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TRICHODERMA AND CHICKEN MANURE EFFECTS ON PURPLE EGGPLANT GROWTH AND YIELD

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ABSTRACT

This study evaluated the effects of Trichoderma sp., chicken manure, and their interaction on the growth and yield of purple eggplant (Solanum melongena L.). The experiment was conducted in Medan Deli, North Sumatra, Indonesia, from December 2024 to March 2025 using a factorial Randomized Block Design with three replications. The first factor was Trichoderma sp. at 0, 10, and 20 mL/polybag, while the second factor was chicken manure at 0, 500, and 1,000 g/polybag. Observed variables included plant height, stem diameter, number of leaves, flowering age, total fruit number, fruit weight per plant, root length, and root weight. Data were analyzed by analysis of variance and significant effects were separated using Duncan's Multiple Range Test at 5%. Trichoderma significantly affected plant height at 2, 6, and 8 weeks after planting and root length, with the 20 mL/polybag treatment producing the highest values for these responses. Chicken manure significantly affected plant height at 2 weeks and stem diameter at 8 weeks. The interaction between the two factors significantly affected plant height at 8 weeks and stem diameter at 4, 6, and 8 weeks. Most yield-related variables were not significantly affected. Overall, the treatments were more consistently associated with vegetative growth than with fruit production.

Keywords: Trichoderma; chicken manure; purple eggplant; vegetative growth; randomized block design.

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INTRODUCTION

Purple eggplant (Solanum melongena L.) is an important vegetable crop in Indonesia and is widely cultivated because of its adaptability and market acceptance. Its growth and productivity are affected by genotype, cultivation practices, soil fertility, water availability, and environmental conditions (Eriyandi, 2018; Eriawati, 2015). Previous studies have shown that fertilizer management and field maintenance can alter eggplant growth and yield, indicating that nutrient availability is an important component of production management (Aldo & Sebayang, 2023; Atika, 2013). Organic inputs are particularly relevant because they can supply nutrients while contributing to soil biological and physical improvement (Gani et al., 2021; Dermiyati, 2020).

Chicken manure is an organic fertilizer that supplies nutrients and organic matter. Its gradual decomposition can improve soil structure, water retention, cation exchange capacity, and biological activity, although the magnitude and timing of plant responses depend on the decomposition process and growing conditions (Siemon et al., 2020; Sutedjo, 2020). Studies on eggplant have reported positive responses to organic fertilization, including chicken manure and other organic amendments, but the optimum response varies with fertilizer dose, crop genotype, and experimental conditions (Hasibuan, 2023; Abdillah et al., 2023; Prathyusha et al., 2023). This variation supports the need to evaluate locally appropriate doses rather than assuming that increasing organic fertilizer always increases yield.

Trichoderma sp. is a beneficial soil fungus that can function as a biological control agent, biostimulant, and biofertilizer. It can colonize the rhizosphere, interact with plant roots, influence nutrient uptake, and contribute to plant growth and stress tolerance (Woo et al., 2023; Guzmán-Guzmán et al., 2023). Beneficial microorganisms can also interact with organic amendments, and their effectiveness is influenced by soil conditions, moisture, temperature, organic matter, and the activity of the rhizosphere microbial community (Bonanomi et al., 2022; Musdalifa et al., 2017). Therefore, combining Trichoderma with chicken manure may provide complementary functions: the manure supplies organic matter and nutrients, whereas Trichoderma may enhance nutrient cycling and root development.

Recent studies in Algebra: Jurnal Pendidikan, Sosial dan Sains have also applied factorial randomized block designs to evaluate treatment combinations in horticultural crops. Hasibuan et al. (2024) evaluated paclobutrazol concentration and application method in beet, while Azhari et al. (2025) examined gibberellin and humic acid in cherry tomato. These studies demonstrate the relevance of factorial experiments for separating main effects from treatment interactions in crop growth and yield research.

