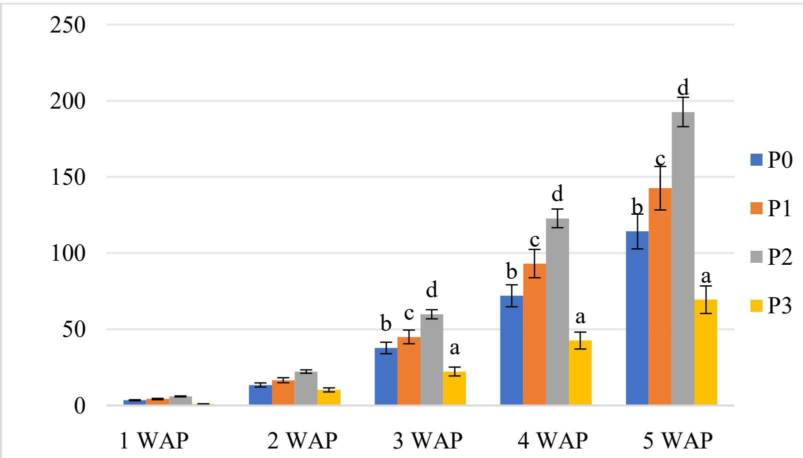
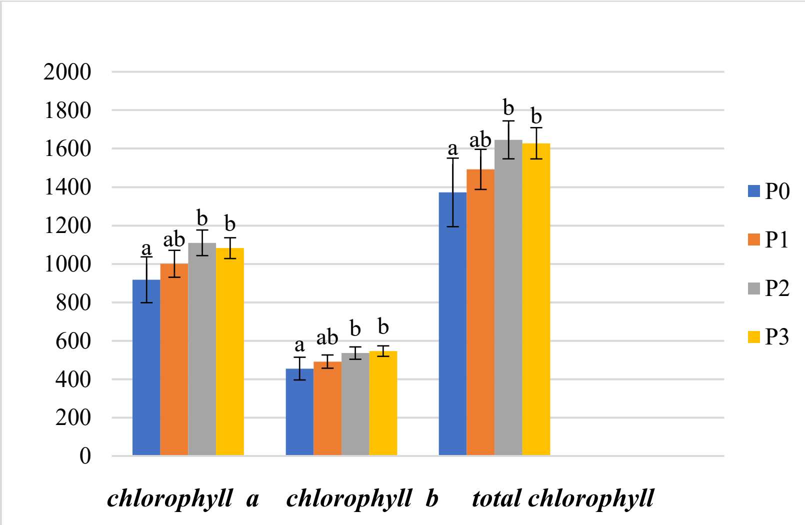


Figure2. Response of pakcoy plant leaf area to the influence of compost cocoa skin induced by Aspergillus sp.

Figure 2 illustrates the growth pattern of pakcoy plant leaf area from 1 WAP to 5 WAP. There was an increase with the highest leaf area in the 5th week being P2. These result are thought to be because cocoa pod husk compost can provide the elements Nitrogen (N), Phosphate (P), and Potassium (K) synergistically. Phosphate and potassium stimulate cell enlargement in expanding leaf tissues, thereby increasing overall leaf size(Farisi et al., 2025). Cocoa pod husk compost contains high levels of potassium, which functions in regulating cell turgor and stomatal opening, allowing the assimilation process to run more effectively and accelerating leaf area expansion. The cocoa pod husk compost used in SCS media is capable accelerate the release of nutrients from complex organic materials to in a form available to plants.

3.3 Chlorophyll A, Chlorophyll B And Total Chlorophyll

Effect of *Aspergillus* induced cocoa pod husk compost sp. (BIOGGP 3) on Soilles Culture System media on chlorophyll a, chlorophyll b and total chlorophyll levels of plant leaves pakcoy.



Figur 3. Chlorophyll a, chlorophyll b and total chlorophyll levels of pakcoy plants under the influence of induced cocoa pod husk compost Aspergillus sp.

