



## Effects of oil palm empty fruit bunches compost on eggplant (*Solanum melongena*) growth and yield in ultisols

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### Abstract

Continuous use of synthetic fertilizers on agricultural land reduces soil fertility, resulting in lower land production. Organic substances, such as cow manure and empty oil palm fruit bunches, can improve soil fertility and enhance plant development and productivity. The objective of the study was to determine the most suitable organic fertilizer dose and type for the growth and yield of purple eggplant (*Solanum melongena*, L.) in Ultisols. The research was conducted in Kandang Limun Village, Muara Bangkahulu District, Bengkulu City, Indonesia, using a Completely Randomized Design (CRD). Treatments consisted of  $P_0$  = no organic fertilizer,  $P_1$  = cow manure 5 ton/ha,  $P_2$  = cow manure 10 ton/ha,  $P_3$  = cow manure 15 ton/ha,  $P_4$  = Oil Palm Empty Fruit Bunches Compost (EFB) 5 tons/ha,  $P_5$  = EFB 10 tons /ha,  $P_6$  = EFB 15 tonnes/ha. Each treatment was repeated thrice, resulting in 21 experimental units, each experimental unit with three plants. The observational findings were statistically analyzed with Analysis of Variance (ANOVA) at a 5% significance level. Treatment means were separated using DMRT (*Duncan Multiple Range Test*) at 5%. The results showed that the application of EFB 5 tons/ha resulted in higher plant fresh weight and dry weight compared to other treatments. In comparison, the EFB application of 10 tons/ha produced fruit weight per plant of 1207 g, higher than other treatments.

**Keywords:** *Solanum melongena*, agricultural, productivity, CRD

### Introduction

Purple eggplant (*Solanum melongena* L.) production in Indonesia increased in 2019 compared to 2018 and 2017. Consumption of eggplant increased in line with production, as did growing populations and an awareness of the health benefits of vegetables. According to Ministry of Agriculture data, the per capita availability of eggplant has decreased. In 2014, the availability of eggplant per capita was 2.13 kg, but by 2018, it had dropped to 1.99 kg (Setjen Pertanian, 2020)<sup>[21]</sup>. One of the reasons for the decrease in eggplant availability on the market is a decrease in the availability of fertile land for eggplant production.

One of the current agricultural issues in Indonesia is a scarcity of fertile land due to land conversion. In Indonesia, 100,000 hectares of land are converted annually, where Java accounts for 80% of the total. Previous agriculture land was converted into transportation, housing, manufacturing, and offices (Nurelawati *et al.*, 2018)<sup>[15]</sup>. On the other hand, land productivity decline is due partially to decreased soil fertility, impacted from excessive use of synthetic fertilizers and long-term pesticide use (Soekamto & Fahrizal, 2019)<sup>[22]</sup>. To improve low soil fertility, the additions of organic materials such as manure and compost and natural non-organic soil amendments including agricultural lime or zeolite are being used. These soil amendment products can improve the soil's physical, chemical, and biological qualities.

Manure applied at a rate of 5 tons per hectare mixed with 0.3 tons of zeolite per hectare could enhance soil physical qualities more effectively than a single treatment (Dariah *et al.*, 2015)<sup>[3]</sup>. According to Du *et al.* (2020)<sup>[5]</sup>, the effect of organic fertilizers is becoming more apparent in acidic soils

and humid regions. Organic fertilizers may increase soil pH by 3.3%, soil carbon = 17.7%, total N = 15.5% and available N = 16.0%, available P = 66.2%, K exchanged = 19.1%, urease enzyme activity = 23.5%, sucrase = 18.3%, and catalase = 16.1%, and bacteria = 60.0%, fungi = 27.7%, and actinomycetes = 38.0%. Long-term application of organic fertilizer combined with synthetic N fertilizer not only improves the physical and chemical characteristics of the soil but also increases the composition of the microbial population in the soil (Liu *et al.*, 2020)<sup>[11]</sup>.

