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Evaluation of Oil Palm Empty Fruit Bunch Compost Application on Samhong Mustard (*Brassica juncea* L.) Cultivation in Polybags

Nur Rizha Adi Kumara[1], Ade Sumiahadi[1]*

[1] Department of Agrotechnology, Faculty of Agriculture, Universitas Muhammadiyah Jakarta, Jakarta, Indonesia

*Correspondence E-mail: ade.sumiahadi@umj.ac.id

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ABSTRACT

Background: Samhong is a mustard variety that is becoming increasingly popular in Indonesia. To increase its production, appropriate cultivation technologies are necessary, such as enriching the growing medium with organic matter. One organic material that can be utilized is compost made from oil palm empty fruit bunches (OPEFB). OPEFB is the solid waste remaining after oil has been extracted from the flesh (mesocarp) and kernel (endocarp) of fresh oil palm fruits.
Aims & Methods: This study aimed to evaluate the effects of different OPEFB compost dosages on the growth and yield of samhong mustard plants. The research was conducted from March to May 2023 at the Experimental Field of the Faculty of Agriculture, Universitas Muhammadiyah Jakarta. The study utilized a Randomized Complete Block Design (RCBD) with five treatment levels, consisting of a control group using inorganic NPK fertilizer and four different doses of OPEFB compost (25, 50, 75, and 100 g/plant).
Result: The results of this study indicate that, in general, all OPEFB compost applications resulted in lower growth and yield compared to the NPK control. However, a positive trend was observed where higher compost doses led to improved plant growth. Furthermore, correlation analysis revealed a strong to very strong positive correlation between OPEFB compost dose and the growth of above-ground parts and yield of the plants. This study indicated that OPEFB compost has potential to be used as organic fertilizer with higher doses.

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1. Introduction

Mustard greens (*Brassica juncea*) are a vegetable widely favored by the Indonesian population. This plant originates from China and East Asia. It has been cultivated for approximately 2,500 years in China and later spread to the Philippines and Taiwan. Mustard greens were introduced to Indonesia in the 11th century along with the trade of other subtropical vegetables. The main centers of mustard green cultivation in Indonesia are Cipanas, Lembang, and Pangalengan (Rukmana, 2007). Samhong mustard is a specific type of mustard green that has gained popularity in Indonesia recently.

According to the Central Bureau of Statistics (BPS, 2020), the production of mustard green vegetables in West Java declined between 2017 and 2019. In 2017, production reached 216,174 tons; in 2018, it dropped to 201,004 tons; and in 2019, it further decreased to 179,925 tons. This represents a 10.48% decline from 2018 to 2019. The decline in production is attributed to the reduced functionality of soil in providing nutrients and retaining water, primarily due to land degradation caused by the continuous use of inorganic fertilizers. Cholisoh *et al.* (2018) emphasized that the long-term use of inorganic fertilizers can have a negative impact on the physical, chemical, and biological properties of the soil.

One strategy to improve mustard green production is the application of appropriate cultivation technology, such as the addition of organic matter to the growing media. This can be achieved through the use of organic fertilizers, one of which is compost. Compost is beneficial because it supplies both macro and micronutrients, enhances soil structure, improves texture, increases porosity and aeration, promotes microbial activity, enhances water-holding capacity, and supports root development. One potential source of compostable organic material for farmers is oil palm empty fruit bunches (OPEFB) of oil palm. Indonesia is the world's largest producer of palm oil, with the plantation area and production volume increasing annually (Ichriani *et al.,* 2016).

EFB is a solid waste byproduct resulting from the extraction of mesocarp (pulp) and endocarp (kernel) oil from fresh oil palm fruit. EFB constitutes approximately 21–23% of the total fresh fruit bunch mass (Pratiwi & Ardiansyah, 2019). Each ton of OPEFB contains approximately 1.5% nitrogen (N), 0.5% phosphorus (P), 7.3% potassium (K), and 0.9% magnesium (Mg) (Sarwono, 2008). Laboratory analysis by Hatta & Permana (2014) showed that composted OPEFB contains 2.24% N, 3.4% P_2O_5, 1.30% K_2O, 0.11% MgO, 0.93% CaO, and 141.4 ppm Mn. These nutrients play a crucial role in plant growth and development. Based on this, EFB holds great potential as a raw material for organic fertilizer production, not only adding economic value but also helping to reduce environmental pollution.

