

The effect of nursery media and growth regulatory substance on the success of eucalyptus cuttings at PT Solusi Bangun Indonesia

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Abstract. Eucalyptus (*Melaleuca leucadendra*) is a fast-growing species with a good adaptation level and is widely grown, especially on marginal land. Eucalyptus seedling production is done through shoot cuttings. This study aims to determine the effect of nursery media and plant growth regulators (PGR) on the success of eucalyptus cuttings. The research was conducted for seven weeks using various nursery media and PGR. The research design used a completely randomized design and one-way ANOVA followed by Duncan's test. Results showed that the percentage of live shoot cuttings was 77%. Shoot cuttings that sprouted showed a total rate of 65%, with a total percentage of roots reaching 34%. The ability of shoot cuttings to sprout and roots simultaneously showed a total percentage of 32%. The treatment of nursery media only really affects the percentage of life and sprouting, while the ability to take root and sprout does not have real effects. Applying PGR significantly influences the rate of life, the ability to sprout and roots, and the ability to root sprouts on the cuttings. The interaction of those factors influences the percentage of life and sprout cuttings.

1 Introduction

Land reclamation, especially in mining-affected areas, poses significant environmental challenges. Effective reclamation involves selecting suitable plant species and techniques to ensure successful establishment and growth. Eucalyptus (*Melaleuca leucadendra*) is notable for such projects due to its rapid growth, high adaptability, and resilience in degraded soils. PT Solusi Bangun Indonesia has utilized these traits for their post-limestone mining reclamation efforts, demonstrating eucalyptus's potential to restore ecological balance and provide economic benefits.

Previous studies have demonstrated how crucial it is to choose suitable nursery media and use plant growth regulators (PGR) to increase the success of eucalyptus cutting propagation.

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Studies indicate that these factors significantly influence cuttings' survival, rooting, and sprouting rates, which are crucial for effective reclamation [1]. Thus, understanding and optimizing these variables is essential for improving propagation techniques and ensuring the successful establishment of eucalyptus in post-mining lands.

One of the main challenges in propagating eucalyptus cuttings is achieving high survival and robust root development. The choice of nursery media is crucial, providing the necessary physical and chemical environment for root initiation and growth. Different media compositions impact water retention, aeration, and nutrient availability, which are essential for successful rooting [2]. The objective of this study is to systematically assess how different nursery media and PGRs affect the success of eucalyptus cutting propagation. The study seeks to identify optimal combinations of media and PGRs that maximize survival rates and root development by conducting controlled experiments. This approach improves practical reclamation efforts and enhances scientific understanding of plant propagation in challenging environments.

This study selects suitable media, applies PGRs (IBA, Root-up, and Rootone-F), and evaluates their effects on eucalyptus cuttings at PT Solusi Bangun Indonesia. By examining these treatments in a real-world setting, the research aims to bridge the gap between controlled experiments and field outcomes, contributing to effective land reclamation practices. This study provides critical information on best practices for eucalyptus propagation, supporting sustainable reclamation of degraded lands and promoting environmental restoration efforts.

2 Materials and Methods

2.1 Time and places

The research was conducted over seven weeks at the nursery of PT Solusi Bangun Indonesia, located in Narogong, West Java.

2.2 Preparation of planting media

Media used in this research was red soil, sand, and various combinations with NPK, animal manure fertilization, husk charcoal, compost, and ecoenzyme. Red soil and sand were dried in the sun and acclimatized for 24 hours before use.

2.2.1 Preparation of growth regulators

This study employed a concentration of 250 ppm of Indole-3-butyric acid (IBA), Root-up, and Rootone-F as PGR. IBA was added to one liter of distilled water after being dissolved in a 1% sodium hydroxide solution. To make a paste, Root-up and Rootone-F were combined with water.

2.2.2 Preparation of cutting material

Shoots were selected from eucalyptus seedlings exhibiting superior growth characteristics. The shoots were cut into 5-7 cm segments using sterilized scissors, with the base of each cutting trimmed at a 45° angle. Each cutting retained 2-3 leaves cut in half to reduce transpiration.

2.2.3 Planting and Maintenance

The prepared cuttings were planted in different media and maintained by regular watering and pest and disease control measures.

2.2.4 Data Collection

The proportion of rooted cuttings, the percentage of surviving cuttings, the percentage of cuttings that sprouted, and the rate at which roots sprouted were the factors measured in this experiment. The percentages of each factor were calculated using the following formula:

$$\text{Percentage} = \frac{\text{number of cuttings meeting the criteria}}{\text{total number of cuttings}} \times 100\% \quad (1)$$

2.3 Data Analysis

This research used a dual factor, a completely randomized design, in the form of nursery media and plant growth regulators. The research design can be seen in Table 1. To determine the true impact of the current circumstances, an ANOVA test was used in the statistical analysis of the data.

