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RESPONSE OF OIL PALM SEEDLINGS TO TRICHODERMA KONINGII AND SP-36

Rendi Aditya[1], Razali[2*], Octanina Sari Br. Sijabat[3]
[123]Program Studi Budidaya Perkebunan, Fakultas Sains dan Teknologi, Universitas Tjut Nyak Dhien, Medan, Indonesia
Correspondence Email: razali@utnd.ac.id

ABSTRACT

This study evaluated the effects of Trichoderma koningii and SP-36 fertilizer, as well as their interaction, on the growth of oil palm (Elaeis guineensis Jacq.) seedlings during the pre-nursery stage. An experiment was conducted in Medan, North Sumatra, from November 2025 to February 2026 using a 3 × 3 factorial Randomized Complete Block Design with three replications. The Trichoderma factor consisted of 0, 10, and 20 g/polybag, while SP-36 consisted of 0, 10, and 20 g/polybag. Growth variables were plant height, stem diameter, number of leaves, and leaf area, observed from 5 to 12 weeks after planting. Trichoderma significantly affected leaf number at 9 and 10 weeks and leaf area at 11 and 12 weeks, with the 20 g/polybag treatment generally producing the highest means. SP-36 significantly affected leaf number at 10–12 weeks and leaf area at 11–12 weeks, with 20 g/polybag giving the highest factor means. The interaction between Trichoderma and SP-36 was not significant for all observed variables. These findings indicate that each factor contributed independently to later vegetative development, whereas their combination did not produce a statistically detectable interaction under the experimental conditions.

Keywords: oil palm; Trichoderma koningii; SP-36; pre-nursery; seedling growth.

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INTRODUCTION

Oil palm (Elaeis guineensis Jacq.) is an important plantation crop in Indonesia, and the quality of seedlings is one of the early determinants of subsequent field performance. National plantation statistics have documented the continuing importance of oil palm cultivation, while nursery management is recognized as a critical stage because uniform and vigorous seedlings are needed before field establishment (Ditjenbun, 2019; Kuvaini, 2014). In the double-stage nursery system, seedlings are first maintained in the pre-nursery before being transferred to the main nursery, making early vegetative growth an important management target (Hartika, 2021; Setyorini et al., 2020).

Vegetative performance in the pre-nursery is influenced by seedling quality, growing medium, nutrient availability, and the biological condition of the rhizosphere. Morphological characteristics such as leaf number and leaf development are particularly relevant because leaves are the main organs supporting photosynthetic production (Idris et al., 2020). Soil and climatic conditions also affect nutrient availability and plant responses; suitable drainage, soil reaction, temperature, humidity, and light are therefore important when evaluating nursery treatments (Listia & Syukur, 2021; Agroklimatologi PPKS, 2023).

Trichoderma spp. are widely studied as beneficial fungi because of their antagonistic activity against soil-borne pathogens and their potential to promote plant growth. Dwiastuti et al. (2015) described the antagonistic capacity of Trichoderma, while Novita et al. (2020) reported its potential contribution to plant growth and nutrient acquisition. In oil palm seedlings, Sofian et al. (2022) reported positive growth responses following Trichoderma application, although the magnitude of the response depends on dose and experimental conditions. Similar evidence from oil palm nursery research indicates that Trichoderma can influence seedling growth, but responses are not necessarily consistent across all variables or treatment combinations (Wibowo et al., 2020; Buulolo, 2019).

Phosphorus fertilization is also relevant to early root and shoot development. SP-36 is a granular phosphate fertilizer and its effectiveness is influenced by soil conditions and the availability of phosphorus to roots. The role of nutrient management in oil palm production has been emphasized by Rahman et al. (2023), while Anhar et al. (2021) showed that nutrient supplementation can affect the growth of pre-nursery oil palm seedlings. The interaction between biological inputs and mineral fertilization is therefore of practical interest. A recent study on phosphorus-solubilizing Trichoderma demonstrated that Trichoderma can improve plant growth under phosphorus-limited conditions, providing a biological rationale for evaluating Trichoderma together with phosphate fertilization (Bononi et al., 2020).

Research published in Algebra has also demonstrated the usefulness of factorial randomized block experiments for evaluating plant growth responses to multiple treatment factors (Hasibuan et al., 2024; Revina Azhari et al., 2025). Based on this background, the present study aimed to determine the individual effects of Trichoderma koningii and SP-36 fertilizer and to evaluate whether their combination produces a significant interaction on the growth of oil palm seedlings in the pre-nursery stage.