Sulaeman & Nurjasmani (2017) reported that the application of OPEFB compost significantly affected the growth and yield of pakcoy plants. Specifically, the application of 100 g OPEFB compost per plant significantly enhanced growth and production. The use of EFB compost is expected to improve soil fertility and support the growth and yield of mustard greens.

The objective of this study is to evaluate the effect of OPEFB compost application rates on the growth and yield of mustard greens.

2. Methods

This research was conducted from March to May 2023 at the experimental field of Universitas Muhammadiyah Jakarta, located at an elevation of 25 meters above sea level. The materials and equipment used in this study included Samhong mustard seeds of the San Feng variety, NPK Mutiara 16-16-16 fertilizer, oil palm empty fruit bunch (OPEFB) compost, polybags measuring 35 cm × 35 cm, soil, rice husks, pesticides, germination trays, a digital scale, and other standard tools commonly used in crop cultivation practices.

This study used a Randomized Complete Block Design (RCBD) with five levels of EFB compost dosage: NPK fertilizer (1.5 g/polybag) as the control, and four other compost doses of 25, 50, 75, and 100 g/polybag. Each treatment level was replicated five times, resulting in a total of 25 experimental units. Each experimental unit consisted of three plant samples, so a total of 75 plants were analyzed. The data were analyzed using Analysis of Variance (ANOVA) to determine the effect of treatments. When significant differences were found, the analysis was followed by Honestly Significant Difference (HSD) test at the 5% significance level. Correlation analysis was also conducted to assess the strength of the relationship between EFB compost application and the growth and yield parameters of Samhong mustard.

The growing medium used in this experiment was a mixture of soil and raw rice husk in a 2:1 ratio. The medium was placed into polybags measuring 35 cm × 35 cm, with each polybag containing 5 kg of the mixture. The growing medium was prepared one week prior to transplanting. The mustard variety used in this study was Samhong mustard (San Feng variety). Seeds were soaked in water for 15 minutes, then sown in germination trays at a rate of 2–3 seeds per hole. The trays were watered every morning and afternoon and kept in a shaded area, away from direct sunlight. Seedlings were transplanted 2 weeks after sowing (WAS), with one seedling planted per polybag.

The application of OPEFB compost was carried out during the preparation of the growing medium, which took place one week before transplanting. The compost was evenly spread and mixed with the soil according to the dosage of each treatment (Herlina *et al.,* 2015). The inorganic fertilizer used in this study was NPK Mutiara 16:16:16 at a rate of 1.5 g/polybag for the control treatment (Ansyahri, 2021). Watering was done twice daily, in the morning and afternoon. Pest control was carried out using a chemical pesticide at a concentration of 1 mL per liter of water when the plants were 3 weeks after transplanting (3 WAT).

3. Results

3.1 Effects of OPEFB compost doses on the growth of samhong mustard plants

The results of the analysis of variance (ANOVA) showed that the application of OPEFB compost had a significant effect on plant height, number of leaves, leaf length, leaf width, and root weight, but had no significant effect on root length. Tables 1 and 2 show that the control treatment produced the highest values across all observed parameters. However, for the variables of plant height, leaf length, and leaf width, the highest compost dose (100 g/polybag) resulted in values that were not significantly different from the control. For the number of leaves and root weight, all OPEFB compost treatments showed significantly lower results compared to the control. Meanwhile, for root length, none of the treatments showed any significant difference.