Cow manure can increase the growth and yield of eggplant because of its contribution to providing nutrients. Cow manure contains C = 23.99%, N = 1.95%, P = 0.64%, K = 2.45%, C/N = 13.00 and pH = 7.24 (Maghfoer, 2018)<sup>[12]</sup>. Sriyanto *et al.* (2015)<sup>[23]</sup> discovered that 15 tons/ha of cow manure increased eggplant height 15 - 45 days after planting, as well as fruit number, weight, length, and diameter. Cow manure combined with 150 kg/ha N synthetic fertilizer increased plant height, number of leaves, fruit weight, fruit diameter, and eggplant fruit length (Waskito *et al.*, 2018)<sup>[25]</sup>.

Another type of organic fertilizer is oil palm empty fruit bunches compost. Oil palm empty fruit bunches (EFB) are the fibrous material left over after extracting palm oil from oil palm fruit bunches. Composting EFB is an environmentally friendly technique to handle this waste and convert it into a valuable soil conditioner and organic fertilizer. EFB compost is rich in organic matter and high in nutrients like as nitrogen, phosphorus, and potassium. It also enhances soil structure and water retention.

Yunindanova *et al.* (2013)<sup>[27]</sup> discovered that empty oil palm bunches have the following components in their

chemical composition, i.e., cellulose = 45.95%, hemicellulose = 22.84%, lignin = 16.49%, oil = 2.41%, ash = 1.23%, N = 1.34%, P = 0.08%, Mg = 0.25%, and K = 1.38%. Palm oil solid waste was reported to increase Ca content and not increase heavy metal levels in eggplant (Embrandiri *et al.*, 2016)<sup>[7]</sup>. According to Sumitro *et al.* (2018)<sup>[24]</sup>, palm oil solid waste compost and organic NPK fertilizer substantially influence plant height, quantity of fruits, and weight of eggplant. The research aims to determine the appropriate type and dosage of organic fertilizer for the growth and yield of eggplant.

## Methodology

### Research site and design

The research was carried out from August to November 2020 in Kandang Limun Village, Muara Bangkahulu District, Bengkulu City, Indonesia, at an altitude of  $\pm 10$  m above sea level. The study employed a Completely Randomized Design (CRD) with a single factor consisting of seven levels: P0 = no organic fertilizer (0 g/polybag), P1 = 5 tonnes/ha, P2 = 10 tonnes/ha, P3 = 15 tonnes/ha cow manure, P4 = 5 tonnes/ha, P5 = 10 tonnes/ha, and P6 = 15 tonnes/ha Oil Palm Empty Fruit Bunches Compost (EFB). All experimental units were repeated three times for a total of 21 experimental units. Each experimental unit comprised three plants.

### Planting medium and soil analysis

Ultisols was air-dried for 7 (seven) days before being ground and sieved through a 2 mm sieve as a planting medium. The soil and burnt husks were then combined with dolomite agricultural lime 1.44 g/polybag in polybags with a capacity of 10 kg and a ratio of 2:1 (v:v). Polybags were set up with a 50 cm  $\times$  50 cm (l  $\times$  w) space between them and incubated for two weeks. The essential fertilizers were urea 100 kg/ha, SP36 50 kg/ha, and KCl 37.5 kg/ha. Organic fertilizer was applied one week before planting by sprinkling it on the planting media and then incorporated with the soil to a depth of 10 cm. Cow manure and EFB were analyzed for organic N, P, K, C- and water content.

### Seedling, Planting and Harvesting

The eggplant utilized in the study was a hybrid named Lezata. Before planting, the seeds were germinated, and the radicles were transferred to a nursery tray, with one seed placed in each hole. The planting medium in the tray as a nursery was a 1:1 (v:v) blend of soil and husk charcoal. After four weeks and five leaves, seedlings were transplanted into the polybag.

Seedlings were transplanted in hole at the center of polybags. A carbofuran of ten granules in each planting hole was applied simultaneously with transplanting to prevent insect infestation. Fertilizer was applied at 50% of the suggested dose during planting, namely 100 kg/ha Urea (1.02 g/plant), 50 kg/ha SP36 (0.63 g/plant), and 37.5 kg/ha KCl (0.28 g/plant) (Firmansyah *et al.*, 2017)<sup>[9]</sup>. Urea fertilizer was applied twice, once at transplanting and the second was one month after transplanting. Watering was done to keep the soil moist, and replanting was done two weeks after transplanting. To control grasshoppers, aphids, leafminers, and green ladybugs, a pesticide with the active ingredient

profenofos 500 g/L, concentration 2 ml/L, and an application frequency of once a week was employed. In addition to spraying insecticides, fungicides with the active ingredient methyl thiophanate 70% were sprayed once a week to suppress fungal infestations. When it rains, spraying fungicide became more intense. Harvesting was carried out five times when the plants were 8, 9, 10, 11, and 12 WAP.