Table 1. The results of the ANOVA test

PGR	Nursery Media						
	A	B	C	D	E	F	G
X	XA	XB	XC	XD	XE	XF	XG
Y	YA	YB	YC	YD	YE	YF	YG
Z	ZA	ZB	ZC	ZD	ZE	ZF	ZG
K	KA	KB	KC	KD	KE	KF	KG

Note: X: IBA, Y: root-Up, Z: rootone-F, K: control, A: red soil, B: rec soil and NPK, C: red soil and animal mature fertilizer, D: Red soil and compost, E: sand and husk charcoal, F: sand, G: red soil and ecoenzym

3 Results

3.1 The condition of cuttings

The observation included a total of 252 eucalyptus cuttings. The success of these cuttings was evaluated based on several parameters. Of the total cuttings, 194 (77%) remained alive, indicating a high survival rate. Additionally, 165 cuttings (65%) sprouted, demonstrating the ability of a significant proportion of cuttings to produce new shoots. Rooting was observed in 86 cuttings (34%), while 81 cuttings (32%) exhibited both rooting and sprouting. These results indicate that while most cuttings can survive and sprout, a smaller proportion successfully develop roots, which is crucial for long-term growth and establishment.

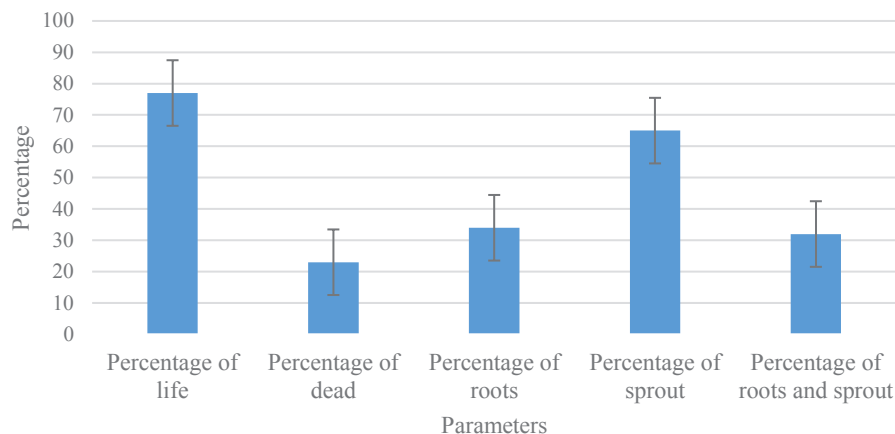


Fig. 1. Percentage of cutting's parameters.

3.2 The influence of nursery media and PGR on cuttings

The results of the one-way ANOVA test, as depicted in Table 2, illustrate the performance of various nursery media in promoting the rooting and sprouting of eucalyptus cuttings. The nursery media, PGR, and their interactions significantly influenced the ability of cuttings to survive, root, and produce shoots. Specifically, nursery media and PGR notably impacted the life percentage, root percentage, sprout percentage, and the combined percentage of roots and sprouts. The significance of these factors is reflected in the coefficients and R^2 values, indicating a robust relationship between the treatments and the observed outcomes. The nursery media primarily influenced the ability of cuttings to root, while growth regulators significantly affected the rooting and sprouting abilities of the cuttings.

Table 2. The results of the ANOVA test

Parameters	Source of Diversity			Coef	R^2
	Nursery Media	Plant Growth Regulator	Interaction		
%life	*	*	*	20,26183	0,881717
%roots	*	ns	ns	83,89395	0,528064
%sprouts	*	*	*	28,31613	0,828118
%roots and sprouts	ns	*	ns	88,79665	0,506974

Note: * : significantly influenced at 95% confidence interval (P-value < 0.05), ns: no significant effect at the 95% confidence interval (P-value > 0.05), coef: coefficient variation, R^2 : R-square

The choice of nursery media significantly affects the success of eucalyptus cuttings. The results in Figure 2 show that the combination of sand and husk charcoal is the most effective medium, providing a porous condition conducive to plant growth. This medium yielded the highest percentage of success, with 90% for rooting, 95% for sprouting, and 100% for both rooting and sprouting, demonstrating the superior performance of this medium. Other media, such as red soil and its combinations with different additives, showed varied but generally lower success rates.