However, the response of purple eggplant to the combined application of Trichoderma sp. and chicken manure under polybag conditions in Medan remains insufficiently documented. The present study therefore aimed to determine the effects of Trichoderma sp., chicken manure, and their interaction on eggplant growth and yield, and to identify the treatment combination associated with the best observed performance. The working expectation was that Trichoderma and chicken manure would improve vegetative growth and that their combination would produce a measurable interaction.

RESEARCH METHODS

The experiment was conducted in Medan Deli, Medan City, North Sumatra, Indonesia, at approximately 25.4 m above sea level, from December 2024 to March 2025. Purple eggplant seedlings, chicken manure, Trichoderma sp., water, topsoil, and seedling media were used. The study used a factorial Randomized Block Design with two factors and three replications, giving 9 treatment combinations and 27 experimental plots. Each plot contained four plants, of which three were sampled, giving 135 plants in total and 81 sampled plants.

The first factor was Trichoderma sp. (T): T0 = 0 mL/polybag, T1 = 10 mL/polybag, and T2 = 20 mL/polybag. The second factor was chicken manure (K): K0 = 0 g/polybag, K1 = 500 g/polybag, and K2 = 1,000 g/polybag. The experimental model was $Yijk = \mu + \rho i + \alpha j + \beta k + (\alpha\beta)jk + \varepsilon ijk$, where μ is the overall mean, ρi is the block effect, αj is the Trichoderma effect, βk is the chicken-manure effect, $(\alpha\beta)jk$ is the interaction, and εijk is the experimental error. The treatments were applied before transplanting: chicken manure was applied approximately one week before transplanting and Trichoderma sp. approximately three days before transplanting.

Seeds were germinated in a mixture of soil, compost, and manure at a 2:1:1 ratio. Healthy seedlings with 3–4 true leaves were transplanted into 35 × 40 cm polybags containing topsoil. Routine maintenance included weed removal and watering twice daily. Fruit was harvested when the skin was bright and glossy and the fruit had reached harvest maturity. Plant height was measured at 2,

4, 6, and 8 weeks after planting (WAP); stem diameter was measured at the same intervals; leaf number was recorded during vegetative growth; flowering age was recorded from the first flowering response; fruit number and fruit weight were recorded at harvest; and root length and root weight were measured at the final harvest.

Data were subjected to analysis of variance (ANOVA). When an F-test indicated a significant treatment effect, mean separation was performed using Duncan's Multiple Range Test (DMRT) at the 5% significance level. The results presented below focus on the treatment responses that were statistically significant while retaining the major non-significant production responses for interpretation.

Table 1. Experimental factors and treatment levels

Factor	Code	Treatment level
Trichoderma sp.	T0	0 mL/polybag
Trichoderma sp.	T1	10 mL/polybag
Trichoderma sp.	T2	20 mL/polybag
Chicken manure	K0	0 g/polybag
Chicken manure	K1	500 g/polybag
Chicken manure	K2	1,000 g/polybag

The factorial design produced nine T × K combinations with three replications. This design allowed the main effects of each input and their interaction to be evaluated independently.

RESULTS AND DISCUSSION

Analysis of variance showed that the response to the treatments was parameter-specific. Trichoderma sp. significantly affected plant height at 2, 6, and 8 WAP and root length, whereas chicken manure significantly affected plant height at 2 WAP and stem diameter at 8 WAP. The interaction between Trichoderma and chicken manure was significant for plant height at 8 WAP and stem diameter at 4, 6, and 8 WAP. In contrast, the number of leaves, flowering age, fruit number, fruit weight, and root weight did not show significant effects from the main factors or their interaction. This pattern indicates that the treatments were more responsive in vegetative growth than in yield formation.

