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RESEARCH ARTICLE — Open Access

Improving the Growth of Tomato Plants (*Lycopersicum esculentum* L.) by Providing Ash from Empty Oil Palm Fruit Bunches

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Abstract

Tomato plants (*Lycopersicon esculentum* L.) are among the most widely consumed vegetables worldwide and belong to the Solanaceae family. They represent a vegetable commodity with significant potential for development. This study aims to evaluate the effect of applying empty oil palm bunch ash (ATKKS) on the growth of tomato plants. The research employed a non-factorial Randomized Block Design (RBD) with four treatments and five replications. Data were analyzed using Analysis of Variance (ANOVA), followed by a 5% Duncan's Multiple Range Test (DMRT) for further comparison. The results showed that the Sand Soil Treatment combined with 450 grams of Empty Oil Palm Bunch Ash per polybag was the most effective in promoting vegetative growth. This yield was evidenced by a significant increase in plant height, number of leaves, and stem diameter compared to other treatments. This finding indicates that the combination can optimally supply the nutrients required by plants up to the fourth week. For future research, it is recommended to evaluate the effects of this treatment during the generative phase of plant development and on production yields. Additionally, assessing its effectiveness on other plant species and under various environmental conditions will help broaden its practical application in the field.

Keywords: Empty Bunch Ash, Oil Palm Empty Bunch Ash, Organic Empty Fruit Bunch Ash, Tomato Plant Growth, Tomato Plant (*Lycopersicum esculentum* L.)

1. Introduction

Tomatoes are among the most widely consumed vegetables globally. Scientifically known as Lycopersicon esculentum L., tomato plants belong to the Solanaceae family and represent a highly valuable agricultural commodity with significant potential for growth. These plants can be cultivated in diverse environments, ranging from lowlands to highlands, and are often grown in former rice fields and drylands (Simpson, 2010). In 2023, Indonesia's tomato production reached approximately 1.12 million tons, with North Sumatra being one of the key production regions, contributing over 100,000 tons.

However, local tomato farmers face challenges such as declining soil fertility and an over-reliance on chemical fertilizers (Statistik, 2023). To address these issues, research into using empty fruit bunch (EFB) ash as an alternative organic fertilizer has gained attention. This waste material is abundant in oil palm plantations and is rich in essential nutrients, particularly potassium and calcium. Utilizing EFB ash could not only improve tomato plant growth sustainably and efficiently but also provide a solution for the environmentally friendly recycling of agricultural waste.

Historically, the tomato was considered a wild plant with limited utility. It was first used as a food ingredient in Peru, and its culinary use expanded widely in Europe, particularly as a seasoning in cooking. Today, tomatoes are a vital ingredient in various foods, including sauces, canned products, and other nutritious dishes (Muanah et al., 2020). They can be consumed fresh, juiced, made into sauce, fried chili sauce, or pickled. Additionally, the shoots and young leaves of tomato plants can be used as vegetables (Fitriani, 2012). Besides their great taste, selecting the right planting medium and providing proper care can significantly enhance the quality of tomato seedlings, ensuring better yields for farmers.

One organic material that can be used as a supplement to growing media is empty oil palm bunch ash (ATKKS).

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Empty oil palm bunch ash is a byproduct of palm oil processing, typically discarded or used as fuel. However, research shows that ATKKS contains nutrients that can benefit plant growth (Nurul Hidayati, 2015).

Empty oil palm bunch ash (OPAF), a solid waste product from the palm oil industry, has excellent potential for use as an ameliorant or fertilizer. OAP ash contains macronutrients, such as potassium (K), phosphorus (P), and calcium (Ca), which play a crucial role in enhancing soil fertility and promoting plant growth. Furthermore, the use of OAP ash can also be a solution to reduce industrial waste, which often causes environmental problems (Mercy et al., 2013).

However, despite its significant potential, research on the effects of ATKKS ash on tomato plant growth remains limited. Factors such as dosage, frequency of application, and the interaction of ATKKS ash with other growing media require further study to ensure optimal benefits. Understanding the effects of ATKKS ash on tomato plant growth parameters, including plant height, leaf number, flowering time, number of flowers per bunch, and number of fruits per bunch, is crucial (Fadhillah & Harahap, 2020).