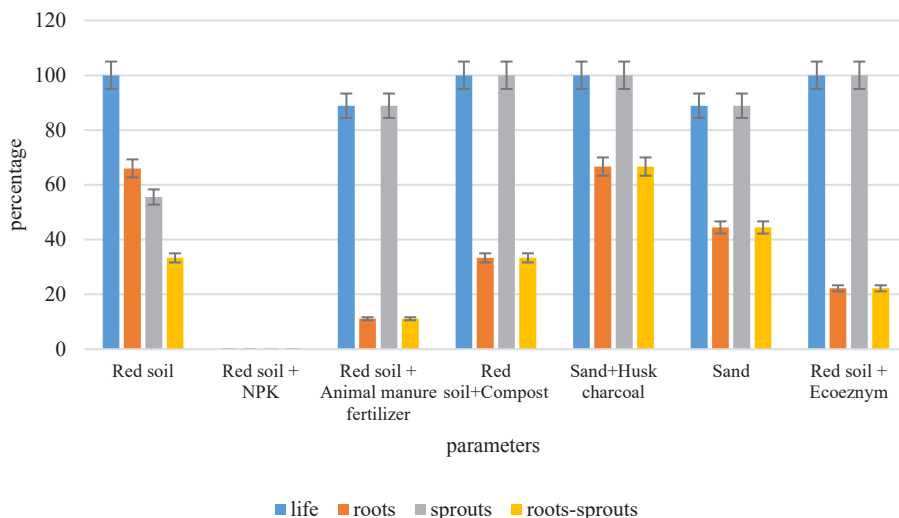


Fig. 2. Parameter comparison of nursery media.

The results, as shown in Figure 3, illustrate eucalyptus cuttings' rooting and sprouting abilities across various PGR. The combination of red soil and Indole-3-butyric acid (IBA) at 250 ppm (XA) yielded the highest success rates in all parameters. Specifically, XA demonstrated a rooting percentage of approximately 85%, a sprouting percentage of 90%, and a combined rooting and sprouting percentage of 95%.

4 Discussion

The results about condition of cuttings align with previous studies emphasizing the complexity of rooting in eucalyptus cuttings. Canopy height, cutting height ratio, stem diameter, and root deformations are critical for cutting health and subsequent field growth [3]. The challenges of adventitious rooting in eucalyptus are influenced by internal and external factors [4]. The observed rooting success of 34% in this study underscores the importance of these factors and the need for optimal nursery conditions. The impact of water stress and planting stock quality on eucalypt survival [5], can explain the variation in rooting and sprouting observed in this study.

Nursery media and PGR that chosen has a crucial impact to the propagation success of plant cuttings. Previous studies have also highlighted the importance of growth media composition in root formation and development [6]. The practical implications of these results are significant for horticultural practices and the commercial propagation of eucalyptus. By optimizing the combination of nursery media and PGR, it is possible to achieve higher success rates in plant propagation, leading to more efficient and cost-effective cultivation methods.

Combining sand and husk charcoal media enhances water retention and aeration, which are critical for root development. Understanding the factors affecting adventitious rooting recalcitrance in eucalyptus [4]. The beneficial effects of eucalyptus plantations on soil characteristics may help ensure that cuttings succeed even more, especially when placed in media that maximises these qualities [7].