Table 2. Summary of treatment significance at the 5% level

Variable	Time	Trichoderma	Chicken manure	T × K
Plant height	2 WAP	Significant	Significant	Not significant
Plant height	4 WAP	Not significant	Not significant	Not significant
Plant height	6 WAP	Significant	Not significant	Not significant
Plant height	8 WAP	Significant	Not significant	Significant
Stem diameter	2 WAP	Not significant	Not significant	Not significant
Stem diameter	4 WAP	Not significant	Not significant	Significant
Stem diameter	6 WAP	Not significant	Not significant	Significant
Stem diameter	8 WAP	Not significant	Significant	Significant
Number of leaves	2–8 WAP	Not significant	Not significant	Not significant
Flowering age	—	Not significant	Not significant	Not significant
Total fruit number	Harvests 1–2	Not significant	Not significant	Not significant
Fruit weight/plant	Harvests 1–2	Not significant	Not significant	Not significant
Root length	Final harvest	Significant	Not significant	Not significant
Root weight	Final harvest	Not significant	Not significant	Not significant

The significance pattern shows that the strongest and most consistent responses occurred in plant height, stem diameter under selected conditions, and root length. The absence of significant effects for most reproductive variables suggests that improved vegetative growth did not automatically translate into increased fruit production under the conditions of this experiment.

Table 3. Mean responses to Trichoderma and chicken manure for significant variables

Variable	T0	T1	T2	K0	K1	K2
Plant height, 2 WAP (cm)	11.64	12.15	12.02	11.72	11.88	12.22
Plant height, 6 WAP (cm)	32.38	32.94	32.83	32.74	32.50	32.91
Plant height, 8 WAP (cm)	42.75	43.27	42.96	43.00	42.78	43.20
Stem diameter, 8 WAP (mm)	8.12	8.17	8.21	8.05	8.21	8.24
Root length (cm)	39.15	38.85	40.30	39.48	39.26	39.56

Trichoderma increased plant height at 2, 6, and 8 WAP. At 2 WAP, T1 produced 12.15 cm compared with 11.64 cm in the control, while at 6 WAP T1 produced 32.94 cm and at 8 WAP it produced 43.27 cm. Although the highest root length occurred under T2 (40.30 cm), the response was not strictly linear for all variables. The significant root response is consistent with the proposed role of Trichoderma as a plant-beneficial microorganism capable of influencing root development, nutrient acquisition, and plant physiology (Woo et al., 2023; Guzmán-Guzmán et al., 2023). Similar evidence that biofertilizers and integrated nutrient management can modify eggplant growth supports the interpretation that microbial inputs may influence vegetative performance even when yield responses remain limited (Prathyusha et al., 2023).

The plant-height response also agrees with the general observation that beneficial microorganisms may improve rhizosphere activity and root development, thereby improving access to water and nutrients (Musdalifa et al., 2017). However, the lack of significant effects on leaf number, flowering age, fruit number, fruit weight, and root weight indicates that the magnitude of the response was not sufficient to overcome other factors governing reproductive development. Genotype, nutrient balance, environmental conditions, and the timing and dose of microbial application can all influence the final crop response (Woo et al., 2023; Bonanomi et al., 2022).

