

Effect of Empty Fruit Bunch Trichocompost on Oil Palm Seedling Quality (*Elaeis guineensis* Jacq.)

Umar Battong^{1*}, Arahman¹, Agus Trikoriantono¹, Kun Rawansari¹, Nabil Hibatullah¹, Nadila Fika Amalya Nurnaini¹, Syahrul Gunawan¹, Sarina¹

¹Department of Agrotechnology, Faculty of Agriculture and Digital Business, Universitas Muhammadiyah Kalimantan Timur, Indonesia

*Corresponding author: ub506@umkt.ac.id

Keywords:

EFB; Nutrients;
Karo; Oil palm;
Trichocompost;
Trichoderma

Submitted:

15-08-2026

Accepted:

24-08-2026

Published:

29-09-2026

ABSTRACT

Large quantities of empty fruit bunches (EFB) are left behind by palm oil mills, and unmanaged accumulation of this residue creates environmental problems. Composting EFB is a sustainable, environmentally sound way to manage it. However, natural decomposition is slow, so a bioactivator such as *Trichoderma* sp. is needed to speed up the process and improve the compost. This research had two objectives: (1) to assess how EFB trichocompost affects seedling growth in the oil palm pre-nursery, and (2) to identify the most effective dose. A single-factor Completely Randomized Design (CRD) was used. EFB trichocompost doses ranged from 0% to 100% in 5% steps (21 levels), each with three replications, in polybags. Statistical software was used to process the data. The work comprised EFB characterization, trichocompost production, preparation of the planting medium, transplanting, maintenance, and measurement of three growth indicators (seedling height, leaf number, and stem-base diameter). The data were subjected to ANOVA followed by the LSD test at $\alpha = 5\%$. All treatments (M1–M21) significantly influenced the three indicators. M13 performed best, giving the highest mean leaf number (7.14), the tallest seedlings (39.20 cm), and the widest stem-base diameter (11.10 mm), whereas M19–M21 gave the poorest results. These results indicate that a medium containing 60% EFB trichocompost (M13) is the best dose for improving overall seedling quality in the pre-nursery stage.

Copyright Authors © 2026 (CC BY-NC-ND 4.0)

1. Introduction

Palm oil plays a strategic role in Indonesia's economy because it contributes significantly to the global supply of vegetable oil (Sumarlin *et al.*, 2024). Yet oil palm processing also yields large amounts of residue, including empty fruit bunches (EFB). EFB is rich in lignocellulose, which makes it resistant to natural breakdown, and if not managed, it can harm the environment. At the same time, demand for organic materials to enrich growing media is rising, especially for raising oil palm seedlings in the pre-nursery stage (Supriatna *et al.*, 2022).

Processing empty fruit bunches (EFB) into compost is an environmentally friendly practice. However, conventional EFB composting processes are often slow and inefficient (Battong *et al.*, 2018). This need drives the search for technological breakthroughs that accelerate decomposition while improving compost quality. One increasingly popular strategy

involves the use of biological agents such as *Trichoderma* spp., which are known to produce lignocellulolytic enzymes and act as bioactivators during the composting process. Compost produced with *Trichoderma* is commonly referred to as trichocompost and offers advantages such as increased nutrient availability and enhanced soil microbial activity (Widiati & Herwati, 2026).

Although interest in using EFB as an organic soil amendment is growing, a systematic literature review of oil palm waste composting shows that rigorous empirical studies of microbially enriched EFB compost formulations are still scarce. This is especially true for dose optimization at the nursery scale (Supriatna *et al.*, 2022). Recent characterization of indigenous *Trichoderma* sp. isolates from oil palm plantations also shows considerable variation in cellulolytic and ligninolytic activity among strains. This underlines the need to evaluate EFB-based trichocompost by strain and by dose before it can be reliably recommended for large-scale seedling production (Rupaedah *et al.*, 2024). Furthermore, *Trichoderma asperellum* inoculation has been reported to markedly improve oil palm seedling growth and photosynthetic performance at defined biomass doses. However, those studies inoculated seedlings directly rather than incorporating the inoculant into a waste-derived growing medium prepared at several compost dose levels (Hutomo *et al.*, 2026). These gaps show the novelty of this study, which examines how EFB trichocompost dose influences the growth and physiological quality of oil palm seedlings in the pre-nursery, an integrated approach not yet fully covered in the literature.