### Observed variables

The vegetative variables measured were plant height, number of leaves, number of branches, flowering time, root and shoot weight. Meanwhile, the generative variables observed were the number of fruit, fruit length, fruit diameter, and fruit weight. There was also an analysis of cow manure and EFB, which included water content, N-P-K nutrient content, and organic C content, as well as climate data, which included rainfall (mm), temperature ( $^{\circ}$ C), light intensity (%), and air humidity (%).

### Data analysis

The data were statistically analyzed using analysis of variance (ANOVA) at a significance level of 5%. Proceed with the DMRT (Duncan Multiple Range Test) analysis if the analysis results show significantly different effects (Gomez & Gomez, 1983)<sup>[10]</sup>.

## Results and discussion

### Research Overview

Rainfall during the research ranged from 114.1 mm/month to 621.6 mm/month, with average temperatures ranging from 26.7  $^{\circ}$ C to 27.2  $^{\circ}$ C and air humidity ranging from 81.9% to 84.6%. The Ultisols analysis revealed that the soil pH was 4.2 (acid), N = 0.2% (low), total P = 7.13 ppm (very high), K = 0.14 me/100 (very low), and organic-C = 2.4% (medium). This analysis shows that the planting media used in this research has low soil fertility. The nutrient content of cow manure is N = 0.84%, P = 0.22%, K = 0.49%, C-organic = 19.09%, and water content = 15.22% while EFB fertilizer contains N = 1.05 %, P = 0.75 %, K = 0.48 %, C-organic = 28.71 %, and water content = 16.65 %. Thus, both cow manure and EFB contain nutrients to increase soil fertility.

At the time of the study, eggplants were growing normally until 2 WAP, when grasshoppers, green ladybugs, aphids, and leaf cutters attacked them. Pest management was done both manually and chemically with an insecticide containing the active ingredient profenofos 500 g/L at a concentration of 2 ml/L, applied once a week. The plants were infested at 8 WAP by the fungus *Cercospora* sp., causing leaf spots and *Phytophthora* sp., leading to fruit rot. Fungal control was accomplished chemically with a fungicide containing the active ingredient Methyl thiophanate 70%, which was applied once a week frequently.

### Variance Analysis

The application of cow manure and EFB significantly affected fresh and dry fruit weight, fruit diameter, and fruit weight. However, it did not significantly affect plant height, flowering time, fruit length, and number (Table 1).

**Table 1:** Varian's analysis of the effect of cow manure and EFB on eggplant growth and yield.

Variable	F-calculated	Coef. Var (%)
Plant height 2 WAP	0.25 <sup>ns</sup>	9.34
Plant height 4 WAP	0.41 <sup>ns</sup>	8.30
Plant height 6 WAP	0.38 <sup>ns</sup>	8.05
Leaves number 2 WAP	0.76 <sup>ns</sup>	17.90
Leaves number 4 WAP	1.14 <sup>ns</sup>	11.93
Leaves number 6 WAP	0.93 <sup>ns</sup>	10.78
Number of branch 2 WAP	1.37 <sup>ns</sup>	15.09
Number of branch 4 WAP	0.72 <sup>ns</sup>	12.27
Number of branch 6 WAP	0.68 <sup>ns</sup>	7.50
Flowering time	1.85 <sup>ns</sup>	1.17
Fruit length	0.57 <sup>ns</sup>	4.43
Fruit diameter	5.06 <sup>*</sup>	0.92
Fruit weight	4.48 <sup>*</sup>	12.45
Number of fruit	1.50 <sup>ns</sup>	13.09
Plant fresh weight	3.88 <sup>*</sup>	13.70
Plant dry weight	4.35 <sup>*</sup>	11.92

**Effect of Organic Fertilizer on Eggplant Growth**

Cow manure or EFB application did not affect plant height, number of leaves, or number of branches. Plant height, number of leaves, and number of branches were not affected significantly due to plant age and the slow decomposition of organic fertilizer (Musnamar, 2003)<sup>[13]</sup>. The delayed decomposition process could create delays in providing appropriate nutrients at the earliest stages of plant growth and competition for nitrogen fertilizer absorption in the soil

between plants, soil organisms, and microorganisms. Optimal plant growth occurs when the plant's nutritional requirements are fulfilled.