Using ATKKS as a supplement to growing media can provide several benefits, including enhancing soil fertility, improving soil structure, and supplying essential nutrients for plants. However, further research is needed to determine the effect of ATKKS on tomato plant growth using polybags as a growing medium (Ananda et al., 2023).

Polybags measuring 35 x 35 cm are commonly used in nurseries due to their practicality and ease of monitoring plant growth. Research on the effect of ATKKS on tomato plant growth using polybags is crucial for providing more in-depth information on ATKKS's potential to enhance tomato productivity (Anggraini & Saleh, 2021).

Based on the explanation above, researchers will conduct a study on the Effect of Providing Empty Oil Palm Fruit Bunch Ash on the Growth of Tomato Plants (*Lycopersicum esculentum* L.). This research aims to determine the effect of providing empty oil palm fruit bunch ash (ATKKS) on the growth of tomato plants.

2. Material and Methods

2.1. Time and Place of Research

This research was conducted from February to April 2025 at the Wonorejo Village nursery in Pekan Tolan Village, South Labuhanbatu Regency, North Sumatra, with coordinates 2°031'67" N and 100°083'61" E, at an altitude of 200 meters above sea level.

2.2. Tools and materials

The tools used in this study include stationery, a cellphone camera, calipers, and a ruler. The materials used are 35 x 35 polybags, sacks, tomato seeds, and empty oil palm bunch ash.

2.3. Research methods

The research method used was a non-factorial Randomized Block Design (RBK) with 4 treatments, five replications, and the research treatment involved adding a mixture of empty coconut bunch ash in different proportions to the topsoil planting medium. The research treatments were: Control, Sandy Soil + 350 grams of Empty Palm Oil Bunch Ash/polybag, Sandy Soil + 400 grams of Empty Palm Oil Bunch Ash/polybag, and Sandy Soil + 450 grams of Empty Palm Oil Bunch Ash/polybag.

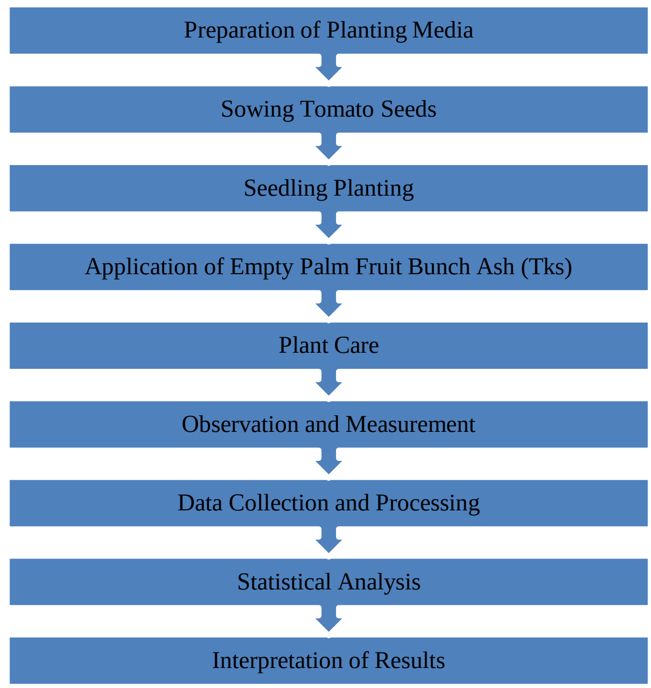

Figure 1. Research flow diagram

2.4. Analysis Method

The research data will be analyzed using Analysis of Variance (ANOVA) using SPSS software version 24. Data analysis was conducted using a factorial randomized block design (FRBD) method. If a significant difference is found, it will be further tested (DMRT) at the 5% level.

2.5. Observation parameters

2.5.1. Plant Height (cm)

Explanation: Plant height is measured from the base of the stem to the point where the tallest leaf grows. This parameter indicates the growth rate of the seedlings and can be used to evaluate seedling quality. Measurements begin 1 week after planting (WAP) to 4 weeks after planting (WAP).

2.5.2. Number of leaves (strands)

Explanation: Count the number of fully opened leaves. The number of leaves reflects the seedlings' photosynthetic capacity and vegetative development. Counting begins when the plants are 1 to 4 weeks after planting.

2.5.3. Diameter of the base of the stem (cm)

Explanation: The diameter of the base of the stem is measured using a vernier caliper. The larger the diameter, the stronger the seedling will be to support further growth. Measurements begin when the plant is 1 to 4 weeks after planting.