The pre-nursery stage is a crucial phase that largely determines the quality of oil palm seedlings for subsequent growth stages. During this period, seedlings require a fertile, loose, nutrient-rich growing medium. Consequently, developing growing media from organic waste is a vital step toward ensuring successful seedling production. Various organic materials used as growing media are known to contain both macro- and micronutrients capable of improving the soil's chemical and biological properties (Harrison *et al.*, 2023).

Earlier studies suggest that oil palm empty fruit bunch (OPEFB) compost helps raise soil organic matter and supports better plant growth (Nurhadiyah *et al.*, 2022). *Trichoderma* sp. has also been shown to accelerate organic matter breakdown and act as a biological agent that promotes plant growth (Basri *et al.*, 2025). However, research on optimizing EFB trichocompost for nutrient efficiency and seedling quality in the pre-nursery, especially in determining the most effective dose and comparing it with conventional fertilization, remains limited.

For these reasons, it is important to make better use of oil palm empty fruit bunches (OPEFB) as *Trichoderma*-enriched compost to raise seedling quality. The results are expected to offer an innovative solution for oil palm waste management that also supports sustainable seedling production.

2. Methodology

The study took place in Damit Village (RT 03), Paser Belengkong District, Paser Regency, East Kalimantan, Indonesia, from May to July 2026. An experiment was set up to identify the best dose of *Trichoderma*-enriched oil palm empty fruit bunch (EFB) compost (trichocompost) for improving seedling quality in the pre-nursery. A single-factor Completely Randomized Design (CRD) was applied, with EFB trichocompost doses from 0% to 100% in 5% increments (Table 1) and three replications per treatment, giving 63 experimental units.

Table 1. Composition of planting media

NO	Trichocompost		Topsoil	
	(%)	Kg	(%)	Kg
1	0	0.00	100	4.00
2	5	0.20	95	3.80
3	10	0.40	90	3.60
4	15	0.60	85	3.40
5	20	0.80	80	3.20
6	25	1.00	75	3.00
7	30	1.20	70	2.80
8	35	1.40	65	2.60
9	40	1.60	60	2.40
10	45	1.80	55	2.20
11	50	2.00	50	2.00
12	55	2.20	45	1.80
13	60	2.40	40	1.60
14	65	2.60	35	1.40
15	70	2.80	30	1.20
16	75	3.00	25	1.00
17	80	3.20	20	0.80
18	85	3.40	15	0.60
19	90	3.60	10	0.40
20	95	3.80	5	0.20
21	100	4.00	0	0.00

The work proceeded through EFB characterization, trichocompost production, preparation of the planting medium, seedling transplanting, maintenance, and measurement of the growth parameters, namely plant height, leaf number, and stem diameter. The data were processed with ANOVA and then the Least Significant Difference (LSD) test at the 5% level to find the treatment with the best performance.

3. Results and Discussion

3.1 Number of leaves

Analysis of variance (ANOVA) indicated that the treatments strongly influenced the number of leaves of pre-nursery oil palm seedlings ($F = 3.12$; F table 1% = 2.94; $df = 20$), with an overall mean of 6.00 leaves per plant and a coefficient of variation of 7.97%, which points to good experimental precision. Because Replication II of this variable contained a data-recording error in the source data sheet, the analysis and Figure 1 for leaf number are based on Replications I and III only ($n = 2$); plant height and corm diameter, presented in Sections 3.1.2 and 3.1.3, were analyzed using the full three replications.