Table 1. Effects of OPEFB Compost on Plant Height, Number of Leaves, Leaf Length, and Leaf Width of Samhong mustard (San Feng Variety)

Treatment	Plant Height (cm)	Number of Leaves	Leaf Length (cm)	Leaf Width (cm)
Inorganic NPK fertilizer (control)	25.05b	11.67b	23.24c	13.59d
25 g/polybag of OPEFB compost	16.88a	7.73a	15.62a	8.41a
50 g/polybag of OPEFB Pcompost	20.08a	8.70a	17.70ab	10.08ab
75 g/polybag of OPEFB compost	19.57a	8.57a	18.28ab	11.44bc
100 g/polybag of OPEFB compost	23.70b	8.90a	20.22bc	12.57cd

Note: Numbers followed by the same letters in the same column are not significantly different according to Tukey test at 5% significance level

These results indicate that, in general, the application of OPEFB compost at doses ranging from 25 to 100 g/polybag was not sufficient to support the optimal growth of Samhong mustard plants. The highest dose of OPEFB compost used in this study (100 g/polybag) only showed better effects on plant height, leaf length, and leaf width. The control treatment, which used inorganic NPK 16:16:16 fertilizer, produced the highest results due to its high macronutrient content—approximately 16% each of nitrogen

(N), phosphorus (P), and potassium (K). In comparison, OPEFB compost contains only 2.24–6.79% N, 3.13–3.40% P_2O_5, and 1.30–8.33% K_2O (Hatta & Permana, 2014; Toiby *et al.,* 2015).

Normal plant growth requires specific nutrients in optimal amounts and balanced concentrations. According to Perwitasari *et al.* (2012), nutrient availability significantly affects the rate of growth and development of leaves, stems, and roots. The quantity and composition of nutrients provided to the plant directly influence its growth performance.

Vegetable crops require relatively high amounts of N, P, and K. A deficiency in any of these macronutrients can inhibit plant development (Firmansyah *et al.,* 2017). Sufficient availability of especially nitrogen (N) during the vegetative growth stage promotes active photosynthesis, which supports cell division, elongation, and differentiation. A high nitrogen (N) content can stimulate an increase in both the number of leaves and the height of lettuce plants. Nitrogen plays an essential role in promoting plant growth and enhancing leaf greenness. It is more abundant in young plant tissues than in older ones, with the highest accumulation found in leaves and seeds (Mas'ud, 2009).

Leaf development is part of the vegetative growth phase and is strongly influenced by the availability of macronutrients such as N, P, and K. The presence of adequate macro- and micronutrients supports the formation of leaves. Adequate and balanced nutrient availability supports optimal plant metabolic processes (Hidayat, 2019). N, P, and K are essential for the synthesis of proteins, carbohydrates, and amino acids. Amino acids, as the building blocks of cell growth and development, play a key role in cell division, enlargement, elongation, and differentiation. As a result, plants are able to produce new tillers, leaves, flowers, branches, and stems (Hendrika *et al.,* 2017).

Table 2. Effects of OPEFB compost on root length and weight of samhong mustard plants

Treatment	Root Length (cm)	Root Weight (g)
Inorganic NPK fertilizer (control)	19.74a	7.38b
25 g/polybag of OPEFB compost	17.23a	2.18a
50 g/polybag of OPEFB compost	16.67a	3.44a
75 g/polybag of OPEFB compost	16.25a	3.78a
100 g/polybag of OPEFB compost	12.78a	2.62a

Note: Numbers followed by the same letters in the same column are not significantly different according to Tukey test at 5% significance level

NPK fertilizer provides readily available and sufficient nutrients in the soil, enabling Samhong mustard roots to grow better and absorb nutrients more efficiently. This is reflected in the data showing that root length and weight in the control treatment were higher than those in the OPEFB compost treatments (Table 2). According to Pahan (2010), root growth and branching can be stimulated when nutrient concentrations in the soil are sufficiently high. Roots are a vital part of plant growth, as they reflect the plant's ability to absorb nutrients. Andiyarto & Purnomo (2012) added that inhibited root growth can lead to poor nutrient uptake from the soil, ultimately resulting in suboptimal plant development.