3. Results and Discussion

3.1. Number of shoots

Based on observations and field research, high plant yields are presented in Table 1.

Table 1. Number of shoots

Treatment	Plant Height (Cm)			
	1 MST	2 MST	3 MST	4 MST
Control	4.12± 0.015 a	6.4± 0.029 a	8.6± 0.058 a	10.84± 0.066 a
Sand Soil + 350 Grams of Ash from Empty Oil Palm Fruit Bunches / Polybag	4.78± 0.015 b	7.2± 0.029 b	10.02± 0.015 b	12.54± 0.020 b
Sandy Soil + 400 Grams of Ash from Empty Oil Palm Fruit Bunches / Polybag	5.05± 0.010 c	7.82± 0.015 c	10.98± 0.040 c	13.68± 0.015 c
Sandy Soil + 450 Grams of Ash from Empty Oil Palm Fruit Bunches / Polybag	5.32± 0.015 d	8.14± 0.021 d	11.5± 0.029 d	14.08± 0.040 d

Note: Mean values in each column followed by the same letter indicate that they are not significantly different at 5% DMRT with five replications.

The observation results showed that the treatment of Sandy Soil + 450 Grams of Ash from Empty Oil Palm Bunches / Polybags had the most significant effect on increasing plant height in all weeks of observation. The average plant height in the treatment of Sandy Soil + 450 Grams of Ash from Empty Oil Palm Bunches / Polybags was 5.32 cm (1 WAP), 8.14 cm (2 WAP), 11.5 cm (3 WAP), and 14.08 cm (4 WAP), respectively, which were significantly different compared to other treatments as indicated by different letter notations (d). The treatment of Sandy Soil + 400 Grams of Ash from Empty Oil Palm Bunches / Polybags also showed a significant increase with a value of 5.05c–13.68c, followed by Sandy Soil + 350 Grams of Ash from Empty Oil Palm Bunches / Polybags with 4.78b–12.54b. Meanwhile, the Control treatment had the lowest growth, with values ranging from 4.12a to 10.84a, indicating that the treatment without additional nutrients or special treatment was unable to stimulate plant growth as well as other treatments. The difference in the letter notation a, b, c, and d in each week indicates a statistically significant difference between treatments at the 5% test level. This study aligns with Hamiya (2024), which shows that the provision of chicken manure, rice husk charcoal, and guano treatments significantly affected the growth and production of large chili peppers in terms of plant height parameters at 7, 14, and 21 HST. This study differs from Adolph (2016), which showed that planting media (including sand, coconut fiber, and manure) significantly affected plant height.

3.2. Number of Leaves

Based on observations and field research, the results of the number of leaves are presented in Table 2.

Table 2. Number of leaves

Treatment	Number of Leaves (Sheets)			
	1 MST	2 MST	3 MST	4 MST
Control	4.2± 0.058 a	6.4± 0.058 a	8.8± 0.058 a	11.8± 0.058 a
Sand Soil + 350 Grams of Ash from Empty Oil Palm Fruit Bunches / Polybag	5.2 ± 0.058 b	7.8± 0.058 b	10.6± 0.058 b	13.6± 0.058 b
Sandy Soil + 400 Grams of Ash from Empty Oil Palm Fruit Bunches / Polybag	5.8± 0.058 c	8.6± 0.058 c	11.8± 0.058 c	14.8± 0.058 c
Sandy Soil + 450 Grams of Ash from Empty Oil Palm Fruit Bunches / Polybag	6.4± 0.058 d	9.6± 0.058 d	12.8± 0.058 d	15.8± 0.058 d

Note: Mean values in each column followed by the same letter indicate that they are not significantly different at 5% DMRT with five replications.