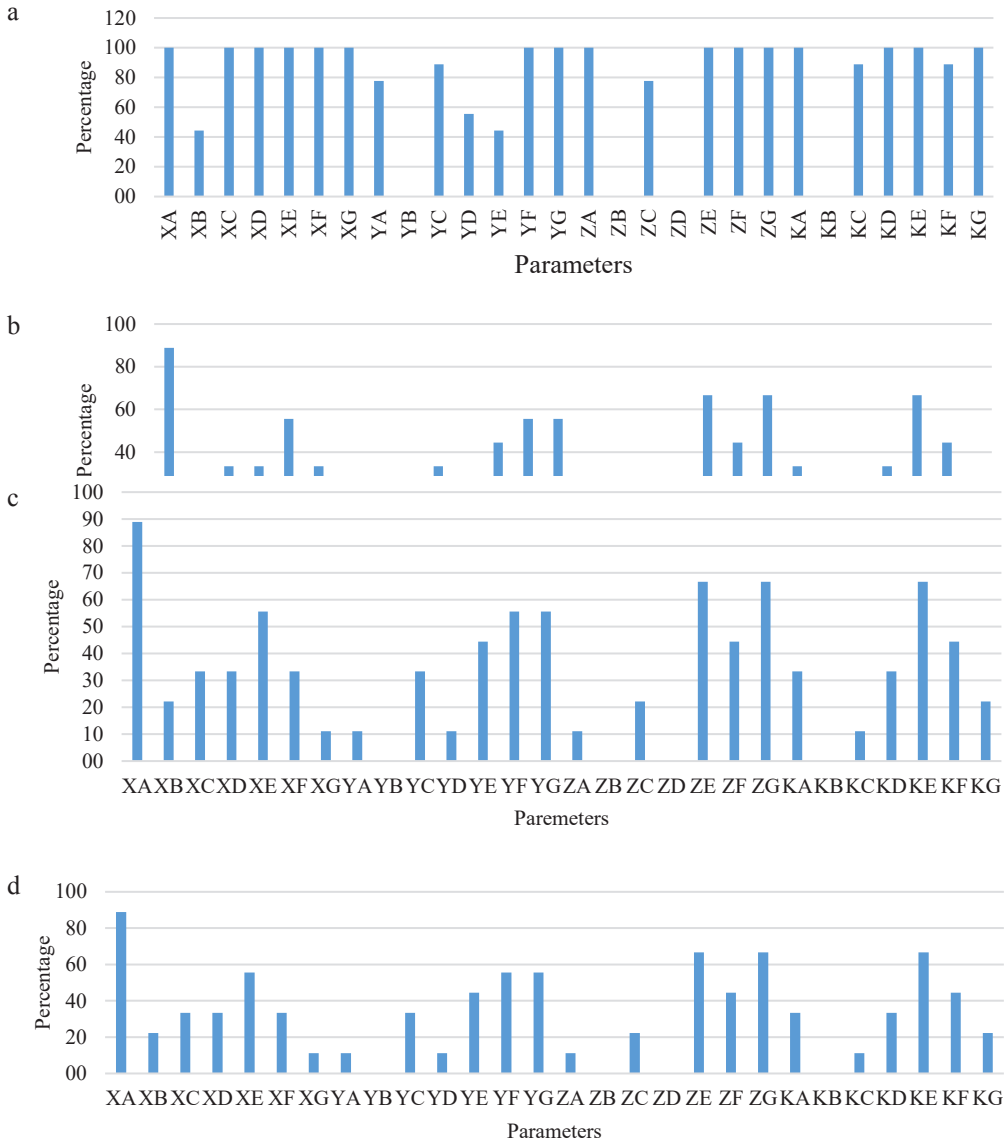


Fig. 3. Parameter comparison of nursery media and PGR. a: percentage of life, b: percentage of roots, c: percentage of sprout, d: percentage of roots and sprouts.

The results of this study are supported by a number of investigations on the effects of various media on plant growth. The role that particular nursery media characteristics, such as porosity and water-holding capacity, play in determining root growth. Sand and husk charcoal work well together to balance these qualities, which helps with aeration and water retention [8]. The results of this study confirm the applicability of this medium by highlighting how important it is for eucalyptus cutting establishment and growth to improve root development. These results highlight how important it is to use the right nursery material in order to maximise the growth and success of eucalyptus cuttings. They also offer insightful

information for future studies and useful applications in clonal propagation and reforestation projects.

The success of the eucalyptus cuttings was largely due to PGR. The highest success rates in all parameters, including rooting, sprouting, and their combination were obtained when 250 ppm of indole-3-butyric acid (IBA) was applied. This is consistent with findings from previous studies, which highlighted the effectiveness of PGRs like auxin in promoting the growth and development of various plant species [9-10]. The results indicate that both nursery media and growth regulators significantly influence the propagation success of eucalyptus cuttings.

The combination of red soil and IBA at 250 ppm (XA) provided the best rooting and sprouting percentages results, emphasizing the importance of media composition and PGR application in propagation practices. Adding IBA at 250 ppm on sand media also yielded excellent results for cuttings to sprout. The potential of PGRs to enhance reclamation success by promoting the growth of native plants and transplanted seedlings. IBA, as pointed out by [11], is particularly effective in rooting cuttings, transplanting, and grafting, supporting the findings of this study. Further, the optimal concentration of IBA for rooting cuttings, as suggested by [12]. Corroborates the high success rates observed with the 250 ppm concentration. This study's results contribute valuable insights into the effective use of nursery media and growth regulators to optimize the propagation of eucalyptus cuttings.

5 Conclusion

Adding PGR significantly enhances the survival, sprouting, rooting, and simultaneous rooting and sprouting of eucalyptus cuttings. While planting media alone significantly affects the survival and sprouting of cuttings, the combination of specific media and PGRs yields superior results. The optimal combination identified in this study was red soil media supplemented with 250 ppm of Indole-3-butyric acid (IBA), which provided the best outcomes across all evaluated parameters. This finding underscores the importance of integrating both media and PGR treatments to maximize the success of eucalyptus cuttings in reclamation projects.

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