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Effect of Different Rates of Coffee Husk Compost as a Soil Amendment on the Growth of Coffee Seedlings

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Abstract

The quality of coffee seedlings is strongly influenced by the growing medium, particularly its organic matter content and nutrient availability. Coffee husk is an abundant agro-industrial by-product that can be composted and utilized as a soil amendment to improve nursery media quality. This study aimed to evaluate the effect of different rates of coffee husk compost on the growth of coffee seedlings. The experiment was conducted for four months in a nursery using a Randomized Complete Block Design (RCBD) with seven compost rate treatments and four replications. Treatments consisted of a control and six compost rates equivalent to 1/4, 1/2, 3/4, 1, 1 1/4, and 1 1/2 of the recommended dose. Observed growth parameters included seedling height, stem diameter, and number of leaves. Data were analyzed using analysis of variance (ANOVA), followed by Duncan's Multiple Range Test (DMRT) at the 5% significance level. The results showed that coffee husk compost significantly enhanced all growth parameters compared to the control. Growth increased with increasing compost rates up to the recommended dose, beyond which no further significant improvement was observed. These findings indicate that coffee husk compost can be effectively used as a soil amendment to improve coffee seedling growth when applied at an optimal rate.

Keywords: Agro-industrial waste; Nursery media; Organic amendment

1. Introduction

Coffee is one of the most economically important plantation crops worldwide, and its productivity is strongly influenced by the quality of seedlings used during plantation establishment. Seedlings with good vigor, characterized by optimal height, stem diameter, and leaf development, are more likely to survive transplanting stress and perform well in the field (Vaast et al., 2016). Nursery management practices, particularly the selection and amendment of growing media, therefore play a critical role in determining early plant performance.

Organic matter is a key component of high-quality nursery media because it improves soil structure, increases water-holding capacity, and enhances nutrient availability. Hernández et al. (2016) reported that organic amendments improve aggregation and porosity of growing media, which supports better root development and nutrient uptake. In coffee nurseries, media poor in organic matter often limit root growth and restrict nutrient supply, resulting in slow seedling development.

Coffee husk is a major agro-industrial by-product generated during coffee processing, and its accumulation poses environmental challenges in many coffee-producing regions. Chemura et al. (2014) reported that coffee husk contains high levels of organic carbon and essential nutrients, particularly potassium, making it a promising raw material for compost production. However, fresh coffee husk may contain phenolic compounds and caffeine that can inhibit plant growth, necessitating composting before agricultural use (Mekonnen et al., 2021).

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Several studies have demonstrated the positive effects of composted agricultural wastes on plant growth. Agegnehu et al. (2016) showed that organic amendments improved soil fertility and crop performance by enhancing nutrient retention and microbial activity. Similarly, Chali et al. (2021) reported that coffee husk compost improved growth and yield of coffee plants by increasing nutrient availability and improving soil physical properties. Despite these findings, information on the optimal application rate of coffee husk compost for coffee seedlings under nursery conditions remains limited. Excessive application may lead to suboptimal aeration or nutrient imbalance (Agyarko et al., 2018). Therefore, evaluating different rates of coffee husk compost is necessary to determine an optimal dose that maximizes seedling growth without negative effects.

2. Materials and methods

2.1. Experimental Site and Design

The experiment was conducted from February to May 2025 in Sudalarang Village, Wanaraja District, Garut Regency, West Java Province, Indonesia. The study was carried out in a nursery environment using polybags as planting containers. A Randomized Complete Block Design (RCBD) was employed, consisting of seven treatments and four replications, resulting in 28 experimental units. Each experimental unit comprised one coffee seedling grown in a polybag filled with nursery growing media.

2.2. Treatments and Compost Application Rates

The treatments consisted of different application rates of coffee husk compost as a soil amendment. The compost rates were expressed as fractions of a recommended dose and were determined based on previous nursery and pot experiments reported in the literature. Dewi et al. (2025) reported effective application rates of coffee husk compost ranging from 150 to 600 g per plant for coffee seedlings, while Napitupulu (2023) demonstrated that coffee husk compost applied at 30–90 g per polybag produced positive growth responses in pot experiments. Based on these findings, the recommended dose (1 dose) in the present study was set at 400 g coffee husk compost per polybag, which falls within the effective and safe range reported for nursery conditions.

The seven treatment levels were as follows:

- A = Control (0 dose): 0 g compost polybag^{-1}
- B = 1/4 dose: 100 g compost polybag^{-1}
- C = 1/2 dose: 200 g compost polybag^{-1}
- D = 3/4 dose: 300 g compost polybag^{-1}
- E = 1 dose: 400 g compost polybag^{-1}
- F = 1 1/4 dose: 500 g compost polybag^{-1}
- G = 1 1/2 dose: 600 g compost polybag^{-1}

Composted coffee husk was thoroughly mixed with the nursery growing media according to the assigned treatment rates prior to transplanting the coffee seedlings into the polybags. Composting was conducted until maturity to reduce phytotoxic compounds and stabilize nutrients, as recommended by Mekonnen et al. (2021).

2.3. Seedling Management

Coffee seedlings were maintained under uniform nursery management practices throughout the experimental period. These practices included regular irrigation to maintain adequate moisture, manual weed control, and general observation to ensure uniform growing conditions across all treatments.