The LSD test separated the twenty-one treatments into three statistically distinct groups (Figure 1). Nine treatments M13 (7.14 leaves), M12 (6.92), M14 (6.64), M15 (6.58), M11 (6.51), M16 (6.43), M17 (6.31), M2 (6.25), and M8 (6.24) formed the highest-performing group (notation a), each producing 4 - 19% more leaves than the trial mean. A second group of nine treatments (M1, M3-M7, M9, M10, and M18; notation b) did not differ significantly from one

another and clustered around the overall mean. M19, M20, and M21 formed the lowest group (notation c); M21 produced the fewest leaves of all treatments tested (4.94, about 18% below the trial mean).

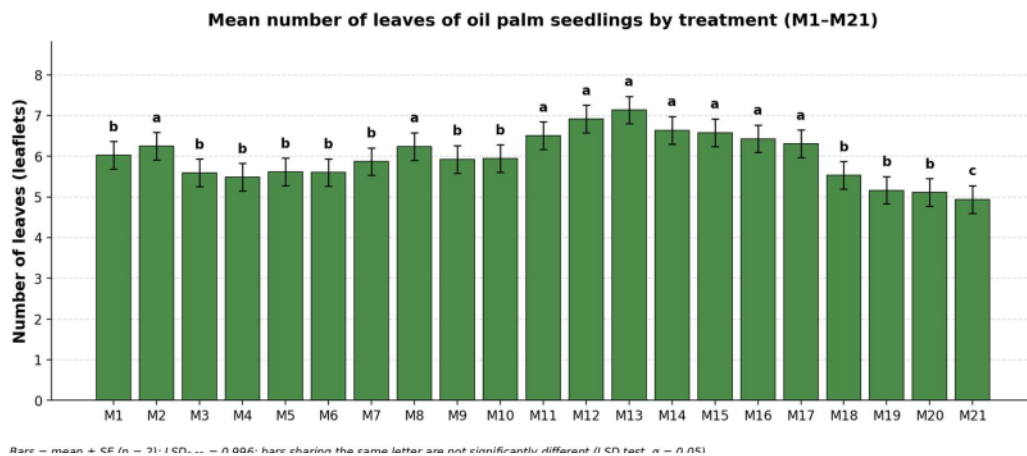


Figure 1. Mean number of leaves of oil palm seedlings for each treatment (M1–M21). Bars represent the treatment mean $\pm$ standard error ($n = 2$); bars that share a letter do not differ significantly by the LSD test at $\alpha = 0.05$ (LSD 5% = 1.00 leaf).

The advantage of M13 and the other top treatments agrees with reports that EFB compost, when applied at a suitable dose, encourages the formation of new leaves in oil palm seedlings during the pre-nursery (Habibah *et al.*, 2022). This suggests that these treatments provided a better balance of nutrients and moisture for leaf development than the lower-ranked media. A similar trend appears in biochar-based media combined with organic–inorganic fertilizer formulations, which can raise leaf number above the standard expected for four-month-old seedlings (Setyawan *et al.*, 2025). These findings support the idea that differences in the composition of the oil palm solid waste-based media were the main cause of the variation in leaf number in this study.

3.2 Plant Height

ANOVA showed that the treatments had a highly significant influence on the height of oil palm seedlings ($F = 12.74$; F table 1% = 2.37; $df = 20$). The grand mean was 32.58 cm and the coefficient of variation was 5.82%, indicating high experimental precision for this variable.

Plant height was separated into five statistically distinct groups (Figure 2). M13, M14, M12, and M15 formed the tallest group (36.4 - 39.2 cm; notation a), 12 - 20% above the trial mean, followed by a group of seven mid-ranking treatments (M3, M4, M6, M7, M10, M11, and M16; notation b; 32.7–35.8 cm). M19 and M20 were significantly shorter than every treatment in groups a–c (27.6 and 25.9 cm; notation d), and M21 was the shortest of all treatments tested (24.2 cm; notation e), 26% below the trial mean and 15.0 cm shorter than M13.