Because the organic C content of the soil in this study is relatively moderate (2.4%), adding organic fertilizer with a C-organic standard of at least 15% is thought to improve the soil's physical, chemical, and biological properties. Compost and manure application may increase soil organic C content. C-organic is an organic matter ingredient that aids in the stability of soil aggregates, the improvement of soil structure, the provision of nutrients for microbial activity, and the acceleration of soil infiltration. The addition of organic matter to the soil can increase the stability of soil aggregates, increase cation exchange capacity (CEC), an energy source for biological processes in the soil and as a source of macronutrients for plants (Saidy, 2018; Yunindanova *et al.*, 2013)<sup>[20,27]</sup>.

Vegetative indices of eggplant plant growth include plant height, number of leaves, and number of branches. Plants require nitrogen (N) during the vegetative growth stage. N assists plants grow by promoting vegetative growth and protein synthesis. The role of organic materials in soil fertility includes mineralizing organic materials, which will release nutrients such as N, P, K, Ca, Mg, S, and other micronutrients. Thus, adding organic matter to the soil increases the availability of N for plants. The results of the EFB analysis contain N = 1.05%, cow manure contains N = 0.84% , and N in the soil = 0.2%. Thus, increasing organic matter in the soil will increase plant N uptake.

**Table 2:** Plant height, number of leaves, and number of branches at 2, 4, and 6 weeks after planting (WAP)

Treatments	Plant height (cm) (WAP)			Leaves number (WAP)			Number of branches (WAP)		
	2	4	6	2	4	6	2	4	6
P <sub>0</sub> (no organic fertilizer)	28.81	38.22	53.44	5.78	8.67	11.66	3.11	5.89	7.89
P <sub>1</sub> (cow manure 5 ton/ha)	28.11	37.87	55.59	4.99	7.44	10	3.44	6	8.44
P <sub>2</sub> (cow manure 10 ton/ha)	27.87	36.25	56.02	5.67	8.22	10.66	2.66	5.22	7.89
P <sub>3</sub> (cow manure 15ton/ha)	28.33	36.52	53.42	5	7.77	11.22	3	5.33	7.77
P <sub>4</sub> (EFB 5 ton/ha)	26.98	36.07	52.61	5.55	8	10.88	2.44	5.44	8.33
P <sub>5</sub> (EFB 10 ton/ha)	28.07	35.61	55.62	6.11	9.11	11.88	2.88	5.88	8.33
P <sub>6</sub> (EFB 15 ton/ha)	29.43	38.43	56.77	6.33	8.89	11.66	2.44	6.11	8.44

**Note:** Numbers followed by the same letter in the same column are not significantly different in the 5% DMRT test. EFB: oil palm empty fruit bunches compost

Although organic fertilizer does not affect plant height, the number of leaves, or branches, it significantly impacts the shoot weight. Table 3 demonstrates that the EFB treatment of 10 tons/ha (291.88 g) produced the highest shoot fresh weight, even though it was not significantly different from

the doses of 5 tons/ha (249 g) and 15 tons/ha (252.89 g). On average, EFB produced a higher shoot fresh weight than the non-organic fertilizer treatment (197.44 g) or the cow manure treatment.