RESEARCH METHODS

The experiment was conducted on Jl. Terompet, Padang Bulan, Medan, North Sumatra, at approximately 28 m above sea level, from November 2025 to February 2026. Oil palm sprouts obtained from PPKS were grown in polybags containing topsoil mixed with manure. The nursery area was protected with 55% shade netting. The experimental materials included Trichoderma, SP-36, manure, topsoil, water, and oil palm sprouts; the main equipment included polybags, scales, measuring instruments, watering equipment, and field labels.

A factorial Randomized Complete Block Design was used with two factors. The first factor was Trichoderma koningii (T): T0 = 0 g/polybag, T1 = 10 g/polybag, and T2 = 20 g/polybag. The second factor was SP-36 (S): S0 = 0 g/polybag, S1 = 10 g/polybag, and S2 = 20 g/polybag. The nine treatment combinations were replicated three times, with five polybags per experimental unit and three sampled plants per unit, giving 135 plants in total.

Table 1. Experimental treatment structure.

Factor	Level 1	Level 2	Level 3
Trichoderma koningii	T0: 0 g/polybag	T1: 10 g/polybag	T2: 20 g/polybag
SP-36	S0: 0 g/polybag	S1: 10 g/polybag	S2: 20 g/polybag
Design	3 × 3 factorial	3 blocks	135 plants

Trichoderma and SP-36 were applied according to treatment doses, with applications separated by approximately seven days. Seedlings were maintained through regular watering, weed control, plant consolidation, and pest and disease management. Plant height and stem diameter were measured weekly from 5 to 12 weeks after planting (WAP). Leaf number was counted weekly, while leaf area was estimated from leaf length and width using the coefficient described in the original research (A = p × l × 0.52).

Data were analyzed using analysis of variance (ANOVA) according to the factorial block model. When a treatment effect was significant, means were separated using Duncan's Multiple Range Test (DMRT) at the 5% level. The interpretation in this article follows the significance decisions and means reported in the original research data.

RESULTS AND DISCUSSION

The experiment showed that Trichoderma and SP-36 did not significantly affect plant height or stem diameter from 5 to 12 WAP, and their interaction was also not significant for these variables. The absence of a significant response in early vegetative dimensions indicates that the treatments did not consistently alter shoot elongation or stem thickening during the observation period. This is compatible with the view that nursery growth is affected by multiple factors, including seedling quality, media condition, water availability, and nutrient status (Kuvaini, 2014; Setyorini et al., 2020).

For leaf number, Trichoderma significantly affected the seedlings at 9 and 10 WAP. At 9 WAP, T2 produced 3.70 leaves, compared with 3.67 leaves for T1 and 3.19 leaves for T0. At 10 WAP, T1 and T2 both reached 3.78 leaves, whereas T0 produced 3.33 leaves. The response was not significant at the other observation times. The later appearance of a response is plausible because biological inoculants may require time to establish in the rhizosphere before effects on plant development become evident. Trichoderma-related improvements in the root environment and nutrient acquisition have been reported in previous work (Dwiastuti et al., 2015; Novita et al., 2020; Sofian et al., 2022).

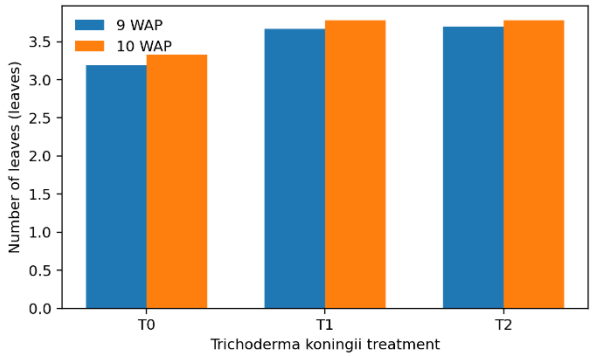


Figure 1. Mean leaf number at 9 and 10 WAP under different Trichoderma koningii doses.

The significant response of leaf area occurred at 11 and 12 WAP. At 11 WAP, T2 produced 14.03 cm², significantly higher than T0 (12.03 cm²) and statistically comparable with T1 (12.65 cm²). At 12 WAP, T2 produced 15.97 cm², compared with 14.90 cm² for T1 and 13.95 cm² for T0. These results are consistent with the role of Trichoderma as a plant-growth-promoting microorganism and with the positive response of oil palm seedlings reported by Sofian et al. (2022). However, the absence of significant effects at earlier weeks indicates that the benefit was expressed more clearly during the later part of the pre-nursery observation.