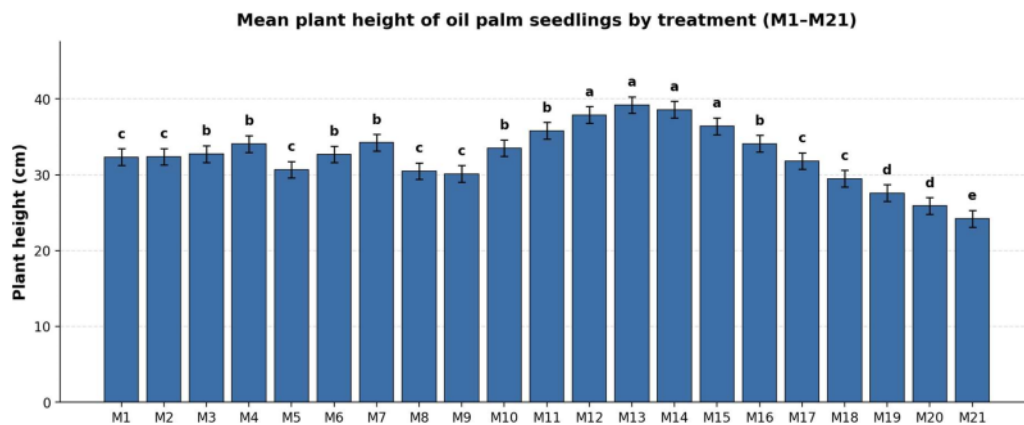


Figure 2. Mean height of oil palm seedlings for each treatment (M1–M21). Bars represent the treatment mean $\pm$ standard error ($n = 3$); bars sharing the same letter show no significant difference by the LSD test at $\alpha = 0.05$ (LSD 5% = 3.13 cm).

The greater height under M12–M15 aligns with findings on light and irrigation management reported for pre-nursery oil palm seedlings, where sufficient but not excessive shade combined with timely irrigation supports height growth (Rusmayadi *et al.*, 2022). The pronounced height reduction in M19 - M21, mirrored by the lowest leaf numbers (Section 3.1) and the smallest corm diameters (Section 3.3) recorded in this study, indicates that the growing medium used in these three treatments was less favourable for seedling growth than in the other eighteen treatments, which shared the same irrigation regime and only differed in growing-medium composition. Four medium-related mechanisms are proposed as plausible, non-exclusive explanations for this consistent decline.

3.2.1 Excessive organic matter content

A growing medium composed mostly of oil palm solid waste (EFB/TKKS compost, solid decanter) without an adequate mineral or sand fraction can carry more organic material than the seedling's root volume can process; if the compost was not fully matured, continued decomposition would compete with the seedling for available nitrogen (immobilization) and may release phytotoxic intermediate compounds, both of which suppress vegetative growth (Rosenani *et al.*, 2016).

3.2.2 Reduced aeration

A medium dominated by fine, decomposed organic material generally holds more water but has lower macroporosity than mineral-based media; under the irrigation regime applied to all treatments, this can lead to localized waterlogging around the root zone, restrict oxygen diffusion to the roots, and impair root respiration and nutrient uptake (Chang *et al.*, 2023). Nutrient imbalance. Compost and solid decanter fractions vary in nutrient content and C:N ratio; an unbalanced supply of N, P, and K relative to seedling demand – for example, excess nitrogen without sufficient phosphorus or potassium – can restrict cell division and elongation even when overall medium fertility appears adequate (Wang *et al.*, 2025).

3.2.3 Salinity effects

Solid decanter and insufficiently weathered EFB compost can carry appreciable levels of soluble salts; elevated electrical conductivity in the root zone raises the osmotic potential of the medium, making water and nutrient uptake more difficult for the seedling and

manifesting as stunted height, fewer leaves, and reduced corm diameter – a pattern consistent with what was observed in M19–M21 (Peña *et al.*, 2024).

These four mechanisms may have acted together in M19–M21; distinguishing their relative contribution would require direct measurement of medium bulk density and porosity, nutrient content, and electrical conductivity (EC) for each treatment, which fell outside the scope of the present analysis and is recommended for follow-up work. This interpretation is broadly consistent with reports that shading or irrigation alone cannot compensate for an unfavourable growing medium in Ultisol-based oil palm nurseries (Husna *et al.*, 2023).