2.4. Observed Parameters

Growth parameters observed at the end of the experimental period included seedling height, stem diameter, and number of leaves. These parameters were selected because they are widely used indicators of coffee seedling vigor and nursery performance (Vaast et al., 2016).

2.5. Statistical Analysis

The collected data were subjected to analysis of variance (ANOVA) to evaluate the effect of coffee husk compost application rates on coffee seedling growth. When significant treatment effects were detected, mean separation was performed using Duncan's Multiple Range Test (DMRT) at the 5% significance level.

3. Results and discussion

3.1. Effect of Coffee Husk Compost Rates on the Growth of Coffee Seedlings

An evaluation was conducted to assess the response of coffee seedling growth to different rates of coffee husk compost applied as a soil amendment in nursery media. Growth parameters, including seedling height, stem diameter, and number of leaves, are key indicators of seedling vigor and nursery performance, as they reflect the effectiveness of nutrient availability and physical conditions of the growing medium. The growth responses of coffee seedlings under different compost rate treatments are presented in Table 1.

Table 1 Results of Sweet Corn Growth

Treatment	Compost Rate (g polybag^{-1})	Seedling Height (cm)	Stem Diameter (mm)	Number of Leaves (leaves plant^{-1})
A	0 (Control)	18.4 ± 0.8 a	3.2 ± 0.1 a	6.1 ± 0.3 a
B	100 (1/4 dose)	21.7 ± 0.9 b	3.6 ± 0.1 b	6.9 ± 0.2 b
C	200 (1/2 dose)	24.9 ± 1.0 c	4.1 ± 0.2 c	7.8 ± 0.3 c
D	300 (3/4 dose)	27.6 ± 0.8 d	4.6 ± 0.2 d	8.6 ± 0.2 d
E	400 (1 dose)	29.8 ± 0.9 e	5.0 ± 0.2 e	9.3 ± 0.3 e
F	500 (1 1/4 dose)	30.4 ± 1.1 e	5.1 ± 0.2 e	9.4 ± 0.2 e
G	600 (1 1/2 dose)	30.1 ± 1.0 e	5.0 ± 0.1 e	9.2 ± 0.3 e

Note: Values are mean ± standard error (SE). Means followed by different letters within the same column are significantly different at $p < 0.05$ according to Duncan's Multiple Range Test (DMRT).

The results presented in Table 1 show that the application of coffee husk compost significantly affected the growth of coffee seedlings. All compost-treated seedlings exhibited higher seedling height, stem diameter, and number of leaves compared to the control treatment (A), indicating that the addition of organic matter improved the quality of the nursery growing medium.

Seedling height increased progressively with increasing compost rates from treatment B (1/4 dose) to treatment E (1 dose). This trend suggests that coffee husk compost enhanced nutrient availability and improved physical conditions of the growing media, thereby supporting cell elongation and vegetative growth. Coffee husk compost is known to supply essential nutrients, particularly nitrogen and potassium, which play important roles in shoot growth and photosynthetic activity (Chemura et al., 2014). Similar increases in coffee seedling height following compost application were also reported by Dewi et al. (2025).

Stem diameter showed a comparable response pattern, increasing significantly with compost application up to the recommended dose (E). Stem diameter is an important indicator of seedling sturdiness and potential survival after transplanting. The improvement in stem diameter may be attributed to enhanced soil aggregation and moisture retention resulting from organic matter addition, which creates favorable conditions for steady stem growth (Hernández et al., 2016). Treatments F and G did not show significant differences compared to treatment E, indicating that higher compost rates did not further improve stem development.

The number of leaves increased significantly with compost rate up to the recommended dose, reflecting improved photosynthetic capacity and overall seedling vigor. Organic amendments are known to stimulate microbial activity and nutrient mineralization, resulting in sustained nutrient supply for leaf initiation and expansion (Aging et al., 2020). However, the absence of significant differences among treatments E, F, and G suggests that the growing medium reached an optimal balance of nutrients and physical conditions at the recommended dose.

Overall, the growth response pattern observed in this study indicates that coffee husk compost is effective as a soil amendment for coffee seedling production. The recommended dose of 400 g compost polybag^{-1} (treatment E) can be considered the optimal rate, as higher doses did not provide additional growth benefits. These findings emphasize the importance of optimizing compost application rates to maximize seedling growth while maintaining efficient use of organic inputs in nursery systems.

4. Conclusions

The application of coffee husk compost as a soil amendment significantly improved the growth of coffee seedlings compared to the control treatment. Increasing compost rates enhanced seedling height, stem diameter, and number of leaves up to the recommended dose of 400 g compost polybag^{-1}. This indicates that the addition of organic matter from coffee husk compost effectively improved the physical and chemical properties of the nursery growing medium.

Among the evaluated treatments, the application of 400 g coffee husk compost polybag^{-1} (treatment E) produced optimal growth responses and was not significantly different from higher compost rates. Therefore, this rate can be considered the most efficient and appropriate dose for coffee seedling production under nursery conditions. The findings demonstrate that coffee husk compost has strong potential as a sustainable soil amendment for improving coffee seedling vigor while promoting the utilization of agro-industrial waste

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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