Several growth parameters showed increasing values with higher doses of compost, such as plant height, leaf length, and leaf width (Table 1). This indicates that OPEFB compost has the potential to enhance the growth of Samhong mjustard when applied at higher doses. Sulaeman & Nurjasmani (2017) reported that OPEFB compost significantly improved the growth of Pak coy at application at the dose of 100–166 g/pot. Similarly, Gunawan (2024) found that OPEFB compost could produce comparable results to the inorganic NPK control when applied at rates between 100–150 g/polybag.

3.2. Effects of OPEFB compost doses on the yield of samhong mustard plants

The ANOVA results showed that the application of OPEFB compost had a significant effect on the yield (gross and consumption weights) of Samhong mustard. The data indicated that the control treatment produced the highest yield, which was significantly greater than all doses of OPEFB compost applied (Table 3). These results suggest that compost application up to 100 g/polybag was not sufficient to match the effect of inorganic NPK fertilizer. This indicates that OPEFB compost was unable to supply adequate nutrients to achieve optimal crop production. Gross weight and consumption weight are influenced by the availability of essential nutrients in the soil that can be effectively absorbed by the roots. This is in line with the statement by Rahma et al. (2014), who noted that nutrient availability plays a critical role as an energy source, and that nutrient sufficiency levels affect the biomass production of a plant.

Table 3. Effects of OPEFB compost on gross and consumption weights of samhong mustard plants

Treatment	Gross Weight (g)	Consumption Weight (g)
Inorganic NPK fertilizer (control)	109.60b	93.01b
25 g/polybag of OPEFB compost	29.55a	22.27a
50 g/polybag of OPEFB compost	46.60a	37.38a
75 g/polybag of OPEFB compost	44.59a	37.09a
100 g/polybag of OPEFB compost	41.50a	34.32a

Note: Numbers followed by the same letters in the same column are not significantly different according to Tukey test at 5% significance level

An increase in leaf and root growth theoretically leads to a linear increase in both gross and consumable plant weight. Moreover, in vegetable crops, leaves are organs that contain a high amount of water. Therefore, a greater number of leaves contributes to higher plant water content, which in turn increases the fresh weight of the plant (Polii, 2009). NPK fertilizer is an inorganic fertilizer containing essential macronutrients required by plants, which support various growth and developmental processes. This is because NPK fertilizer supplies nitrogen (N), phosphorus (P), and potassium (K), which are generally needed by plants and help maintain nutrient balance necessary for optimal growth and yield (Marseta, 2021). A deficiency in these nutrients can inhibit plant growth and directly affect crop productivity (Leiwakabessy & Sutandi, 2004).

OPEFB compost holds potential for use as fertilizer in crop cultivation when it is applied in sufficient quantities. According to Sumartoyo (2017), OPEFB compost is an organic fertilizer that can improve soil water-holding capacity, enhance soil aggregation and granulation, increase soil porosity, raise the cation exchange capacity (CEC), reduce nutrient leaching, and enhance microbial activity as well as the availability of nutrients such as N, P, K, C, Mg, and S. Subagio *et al.* (2018) further noted that OPEFB compost improves soil fertility at all plant growth stages by increasing organic carbon, pH, CEC, total P, and total N, thereby effectively supporting plant growth.

The results of this study also highlight the importance of adjusting the dose, method, and timing of OPEFB compost application based on the specific crop. Safitri *et al.* (2013) reported that the optimal application rate of OPEFB compost for maize was between 656–1257 g/polybag (equivalent to 12–16% of the total growing medium). Santi *et al.* (2018) similarly found that the most effective dose for radish was around 10–25% of the total growing media weight. In contrast, this study applied a maximum of only 100 g of compost per 5 kg of growing medium per polybag—equivalent to just 2% of the total medium used.