Figure 3 shows that the increased plant growth and productivity were likely driven by an optimal supply of phosphorus (P) for cell division, potassium (K) as a driver of respiratory enzymes, and nitrogen (N) which increases leaf chlorophyll concentration. The availability of balanced nutrients makes it easier for plants to maximize the biosynthesis of photosynthetic pigments to increase the efficiency of light energy absorption(Yama & Kartiko, 2020).Nitrogen functions as a key element in the synthesis of proteins and organic compounds, while magnesium (Mg) acts as an activator of photofunctional enzymes. An abundance of macronutrients essential for chlorophyll formation was successfully provided in a balanced manner through the SCS media in treatment P2, driven by the effective decomposition by functional microbes (*Aspergillus* sp.) in the cocoa pod husk compost, resulting in the highest average values in this study(Farisi et al., 2025).

3.4 Shoot-Root Ratio

The root-shoot ratioof pakcoy plants is influenced cocoa by solid compost of cocoa pod husks induced by *Aspergillus* sp. (BIOGGP 3) in the media Soilles Culture System.

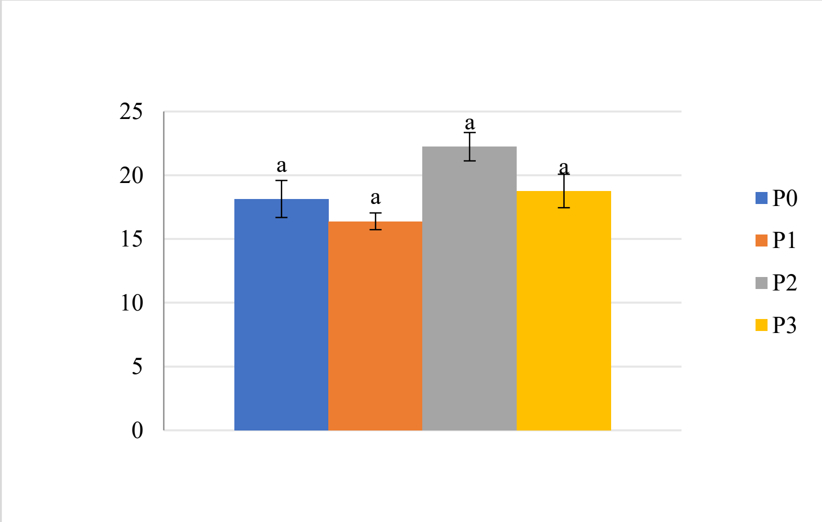


Figure4. Root crown ratio of deep pakcoy plants effect of cocoa husk compost induced by Aspergillus sp.

Figure 4 shows that the dry root-shoot ratio was highest in treatment P2. The increase in the shoot ratio at this dose is likely because the plants allocated more energy toward leaf growth, meaning that a larger portion of photosynthetic organic matter was translocated to the shoots rather than the roots. Nova et al., (2020)stated that the wet weight of the canopy is influenced by root water absorption. Polnaya & Lesilolo, (2012)also stated that the high canopy ratio was due to the allocation of photosynthate to a larger canopy. Baehaki et al., (2019)added that the increase in dry weight was in line with the addition of compost, indicating that more nutrients were available from the decomposition of *Aspergillus* sp., which increased photosynthate translocation throughout the plant.

3.5 Wet Weight and Dry Weight of Pakcoy Plants

The effect of cocoa hull compost on *Aspergillus* sp. (BIOGGP 3) on Soilles Culture System media on the wet weight and dry weight of pakcoy plants.