3.3 Corm Diameter

ANOVA revealed a highly significant treatment effect on the corm diameter of oil palm seedlings ($F = 11.87$; F table 1% = 2.37; $df = 20$). The grand mean was 8.34 mm and the coefficient of variation was 9.43%.

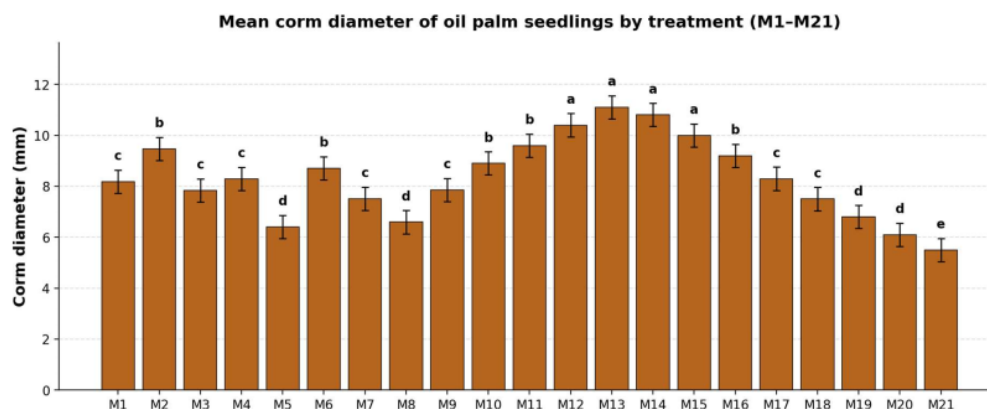


Figure 3. Mean corm diameter of oil palm seedlings for each treatment (M1–M21). Bars represent the treatment mean $\pm$ standard error ($n = 3$); bars with the same letter are not significantly different by the LSD test at $\alpha = 0.05$ (LSD 5% = 1.30 mm).

As with leaf number and plant height, M13, M14, M12, and M15 formed the group with the largest corm diameter (10.0 - 11.1 mm; notation a), confirming that these four treatments consistently produced the best vegetative growth across all three parameters measured in this study. M19, M20, and M21 again ranked lowest (5.5-6.8 mm; notations d-e), with M21 having a corm diameter 34% smaller than M13.

The consistent ranking of M13, M14, M12, and M15 across all three growth parameters supports the interpretation that their growing-medium composition, most likely oil palm solid waste combined with a complementary mineral or organic component in a favourable ratio, supplied more balanced aeration, moisture, and nutrients than the lower-ranked media. This aligns with reports that EFB compost mixed with a component such as coconut coir dust can improve the physiological condition of oil palm seedlings compared with organic waste alone (Lau *et al.*, 2024).

Oil palm solid waste, whether used as a growing medium or a biochar source, contributes to bulb (corm) diameter growth. Biochar made from oil palm empty fruit bunches and mixed with rubberwood biochar at a 10% dose significantly enlarged seedling stem diameter relative to the control (Prayoga *et al.*, 2025). Raising the dose of oil palm EFB compost was also strongly and positively related to growth parameters such as plant height and leaf number (Kumara & Sumiahadi, 2025). This aligns with the literature highlighting the

potential of EFB compost as an alternative growing medium in oil palm nurseries, replacing topsoil, whose availability is increasingly limited (Zakri & Adam, 2021). In addition, combining EFB compost with coconut coir dust in a soilless system has been shown to improve plant physiological condition (Karim & Saimi, 2023). This further supports the view that the composition of the oil palm solid waste-based medium played an important role in the differences in corm diameter among treatments.