**Table 3:** Effect of organic fertilizer on eggplant shoot fresh and dry weight

Treatments	Shoot fresh weight (g)	Shoot dry weight (g)
P <sub>0</sub> (no organic fertilizer)	197.44 b	47.15 c
P <sub>1</sub> (cow manure 5 ton/ha)	196.11 b	46.92 c
P <sub>2</sub> (cow manure 10 ton/ha)	200.66 b	50.13 bc
P <sub>3</sub> (cow manure 15 ton/ha)	227.88 b	55.75 abc
P <sub>4</sub> (EFB 5 ton/ha)	249 ab	59.98 ab
P <sub>5</sub> (EFB 10 ton/ha)	291.88 a	68.04 a
P <sub>6</sub> (EFB 15 ton/ha)	252.89 ab	61.29 ab

According to the findings of this study, EFB application leads to increased shoot fresh and dry weight, compared to cow manure or the control treatment. This is presumed to be due to the effect of EFB compost on nitrogen and water

availability. EFB improves soil's physical, chemical, and biological properties. Soil biological activity accelerates the decomposition of EFBs, leading to nutrients available to plants and enhancing the soil structure. Improving the

soil's physical qualities will increase its water retention capacity. The better the water available to plants, the better the plant growth and water composes around 80-95% of the fresh weight of plants, with the remaining 10-15% comprising organic and inorganic substances.

C-organic content as a constituent of organic matter can increase the soil's ability to hold water during dry periods and absorb water during wet periods, thereby increasing water availability for plants. Water availability aids in transferring photosynthetic products to plant vegetative parts such as stems, leaves, and branches for growth and development. The amount of water absorption by plants is highly dependent on root uptake. In addition to increasing

nutrients, organic material can improve soil structure by rendering aggregates or soil particles larger or able to retain water so that aeration in the soil is smooth and root development can be enhanced (Musnamar, 2003; Dhani *et al.*, 2014).<sup>[13, 4]</sup>

The dry weight of the 10-ton/ha EFB treatment was 68.04 g higher than without organic fertilizer (47.15 g) or cow manure. Shoot dry weight is the product of three processes: assimilate fertilization by photosynthesis, respiration, and organic compound accumulation, which is determined by nutrient availability. Research by Riki *et al.* (2020)<sup>[18]</sup> shows that EFB 10 tons/ha + 40 kg/ha of oil palm waste ash can increase shoot dry weight.

**Table 3:** Effect of cow manure and oil palm empty fruit bunches compost on shoot fresh and dry weight.

Treatments	Shoot fresh weight (g)	Shoot dry weight (g)
P <sub>0</sub> (no organic fertilizer)	197.44 b	47.15 c
P <sub>1</sub> (cow manure 5 ton/ha)	196.11 b	46.92 c
P <sub>2</sub> (cow manure 10 ton/ha)	200.66 b	50.13 bc
P <sub>3</sub> (cow manure 15 ton/ha)	227.88 b	55.75 abc
P <sub>4</sub> (EFB 5 ton/ha)	249 a	59.98 ab
P <sub>5</sub> (EFB 10 ton/ha)	291.88 a	68.04 a
P <sub>6</sub> (EFB 15 ton/ha)	252.89 a	61.29 ab

Application of EFB could increase the fresh and dry weight of eggplant. The fresh and dry weight of eggplant fertilized with EFB 5 tons/ha was greater than that of eggplant fertilized without EFB, and an increase did not follow a rise in EFB dose in eggplant shoot weight. Conversely, cow manure had no effect on eggplant shoot weight (Table 3).

#### Effect of Organic Fertilizer on the Yield

Cow manure and EFB did not affect flowering time, fruit length, or fruit number. Because of genetic characteristics, the time of flowering is not significantly different. According to Wibowo (2016)<sup>[26]</sup>, plants of the same variety tend to have the same genetic traits. Due to the soil's low P and K content, there were no significant differences between treatments in terms of fruit length and fruit number. Plants require energy during fertilization, so the availability of P

and K nutrients is crucial. P nutrient content in soil = 7.13 % (low), while K nutrient content = 0.14 % (low).

Phosphorus (P) and potassium (K) are essential macronutrients for plant development and growth. P and K play a role in the flower, fruit, and seed formation phase, closely related to assimilation, respiration, and the acceleration of flowering and fruit or seed maturation (Arwani *et al.*, 2013)<sup>[2]</sup>. P also plays a role in pollination and can increase the percentage of flowers that develop into a fruit. In contrast, K facilitates the entry of CO<sub>2</sub> through the stomata, which is necessary for photosynthesis. Photosynthesis products are distributed to all plant organs, including fruit (Ervin *et al.*, 2016)<sup>[8]</sup>. Thus, the lack of P and K elements contributes to the formation of very small to no seeds or fruit.