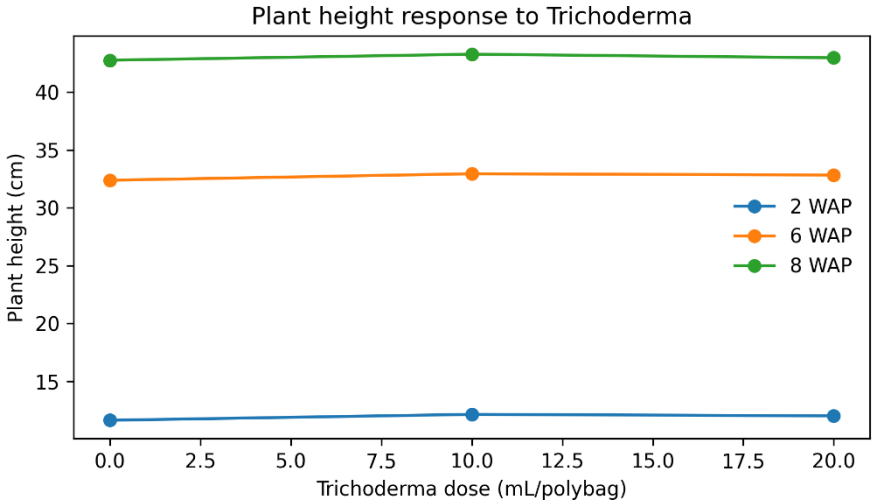


Figure 1. Plant height response to Trichoderma at 2, 6, and 8 WAP

Figure 1 illustrates the generally higher plant-height means under Trichoderma treatments, especially at 6 and 8 WAP. The pattern suggests that the treatment effect became more apparent as plants developed, although the 20 mL/polybag dose did not always exceed the 10 mL/polybag dose for plant height. This reinforces the need to interpret dose responses from statistical comparisons rather than assuming that the highest dose is always optimal.

Chicken manure significantly increased plant height at 2 WAP, where K2 reached 12.22 cm compared with 11.72 cm for K0. At 8 WAP, chicken manure significantly affected stem diameter, with K2 producing 8.24 mm compared with 8.05 mm in the control. The response is biologically plausible because poultry manure provides nutrients and organic matter and can improve the physical and biological properties of the growing medium (Siemon et al., 2020; Gani et al., 2021). Studies on eggplant have also demonstrated significant growth responses to chicken manure dose, although the optimum dose differs among experiments (Hasibuan, 2023; Abdillah et al., 2023).

The absence of significant chicken-manure effects on most later growth and yield variables may reflect the gradual release of nutrients from organic fertilizer. Organic amendments are influenced by decomposition, temperature, moisture, and microbial activity, so nutrient availability is not

necessarily synchronized with the crop's peak demand (Dermiyati, 2020). Similar variability has been reported in eggplant studies using organic amendments, where decomposition time and fertilizer dose affected some growth variables but not all parameters simultaneously (Abdillah et al., 2023).

Table 4. Selected means for significant Trichoderma × chicken manure interactions

Combination	Mean	Response
T0K0	42.43	Plant height, 8 WAP
T0K1	43.03	Plant height, 8 WAP
T0K2	42.79	Plant height, 8 WAP
T1K0	43.65	Plant height, 8 WAP
T1K1	42.77	Plant height, 8 WAP
T1K2	43.37	Plant height, 8 WAP
T2K0	42.91	Plant height, 8 WAP
T2K1	42.54	Plant height, 8 WAP
T2K2	43.44	Plant height, 8 WAP
T0K0	4.42	Stem diameter, 4 WAP
T0K1	4.30	Stem diameter, 4 WAP
T0K2	4.19	Stem diameter, 4 WAP
T1K0	3.98	Stem diameter, 4 WAP
T1K1	4.29	Stem diameter, 4 WAP
T1K2	4.26	Stem diameter, 4 WAP
T2K0	4.31	Stem diameter, 4 WAP
T2K1	4.07	Stem diameter, 4 WAP
T2K2	4.37	Stem diameter, 4 WAP
T0K0	5.91	Stem diameter, 6 WAP
T0K1	6.03	Stem diameter, 6 WAP
T0K2	5.97	Stem diameter, 6 WAP
T1K0	5.83	Stem diameter, 6 WAP
T1K1	6.24	Stem diameter, 6 WAP
T1K2	6.20	Stem diameter, 6 WAP
T2K0	6.17	Stem diameter, 6 WAP
T2K1	5.96	Stem diameter, 6 WAP
T2K2	6.24	Stem diameter, 6 WAP
T0K0	7.88	Stem diameter, 8 WAP
T0K1	8.30	Stem diameter, 8 WAP
T0K2	8.17	Stem diameter, 8 WAP
T1K0	7.97	Stem diameter, 8 WAP
T1K1	8.29	Stem diameter, 8 WAP
T1K2	8.25	Stem diameter, 8 WAP
T2K0	8.30	Stem diameter, 8 WAP
T2K1	8.03	Stem diameter, 8 WAP
T2K2	8.30	Stem diameter, 8 WAP