4. Conclusion

Based on the ANOVA and LSD results from observations of *Elaeis guineensis* Jacq. seedlings in the pre-nursery phase, the following conclusions were reached:

1. All treatments (M1–M21) exerted a highly significant influence on leaf number, plant height, and corm diameter of the seedlings, while the block factor (replication) had no significant effect on these three variables.
2. The M13 treatment consistently demonstrated the best performance across the three observed variables, yielding the highest average number of leaves (7.14), the greatest plant height (39.20 cm), and the largest corm diameter (11.10 mm).
3. Treatments M19, M20, and M21 consistently showed the lowest performance across all three variables, with the lowest plant height recorded for M21 (24.20 cm) and the smallest corm diameter also observed in M21 (5.50 mm).
4. Observations for the leaf count variable utilized only two replicates (Replicates I and III) due to a data error found in Replicate II of the source document; consequently, the results for this variable are subject to statistical limitations compared to the other two variables, which utilized three full replicates.

References

- Basri, Meliani, Ismail, A. T., Iqbal, M., Irfan, M., Norman, A., Andreansyah, R., Cennawati, & Suharman, H. (2025). *Jbima: Jurnal Pengabdian Kepada Masyarakat*. *Jbima: Jurnal Pengabdian Kepada Masyarakat*, 2(3), 126–133.
- Chang, Y. Y., Razak, M., & Sim, C. (2023). *Effects of Different Growing Media under Soilless Culture on the Growth and Nutrient Uptake of Oil Palm Seedlings in the Pre-Nursery Stage*. 28, 256–263.
- Habibah, P., Dwipa, I., & Satria, B. (2022). The effect of oil palm empty fruit bunch compost and watering interval on oil palm (*Elaeis guineensis* Jacq.) seedling growth in the pre-nursery. *Agrohita*, 7(1), 202–209.
- Harrison, M., Sintès, P. B., Kusin, K., Katoppo, D., Marchant, N., Morrogh-Bernard, H., Nasir, D., Capilla, B. R., Salahudin, Suppan, L., Veen, F. F., & Smith, S. (2023). Accounting for seedling performance from nursery to outplanting when reforesting degraded tropical peatlands. *Restoration Ecology*, 31. <https://doi.org/10.1111/rec.13984>
- Husna, M., Salamah, U., Herman, W., & Agwil, W. (2023). The improvement of oil palm seedling through shade, manure and organic liquid fertilizer in Ultisol media. *Planta Tropika*, 11(1), 33–40. <https://doi.org/10.18196/pt.v11i1.13415>

- Hutomo, P. P., Maghfiro, R. Y., Abadi, A. L., Natawijaya, A., Sone, T., Setiawan, A., & Syib'li, M. A. (2026). In vitro–In vivo efficacy of *Trichoderma asperellum* and *Trichoderma virens* against *Ganoderma boninense* in oil palm seedlings. *Plant Signaling and Behavior*, 21(1), 1–17. <https://doi.org/10.1080/15592324.2026.2671575>
- Karim, M. F., & Saimi, N. N. (2023). Evaluating the benefits of empty fruit bunch compost from oil palm into coconut coir dust growing media for soilless culture practice. *Revelation and Science*, 1(1). <https://doi.org/10.31436/revival.v1i1.374>
- Kumara, N. R. A., & Sumiahadi, A. (2025). Evaluation of oil palm empty fruit bunch compost application on samhong mustard (*Brassica juncea* L.) cultivation in polybags. *Applied Research in Science and Technology*, 4(2).
- Lau, G. W., King, P., Chubo, J., King, I. C., Ong, K., Ismail, Z., Robin, T., & Shamsi, I. (2024). The Potential Benefits of Palm Oil Waste-Derived Compost in Embracing the Circular Economy. *MDPI Agronomy*, 14(2517), 1–16. <https://doi.org/10.3390/agronomy14112517>
- Nurhadiah, Sukasih, N. S., Tri, F. X., & P., M. Y. (2022). Aplikasi Kompos Tandan Kosong Kelapa Sawit Terhadap Pertumbuhan Bibit Kakao (*Theobroma Cacao*, L) Sambung Pucuk. *Piper*, 18(April).
- Peña, M. De, Ruiz-romero, R., & Castro-arza, L. I. (2024). Changes in the Root Architecture of Oil Palm Seedlings in Response to Nitrogen Starvation. *MDPI Agronomy Article*, 14(409), 1–11.
- Prayoga, S., Riniarti, M., Prasetya, H., Setiawan, K., Bakri, S., & Hidayat, W. (2025). Growth improvement of palm oil seedling using biochar from oil palm empty fruit bunch and rubber wood. *Jurnal Teknik Pertanian Lampung*, 14(6), 2179–2186. <https://doi.org/10.23960/jtepl.v14i6.2179-2186>
- Rosenani, A. B., Rovica, R., Cheah, P. M., & Lim, C. T. (2016). Growth Performance and Nutrient Uptake of Oil Palm Seedling in Prenursery Stage as Influenced by Oil Palm Waste Compost in Growing Media. *International Journal of Agronomy*, 2016(1), 1–8. <https://doi.org/10.1155/2016/6930735>
- Rupaedah, B., Eko Prasetyo, A., Hidayat, F., Asiani, N., Wahid, A., Nurlaila, & Lutfia, A. (2024). Evaluation of microbial biocontrol agents for *Ganoderma boninense* management in oil palm nurseries. *Journal of the Saudi Society of Agricultural Sciences*, 23(3), 236–244. <https://doi.org/10.1016/j.jssas.2023.12.001>
- Rusmayadi, G., Adriani, D. E., Masria, M., & Salawati, U. (2022). Growth response of oil palm seedlings (*Elaeis guineensis* Jacq) in pre nursery nurseries to intensity of solar radiation in the moonsun region. *International Journal of Engineering Business and Social Science*, 1(2), 76–79. <https://doi.org/10.58451/ijebss.v1i02.26>
- Setyawan, H., Elfatma, O., Aji, W. A., & Gunawan, S. (2025). Potential acceleration of early growth in oil palm seedlings through the optimization of biochar growing media and organic-inorganic fertilizer formulation. *Journal of Agriculture (JoA)*, 4(3), 393–401. <https://doi.org/10.47709/joa.v4i03.7299>