The nutrient requirements of larger and longer-lived crops are also naturally greater. As reported by Habibah *et al.* (2022), the application of OPEFB compost at 225 g/polybag with a two-day application interval significantly increased the height and fresh root weight of oil palm seedlings. Earlier research by Satria *et al.* (2015) also recommended using OPEFB compost as part of the growing medium for agarwood seedlings, with a compost ratio of one-third to two-thirds of the total growing medium volume.

3.3 The Relationship Between OPEFB Compost Dosage and the Growth and Yield of Samhong Mustard

The relationship between OPEFB-compost dosage and the growth and yield of Samhong mustard was quantified through correlation coefficients (r) calculated between compost dose and each growth or yield variable. These coefficients clarify how increases in compost dosage affect crop performance. The analysis showed very strong positive correlations between compost dose and the growth variables plant height (r = 0.920), leaf number (r = 0.869), leaf length (r = 0.984), and leaf width (r = 0.999). The dosage of OPEFB compost also showed a strong positive correlation with the yield variables (gross weight and consumable weight) of Samhong mustard, with correlation coefficients (r) of 0.610 and 0.683, respectively (Table 4). These results confirm that increasing the rate of OPEFB compost (within the dosage range tested) significantly enhances plant height, leaf number, leaf size, gross weight, and consumable weight of Samhong mustard.

Table 4. Correlation coefficients (r) between dose of OPEFB compost and the growth and yiled variables of samhong mustard plants

Variables	Plant Height	Number of Leaves	Leaf Length	Leaf Width	Root Length	Root Weight	Gross Weight	Consumption Weight
Dose of OPEFB Compost	0.920	0.869	0.984	0.999	-0.870	0.330	0.610	0.683

Note: r < ±0.20 = very week; ±0.02-0.39 = week; ±0.40-0.59 = moderate; ±0.60-0.79 = strong; > ±0.80 = very strong; ±1 = perfect (Papageorgiou, 2022)

Based on these findings, OPEFB compost has the potential to be used as an alternative organic fertilizer in crop cultivation. However, further research is needed to determine the optimal dosage. Kamsurya & Botanri (2022) stated that organic matter plays a significant role in improving the physical, chemical, and biological properties of soil. It can enhance soil aeration, root penetration, water retention, and reduce surface runoff. The application of organic materials also contributes to improved soil fertility by gradually releasing nitrogen and other essential nutrients through the process of mineralization. Moreover, as a source of energy for soil microorganisms, organic matter can stimulate the release of enzymes that increase the availability of nutrients in the soil.

The dosage of OPEFB compost showed a very strong negative correlation with root length, but a weak positive correlation with root weight. This suggests that increasing the compost dosage within a certain range tends to reduce root length without significantly affecting root weight (Table 4). These results indicate that Samhong mustard plants may develop similar root biomass but exhibit reduced root length with increasing doses of OPEFB compost. The reduction in root length at higher compost doses is likely due to the increased availability of nutrients in the growing medium. Roots tend to elongate when nutrient availability is limited, in an effort to explore the soil for nutrients. Lopez-Bucio *et al.* (2003) reported that limited phosphorus availability stimulates elongation of both primary and lateral roots, while nitrogen deficiency promotes lateral root elongation. Bell & Egon (2024) further confirmed that plants grown in nutrient-deficient soils exhibit significantly longer and deeper root systems compared to those grown in nutrient-rich soils.

4. Conclusions

The application of OPEFB compost had a significant effect on nearly all observed growth and yield parameters, except for root length. At a dosage of 100 g/polybag, OPEFB compost produced plant height, leaf length, and leaf width that were statistically similar to those of the control treatment. However, for other parameters, none of the compost doses applied were able to match the effects of the inorganic fertilizer (control). Furthermore, correlation analysis indicated that increasing the dose of OPEFB compost has the potential to improve plant height, leaf number, leaf length, leaf width, gross weight, and consumable weight of Samhong mustard, as reflected by strong to very strong positive correlations.

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6. Authors Note

The authors declare that there is no conflict of interest regarding the publication of this article. Authors confirmed that the paper was free of plagiarism.

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