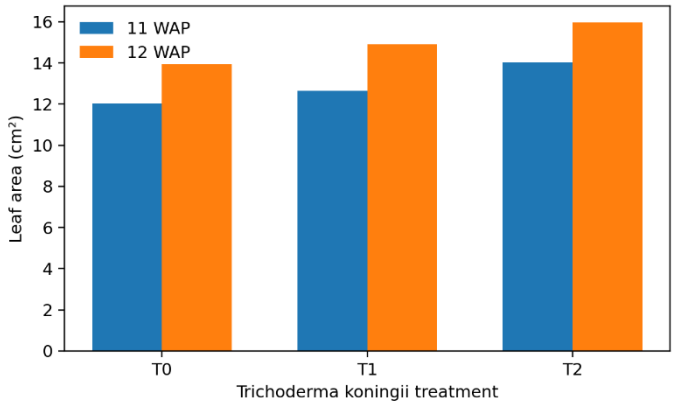


Figure 2. Mean leaf area at 11 and 12 WAP under different Trichoderma koningii doses.

SP-36 significantly affected leaf number at 10, 11, and 12 WAP. The highest means were obtained with S2: 3.85 leaves at 10 WAP, 4.67 leaves at 11 WAP, and 5.44 leaves at 12 WAP. SP-36 also significantly affected leaf area at 11 and 12 WAP, with S2 producing 13.51 and 15.63 cm², respectively. The increasing response at the later observation stage suggests that phosphorus availability contributed to continued vegetative development once the seedlings had progressed beyond the earliest establishment phase. Nutrient management is an important component of oil palm nursery management, and soil and environmental conditions can modify the magnitude of fertilizer responses (Rahman et al., 2023; Agroklimatologi PPKS, 2023).

Table 2. Significant treatment responses reported in the experiment.

Treatment factor	Variable	Observation	Best treatment	Mean
Trichoderma	Leaf number	9 WAP	T2	3.70 leaves
Trichoderma	Leaf number	10 WAP	T1/T2	3.78 leaves
Trichoderma	Leaf area	11 WAP	T2	14.03 cm²
Trichoderma	Leaf area	12 WAP	T2	15.97 cm²
SP-36	Leaf number	10 WAP	S2	3.85 leaves
SP-36	Leaf number	11 WAP	S2	4.67 leaves
SP-36	Leaf number	12 WAP	S2	5.44 leaves
SP-36	Leaf area	11 WAP	S2	13.51 cm²
SP-36	Leaf area	12 WAP	S2	15.63 cm²

The interaction between Trichoderma and SP-36 was not significant for plant height, stem diameter, leaf number, or leaf area. Although the T2S2 combination generally produced high numerical means at the final observation, the differences among combinations were not statistically significant. This distinction is important: a numerically superior treatment combination cannot be described as an interaction effect when the factorial ANOVA does not detect significance. The result may reflect the independent contribution of the two factors under the experimental conditions. Previous oil palm nursery studies have likewise reported that Trichoderma can improve selected growth parameters without necessarily producing a significant interaction with another biological input (Sofian et al., 2022).

The non-significant interaction may also be related to the growing environment and the relatively short pre-nursery observation period. Trichoderma establishment depends on the condition of the growing medium and rhizosphere, while phosphorus availability is affected by soil properties. The original study was conducted under nursery conditions that produced relatively uniform seedling growth, which may have reduced the opportunity for a strong treatment interaction to emerge. Similar considerations regarding media, humidity, and environmental conditions have been emphasized in research on Trichoderma and nursery management (Buulolo, 2019; Simbolon, 2016; Listia & Syukur, 2021).

From a practical perspective, the results support the use of Trichoderma koningii and SP-36 as separate management inputs when the objective is to improve later leaf development, but they do not demonstrate a statistically superior combined effect. The finding is also consistent with the broader principle that biological and mineral inputs should be evaluated according to the specific soil, dose, timing, and growth stage rather than assuming that combining inputs will always generate synergy. Research on nutrient release and soil amendment further indicates that nutrient dynamics depend on the characteristics of the growing medium (Kristianto et al., 2020).

CONCLUSIONS

Trichoderma koningii significantly increased leaf number at 9 and 10 WAP and leaf area at 11 and 12 WAP, with 20 g/polybag generally giving the highest means. SP-36 significantly increased leaf number at 10–12 WAP and leaf area at 11–12 WAP, with 20 g/polybag producing the highest factor means. Neither factor significantly affected plant height or stem diameter, and no significant interaction between Trichoderma and SP-36 was detected for any observed growth variable. Therefore, under the conditions of this experiment, the effects of the two inputs were predominantly independent rather than synergistic.

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