- Sumarlin, Sangkala, Zainuddin, Gaffar, U. H., Sutiharni, Husen, O. O., Robbani, S., Alam, R. A. C., Harwanto, F., Jayadisastra, Y., Pramulya, R., & A., K. (2024). *Minyak Kelapa Dan Minyak Sawit: Dampak Kesehatan, Lingkungan, Ekonomi Dan Sosial Di Balik Produksi*.
- Supriatna, J., Rohman, F., Iskandar, J., Sirait, J., & Warouw, V. (2022). Composting for a more sustainable palm oil waste management: A systematic literature review. *The Scientific World Journal*, 2022, 5073059. <https://doi.org/10.1155/2022/5073059>
- Umar Battong, Raihani Wahdah, G. R. (2018). Respon Pertumbuhan dan Produktivitas Kelapa Sawit (*Elaeis Guineensis* Jacquin) Terhadap Kedalaman dan Bobot Bahan Organik Penutup Biopori Pada Tanah Podsolik Merah Kuning. *EnviroScienteeae*, 14(2), 147–160. <https://ppjp.ulm.ac.id/journal/index.php/es/article/view/5479/4626>
- Wang, R., Pu, P. O., Huang, D. A. N., Du, X., Xiang, R. U. I., Li, G., & Jiaka, L. (2025). The Dynamic Changes of Nutrient and Microbial Succession in Nanomembrane Aerobic Composting of Tomato Straw. *Polish Journal of Microbiology*, 74(3), 347–362. <https://doi.org/10.33073/pjm-2025-030>
- Widiati, B. R., & Herwati, A. (2026). Pemanfaatan *Trichoderma* Sp. Sebagai Agens Hayati Untuk Pengendalian Penyakit Layu Fusarium Dan Pembuatan Trichokompos Di Desa Cenrana Baru. *Abdimas Universal*, 8(1), 105–113.
- Zakri, N. A., & Adam, S. (2021). A review on the potential of empty fruit bunch (EFB) compost as growing medium for oil palm seedling production. *Food Research*. [https://doi.org/10.26656/fr.2017.5\(s4\).003](https://doi.org/10.26656/fr.2017.5(s4).003)