The significant interaction at 8 WAP indicates that the effect of one input depended partly on the level of the other input. The highest plant-height mean was observed at T1K0 (43.65 cm), followed closely by T2K2 (43.44 cm) and T1K2 (43.37 cm). For stem diameter, several combinations produced the highest mean at each observation time, including T0K0 at 4 WAP and T1K1/T2K2 at 6 WAP, while T0K1, T2K0, and T2K2 reached 8.30 mm at 8 WAP. This pattern does not support a simple assumption that the highest dose of both inputs must always be the best combination.

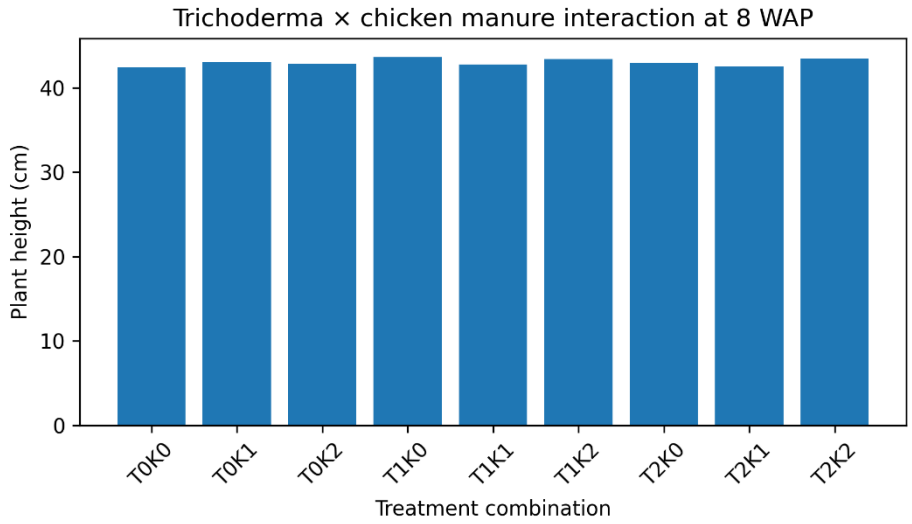


Figure 2. Trichoderma × chicken manure interaction for plant height at 8 WAP

The interaction pattern is consistent with the principle that beneficial microorganisms and organic amendments may act through different but complementary pathways. Organic amendments provide substrates and nutrients, while Trichoderma can contribute to decomposition, rhizosphere interactions, and plant-growth stimulation (Bonanomi et al., 2022; Woo et al., 2023). Nevertheless, the strength of the interaction depends on the environmental context and microbial establishment, which may explain why the interaction was significant for selected vegetative variables but not for reproductive traits.

Root length was significantly affected by Trichoderma, with T2 reaching 40.30 cm, compared with 39.15 cm under T0 and 38.85 cm under T1. The increase in root length under T2 provides the clearest evidence in this experiment that Trichoderma influenced below-ground vegetative development. Root stimulation is consistent with the recognized plant-beneficial functions of Trichoderma, including root colonization, hormonal signaling, and improved nutrient uptake (Woo et al., 2023; Guzmán-Guzmán et al., 2023).

