# Potassium Uptake Effectiveness in Oil Palm Cultivation at Bp1 Estate, PT. Pilar Wanapersada

**Dani Hambali, Hanifah Mutia Amrul, Kurniawan Sinaga**

## Abstract

Potassium (K) is an essential macronutrient that plays a key role in various physiological processes of oil palm, including enzyme activation, translocation of photosynthates, regulation of water balance, and fruit-bunch formation. One environmentally friendly alternative for supplying potassium is the use of composted oil palm empty fruit bunches (EFB), which also contributes to the sustainable management of plantation waste. This study aimed to evaluate the effect of EFB compost application on the potassium uptake of oil palm at BP1 Estate, PT Pilar Wanapersada. The research was conducted from June to December 2025 using a non-factorial randomized block design (RBD) with three treatment levels: without EFB (P0), EFB at 30 t/ha (P1), and EFB at 40 t/ha (P2), each replicated five times. The observed parameter was plant potassium uptake. Data were analyzed using analysis of variance (ANOVA) at the 95% confidence level, followed by Duncan's Multiple Range Test (DMRT) at the 5% level. The results showed that EFB compost application had a significant effect on potassium uptake throughout the observation period. Potassium uptake increased in all treatments over time, indicating ongoing compost decomposition and the gradual release of potassium. The findings indicate that EFB compost, particularly at 40 t/ha, effectively increased potassium uptake and has the potential to serve as an organic potassium source supporting sustainable oil palm productivity.

**Keywords**: *Elaeis guineensis Jacq.; empty fruit bunches; potassium; nutrient uptake*

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## Introduction

Oil palm (*Elaeis guineensis* Jacq.) is one of Indonesia's strategic plantation commodities, making a major contribution to the national economy through exports of crude palm oil (CPO) and its derivative products. Increasing oil palm productivity is therefore an important effort to meet industrial demand and strengthen the competitiveness of the national plantation sector. Crop productivity is strongly influenced by nutrient sufficiency, particularly potassium (K), which is the macronutrient required in the highest amount after nitrogen in oil palm [1].

Potassium plays a central role in numerous physiological processes, including enzyme activation, regulation of cell osmotic pressure, opening and closing of stomata, translocation of photosynthates, and the formation and filling of fruit bunches. Potassium deficiency reduces photosynthetic efficiency, disrupts carbohydrate translocation, and lowers both bunch production and fruit quality. Adequate potassium availability is thus an important factor in sustaining oil palm productivity [2].

One potential potassium source is oil palm empty fruit bunches (EFB), a solid waste from palm oil processing. Each tonne of fresh fruit bunches processed generates approximately 20–23% EFB, so the volume of waste produced is very large. If not utilized optimally, EFB can create environmental problems; conversely, composting and using EFB as an organic fertilizer recycles nutrients back to the land while increasing soil organic-matter content [3].

EFB compost contains various macronutrients, especially potassium, and can improve the physical, chemical, and biological properties of the soil. The addition of organic matter increases the cation exchange capacity, the soil's water-holding capacity, microbial activity, and the efficiency of nutrient uptake by plant roots. Consequently, EFB application not only serves as a potassium source but also enhances nutrient-use efficiency, with the potential to increase potassium uptake by oil palm [4].

Potassium uptake is an important indicator for evaluating fertilization effectiveness because it reflects a plant's ability to absorb and utilize the potassium available in the soil. High potassium uptake generally correlates with increased physiological activity and productivity, particularly during the formation and development of fruit bunches [5]. Measuring potassium uptake is therefore necessary to determine the extent to which EFB compost application improves nutrient-use efficiency.

Although various studies have reported the benefits of EFB for improving soil fertility and oil palm growth, information on the effectiveness of EFB compost doses of 30 t/ha and 40 t/ha on potassium uptake under field conditions at BP1 Estate, PT Pilar Wanapersada, remains limited. This study therefore aimed to evaluate the effect of EFB compost application on the potassium uptake of oil palm, as a basis for developing sustainable and efficient strategies for utilizing oil palm waste.

## Literature Review

EFB contains various important nutrients that benefit both soil and plants. It is rich in organic carbon, potassium, and other micronutrients, which help increase soil organic matter and improve soil structure [6][7]. EFB can be processed into a useful organic fertilizer: composting produces a material that improves soil structure, increases organic-matter content, and supplies the macro- and micronutrients required by plants [8].

Large quantities of EFB can potentially be composted and used to improve the physical, biological, and chemical properties of the subsoil of Ultisols. The nutrient content of EFB compost has been reported to comprise 1.91–3.62% nitrogen, 0.62–1.51% potassium, 0.83% calcium, 0.54–0.94% phosphorus, and 0.09% magnesium, with 51.23% organic carbon, a C/N ratio of 26.82, and a pH of 7.13–9.59 [9].

A study comparing a control without EFB compost with a treatment applying EFB compost at 50 kg per palm found that compost application had a positive effect, as indicated by higher leaf potassium content under the compost treatment than under the no-compost treatment. Although the difference was not significant, the result suggests that compost contributes to increasing the availability and uptake of potassium by the plant, thereby supporting better plant growth [10].

Application of EFB at 37.5 t/ha/year together with inorganic N and K fertilizers (0.735 kg N and 1.75 kg K per palm per year) increased leaf N and K contents, bunch number, bunch weight, and fresh-fruit-bunch yield, while leaf Mg content decreased [11].

The high potassium content of EFB allows partial substitution of the potassium in NPK fertilizer, significantly reducing chemical-fertilizer requirements. Integrating EFB into a circular nutrient strategy aims to reduce dependence on synthetic fertilizers by using organic waste as a sustainable source of plant nutrients [12].