**Table 4:** Effect of cow manure and oil palm empty fruit bunches compost on the yield.

Treatments	Fruit length (cm)	Fruit diameter (mm)	Fruit number/plant	Fruit weight/plant (g)	Flowering time (DAP)
P <sub>0</sub> (no organic fertilizer)	20.21	30.56 bc	11.33	898.61 b	29.22
P <sub>1</sub> (cow manure 5 ton/ha)	20.70	30.20 c	10.83	933.16 b	28.89
P <sub>2</sub> (cow manure 10 ton/ha)	20.86	30.97 ab	11.77	881.72 b	29.22
P <sub>3</sub> (cow manure 15 ton/ha)	20.9	31.14 a	12.44	1204.83 a	28.78
P <sub>4</sub> (EFB 5 ton/ha)	21.09	30.63 abc	11.89	1112 ab	28.89
P <sub>5</sub> (EFB 10 ton/ha)	21.36	31.13 a	13	1207 a	28.44
P <sub>6</sub> (EFB 15 ton/ha)	20.39	31.17 a	14.22	1264.05 a	28.89

**Note:** Numbers followed by the same letter in the same column are not significantly different in the 5% DMRT test. DAP=days after planting

While not substantially different, an increase in the dose of chicken manure and EFB was followed by an increase in fruit diameter. The 15 ton/ha EFB treatment yielded the largest average fruit diameter, followed by the 15 ton/ha cow manure treatment. This study's fruit diameter is less than that of Sriyanto *et al.* (2015)<sup>[23]</sup>, who found that cow fertilizer at a dose of 15 tons/ha yields eggplant with a fruit diameter of 4.6 cm. Ariani *et al.* (2018)<sup>[1]</sup> discovered that applying 34 tons of EFB per hectare to eggplant resulted in fruit diameters of 8.14 cm. Organic matter in soil might benefit plants by increasing nutrient availability. According to Nursyamsi *et al.* (2007)<sup>[16]</sup>, soil's Cation Exchange

Capacity (CEC) influences potassium availability. Increasing the dose leads to an increase in the CEC of the soil, resulting in soil with a more remarkable ability to bind cations and nutrients that are not readily leached (Rajiman, 2020)<sup>[17]</sup>. This certainly will improve the plant's availability of the K nutrient, resulting in a rise in fruit diameter with each more dose supplied. Fruit weight fertilized with EFB or cow manure at a dose of 15 ton/ha was higher than control treatment or cow manure at doses of 5 and 10 ton/ha.

The treatment of EFB 15 tons/ha and cow manure 15 tons/ha yielded the highest average fruit weight, 1264.02 g

and 1204.83 g, respectively. The role of organic matter can be seen from two perspectives: soil and plant. Weathering organic matter provides N, P, and K to plants in the soil, improves soil structure through aggregation and soil aeration, and enhances soil physical qualities regarding water holding capacity. Furthermore, according to Roidah (2013)<sup>[19]</sup>, organic materials can improve the organic C content of soil, influencing soil qualities to be better physically, chemically, and biologically.

Carbon is a food source for soil microorganisms, so the presence of organic C in the soil will stimulate their activities, increasing soil decomposition as well as reactions that require the assistance of microorganisms, such as P dissolution and N fixation (Nikiyulw *et al.*, 2018)<sup>[14]</sup>. Meanwhile, organic material weathering products contain organic acids that may increase nutrient availability and are readily utilized by plants (Elisabeth *et al.*, 2013)<sup>[6]</sup>. The availability of P and K substantially affects fruit weight by increasing fruit diameter and length.

### Conclusion

The fastest growth rate of purple eggplant plants with a fresh shoot weight of 249 g and a dry shoot weight of 59.98 g was attained by applying 5 tonnes/ha of EFB organic fertilizer. EFB at a dose of 10 tons/ha produced the heaviest fruit at 1,207 g per plant.

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