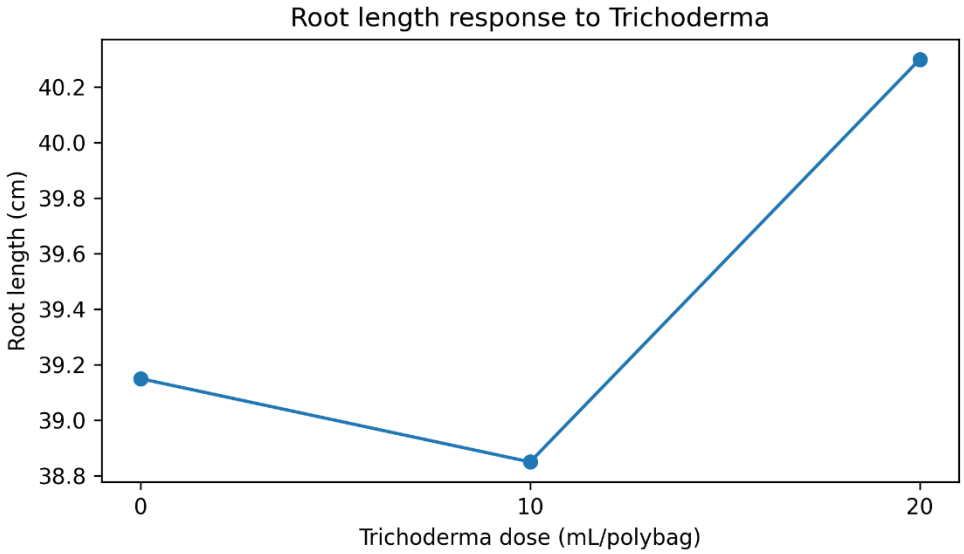


Figure 3. Root length response to Trichoderma

Although T2 produced the longest roots, root weight was not significantly affected. This distinction is important: a longer root system does not necessarily mean greater root biomass. Root architecture can change through elongation or branching without a proportional increase in dry or fresh mass. Therefore, the significant root-length response should be interpreted as a specific morphological response rather than evidence of a universal improvement in all root characteristics.

Table 5. Main-effect means for non-significant yield-related responses

Variable	T0	T1	T2	K0	K1	K2
Flowering age (days)	26.81	27.07	26.93	26.89	27.11	26.81
Fruit number, harvest 1	1.93	1.96	2.19	2.00	1.96	2.11
Fruit number, harvest 2	1.89	1.78	1.89	1.85	1.70	2.00
Fruit weight/plant, harvest 1 (g)	6.89	6.89	7.05	6.87	7.00	6.97
Fruit weight/plant, harvest 2 (g)	6.92	6.88	7.12	6.89	7.00	7.03
Root weight (g)	7.24	7.28	7.47	7.34	7.28	7.37

Most reproductive variables did not differ significantly among treatments. The highest numerical means were often associated with T2 and/or K2, but the differences were not statistically significant. This distinction prevents overinterpretation of numerical trends as treatment effects. Previous eggplant research likewise shows that nutrient management can improve some growth or yield components without producing uniform responses across all variables (Aldo & Sebayang, 2023; Purba & Wicaksono, 2022). The present findings therefore suggest that the treatments primarily modified vegetative growth under the tested conditions.

The overall response also agrees with the broader literature showing that organic amendments and microbial inoculants can improve crop performance, but their effects are context dependent. Factors such as soil properties, moisture, temperature, nutrient availability, microbial establishment, and crop genotype can modify treatment effectiveness (Bonanomi et al., 2022; Woo et al., 2023). The results should therefore be interpreted as evidence for the tested Medan Deli conditions rather than as a universal optimum for all eggplant production systems.

CONCLUSIONS

Trichoderma sp. significantly improved plant height at 2, 6, and 8 WAP and increased root length, with the 20 mL/polybag treatment producing the highest root-length mean. Chicken manure significantly increased plant height at 2 WAP and stem diameter at 8 WAP, with 1,000 g/polybag producing the highest means for these significant responses. The interaction between Trichoderma and chicken manure was significant for plant height at 8 WAP and stem diameter at 4, 6, and 8 WAP. Most leaf, flowering, fruit, and root-weight variables were not significantly affected. Thus, under the experimental conditions, Trichoderma and chicken manure were more consistently associated with vegetative growth than with yield improvement. The combination T2K2 (20 mL Trichoderma sp. + 1,000 g chicken manure per polybag) produced several high numerical means, but it should not be described as universally superior because some responses were not statistically significant.

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