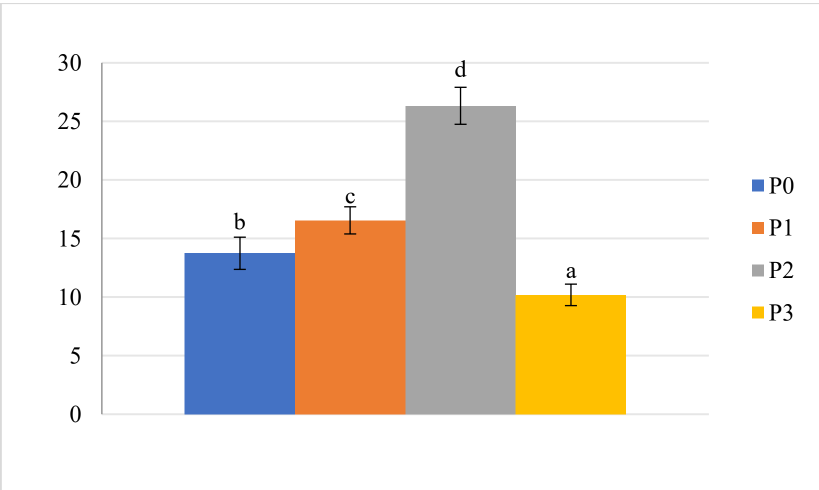


Figure 5. Influence cocoa hull compost induced by Aspergillus sp. on the wet weight of pakcoy plants.

Figure 5 shows the pattern of wet weight of pakcoy plants under treatment P2 was significantly different from treatments P1 and P3. As observed in the graph, treatment P2 exhibited the highest values among all treatments. It is suggested that plant wet weight is strongly influenced by water and nutrient uptake via the root system.In line with the statement of Diantari et al., (2023)that roots are an important organ for absorption nutrients in the planting medium. The nutrients contained in Planting media affects the performance of roots to meet nutrients plants thereby increasing plant growth.

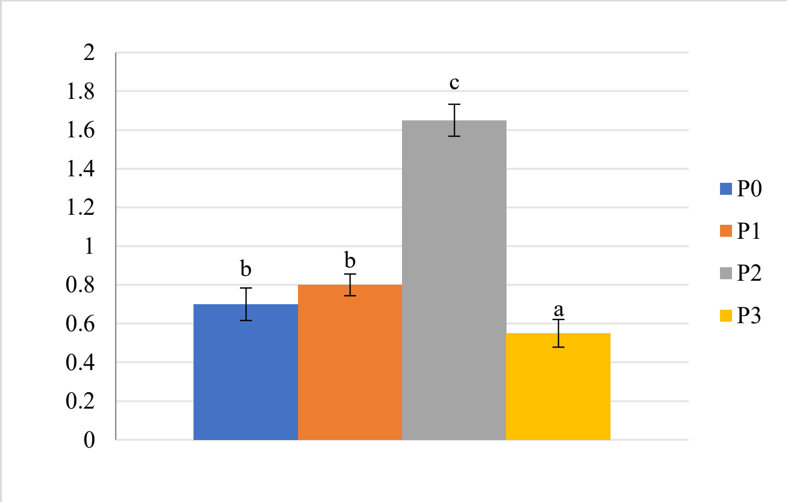


Figure 6. Influence cocoa hull compost induced by Aspergillus sp. on the dry weight of pakcoy plants

Figure 6 shows that the dry weight of pakcoy plants under treatment P2 was significantly different from treatments P1 and P3. As shown in the graph, treatment P2 achieved the highest dry weight compared to P1 and P3. The dry weight of the plant will increase substantially if variables such as canopy height, leaf number, and shoot fresh weight exhibit high values. Dry weight is indicative successful plant growth, due to dry weight shows the net result of plant metabolism such as photosynthesis(Sarif et al., 2015). High and low plant dry matter depending on how little nutrient uptake occurs in the growth process.

IV. CONCLUSION

The addition of solid cocoa pod husk compost induced *Aspergillus* sp. (BIOGGP 3) into the Soilless Culture System (SCS) media with composition P2 (2:1:2:1:3) was proven to be significantly effective in increasing various pakcoy growth parameters consisting of number of leaves, leaf area, increasing levels of chlorophyll a, chlorophyll b and total chlorophyll, root shoot ratio and increasing wet weight and dry weight of plants.

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