The results of observations on the number of plant leaves from week 1 to week 4 showed that the treatment of Sand Soil + 450 Grams of Ash from Empty Oil Palm bunches/polybags yielded the best results, with the highest number of leaves, and was significantly different from other treatments. In week 1 (1 WAP), the number of leaves in Sand Soil + 450 Grams of Ash from Empty Oil Palm Bunches / Polybags reached 6.4 leaves, while the control was only 4.2 leaves. The increasing trend continued from week 2 to week 4, where Sand Soil + 450 Grams of Ash from Empty Oil Palm bunches / Polybags recorded 9.6, 12.8, and 15.8 leaves, respectively. In contrast, the control treatment consistently had the lowest number of leaves, specifically 6.4 leaves (2 WAP), 8.8 leaves (3 WAP), and 11.8 leaves (4 WAP). Different letter notations (a, b, c, d) in each week indicate that the difference in the number of leaves between the Control treatment to Sand Soil + 450 Grams of Ash of Empty Oil Palm Fruit Bunches / Polybag is statistically significant, indicating that the higher the treatment level, the greater the number of leaves produced by the plant. This study aligns with Jatsiyah & Setiawan (2024). All doses of AJKS have a significant effect on the number of leaves parameter, with a dose of 550 g/ g/polybag as the optimal. High doses (450 g/ g/polybag) produce the highest number of leaves per polybag. While this study is different from (Ramanda et al., 2022) which shows that the administration of The 450 g/ g/polybag dose also had a positive impact on leaf number, but was used as a benchmark without showing significant differences between higher and lower doses, in contrast to your results, which showed lower control and significant differences between treatments.

3.3. Stem diameter

Based on observations and field research, the results of the stem diameter of tomato plants are presented in Table 3.

Table 3. Stem diameter

Treatment	Stem Diameter (cm)			
	1 MST	2 MST	3 MST	4 MST
Control	0.28± 0.006 a	0.42± 0.006 a	0.56± 0.006 a	0.68± 0.006 a
Sand Soil + 350 Grams of Ash from Empty Oil Palm Fruit Bunches / Polybag	0.32± 0.006 b	0.47± 0.006 b	0.62± 0.006 b	0.74± 0.006 b
Sandy Soil + 400 Grams of Ash from Empty Oil Palm Fruit Bunches / Polybag	0.35± 0.006 c	0.51± 0.006 c	0.67± 0.006 c	0.8± 0.006 c
Sandy Soil + 450 Grams of Ash from Empty Oil Palm Fruit Bunches / Polybag	0.38± 0.006 d	0.56± 0.006 d	0.72± 0.006 d	0.85± 0.006 d

Note: Mean values in each column followed by the same letter indicate that they are not significantly different at 5% DMRT with five replications.

Observations on the diameter of plant stems showed that the treatment of Sand Soil + 450 Grams of Ash from Empty Oil Palm Bunches / Polybags had the most significant effect on increasing stem diameter from week to week. At 1 WAP, the stem diameter of Sand Soil + 450 Grams of Ash from Empty Oil Palm Bunches / Polybags reached 0.38 cm and continued to increase to 0.85 cm at 4 WAP, significantly different from other treatments as indicated by the letter notation "d". The treatment of Sand Soil + 400 Grams of Ash from Empty Oil Palm Bunches / Polybags showed an increase from 0.35 cm (1 WAP) to 0.80 cm (4 WAP), while Sand Soil + 350 Grams of Ash from Empty Oil Palm Bunches / Polybags increased from 0.32 cm to 0.74 cm. The control treatment had the smallest stem diameter, which was only 0.28 cm at 1 WAP and 0.68 cm at 4 WAP, and was consistently significantly different from the other treatments (notation "a"). Overall, these data indicate that the treatment of sandy soil + 350 grams of empty oil palm bunch ash/polybag, sandy soil + 400 grams of empty oil palm bunch ash/polybag, and especially sandy soil + 450 grams of empty oil palm bunch ash/polybag can significantly increase the diameter of the plant stem compared to no treatment. This research aligns with Setyawati et al.'s (2021) study, indicating that the dose of empty oil palm bunches up to 400 g per plant provides a significant increase in stem diameter. While this study differs from Santa et al. (2015), which shows that the dose of organic material OPEFB affects stem diameter, this study found that the optimal dose (600 g/polybag) in rubber plants only provides a significant effect, not a significant difference.


Figure 2. Research Documentation

4. Conclusion

The treatment of sand soil combined with 450 grams of ash from empty oil palm fruit bunches in polybags proved to be the most effective in promoting vegetative growth. This yield was evidenced by a significant increase in plant height, number of leaves, and stem diameter compared to other treatments. This superiority suggests that the combination provides the necessary nutrients optimally up to the fourth week. For future research, it is recommended to evaluate the effects of this treatment during the generative phase of plants and on production outcomes. Additionally, assessing its effectiveness on other plant species and under different environmental conditions would help expand its practical applications in the field.

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