## Research Methodology

The study was conducted at BP1 Estate, PT Pilar Wanapersada, from June to December 2025. A non-factorial randomized block design (RBD) was used, consisting of a single factor the dose of oil palm empty fruit bunch (EFB) application at three treatment levels: P0 = without EFB application (control), P1 = EFB at 30 t/ha, and P2 = EFB at 40 t/ha. Each treatment was replicated five times, yielding 15 experimental units (15 blocks). Observations were carried out periodically from June to December 2025. The main parameter observed was potassium uptake by the oil palm. The data obtained were analyzed using analysis of variance (ANOVA) at the 5% level; where the analysis indicated a significant effect, it was followed by Duncan's Multiple Range Test (DMRT) at the 5% level.

## Results

The statistical analysis showed that EFB application had a significant effect on potassium uptake. Table 1 presents the mean potassium uptake over the observation period from June to December 2025.

**Table 1. Mean potassium uptake following the application of oil palm empty fruit bunch (EFB) compost, June–December**

| Treatment | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|
| P0 (Control) | 0.70$^{b}$ | 0.78$^{b}$ | 0.82$^{c}$ | 0.84$^{c}$ | 0.88$^{b}$ | 0.88$^{c}$ | 0.90$^{b}$ |
| P1 (EFB 30 t/ha) | 1.04$^{a}$ | 1.05$^{a}$ | 1.07$^{b}$ | 1.07$^{b}$ | 1.08$^{a}$ | 1.08$^{a}$ | 1.10$^{a}$ |
| P2 (EFB 40 t/ha) | 1.12$^{a}$ | 1.13$^{a}$ | 1.15$^{a}$ | 1.17$^{a}$ | 1.18$^{a}$ | 1.19$^{a}$ | 1.20$^{a}$ |
| **Mean** | 0.95 | 0.99 | 1.01 | 1.03 | 1.05 | 1.05 | 1.07 |

*Note: Within the same column, values followed by different letters differ significantly according to DMRT at the 5% level.*

The highest mean potassium uptake occurred under the EFB 40 t/ha treatment, which did not differ significantly from the EFB 30 t/ha treatment in June, July, October, November, and December, whereas in August and September the two treatments differed significantly. The EFB 40 t/ha treatment recorded the highest mean potassium uptake and differed significantly from the control (without EFB) in every month of observation. This indicates that EFB application increased potassium availability in the soil, allowing more potassium to be absorbed by the plants. Because potassium is the most abundant nutrient in EFB, EFB compost can serve as an effective potassium source for oil palm. This is consistent with [13], who noted that EFB is rich in nutrients such as organic carbon, nitrogen (N), phosphorus (P), and potassium (K)—key components for improving soil fertility. As noted earlier, the nutrient content of EFB compost includes 0.62–1.51% potassium, and its high potassium content allows partial substitution of the potassium in NPK fertilizer, significantly reducing chemical-fertilizer requirements.

Beyond serving as a potassium source, EFB compost increases soil organic-matter content, which helps improve the physical, chemical, and biological properties of the soil [10]. Higher organic matter improves soil structure, raises the cation exchange capacity (CEC), enhances the soil's water-holding capacity, and stimulates soil microbial activity.

These conditions create a better rooting environment and thus increase the efficiency of nutrient uptake. The increased potassium uptake under the EFB treatments was therefore due not only to the added potassium but also to the soil's improved capacity to supply nutrients to the plant.

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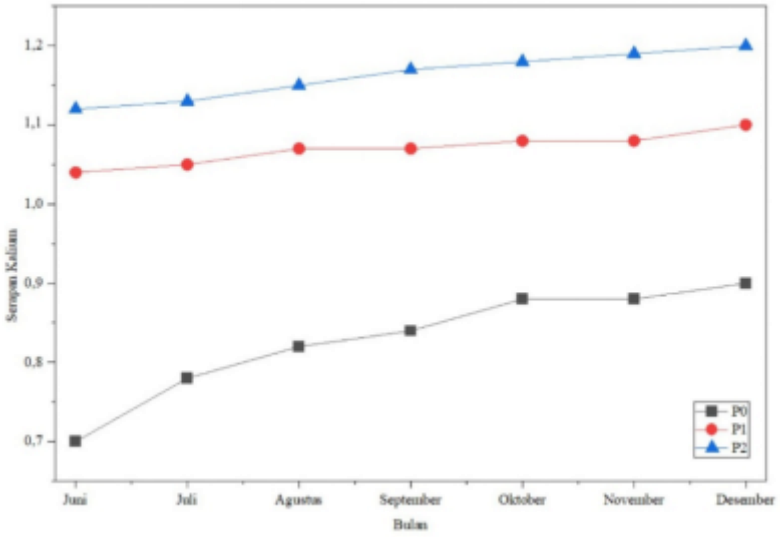


**Figure 1. Potassium uptake following the application of oil palm empty fruit bunch (EFB) compost, June–December**

As shown in Figure 1, the EFB 40 t/ha treatment produced the highest mean potassium uptake compared with the EFB 30 t/ha and control treatments, and potassium uptake tended to increase from June to December. The rising potassium uptake under the EFB treatments indicates that EFB compost is a potassium source capable of supplying nutrients continuously through decomposition. Potassium released from the compost is made available slowly and steadily in the soil solution, from which it can be absorbed by the plant's root system. This is consistent with [15], who reported that organic fertilizers tend to release nutrients more slowly and steadily, thereby providing nutrients over the long term.

## Conclusion

The application of oil palm empty fruit bunch compost was shown to increase the potassium uptake of oil palm compared with no EFB application. The 40 t/ha dose produced the highest potassium-uptake response throughout the observation period, indicating that EFB compost particularly at this dose has strong potential as an organic potassium source for supporting sustainable oil palm productivity.

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