Jurnal Pembelajaran Dan Biologi Nukleus p-ISSN: 2442-9481
Vol 11 (4): 1423 - 1436, December 2025 e-ISSN: 2685-7332

Synergystic Role of Cocopeat Matrix and Foliar Nutrient Type on Aclimatization Success of Micropropagated *Dendrobium* Seedlings

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Submitted August 14 Th 2025, and Accepted November 27 Th 2025

Abstract

Background: *Dendrobium orchids have high economic value (in 2020 generated an export value of US$61.87 thousand), yet micropropagated seedlings commonly exhibit slow growth and high mortality during the acclimatization stage. This problem is largely associated with the use of unsuitable planting media and inadequate nutrient supply, which limit seedling adaptation and survival after tissue culture. This study aims to determine the best combination of planting media and foliar fertilizer types for the growth of Dendrobium orchid seedlings during the acclimatization stage.* **Methodology:** *The study was conducted in Penambangan Village, Semanding District, Tuban Regency, East Java Province from November 2024 to February 2025 using a Completely Randomized Design (CRD) with 9 treatment combinations and 4 replications. The first factor was the treatment of planting media types (M1: Black Moss, M2: Rice Husk Charcoal, M3: Cocopeat), and the second factor was the type of foliar fertilizer (P1: Gandasil D, P2: Gaviota 63, P3: Grow Quick LB). The observed research variables included the percentage of live seedlings, plant height, leaf area, seedling growth rate, number of shoots, and number of roots.* **Findings:** *The results showed that the use of cocopeat planting media resulted in the highest percentage of seedling survival at 88.33%. The combination of cocopeat planting media and Grow Quick LB leaf fertilizer produced the best relative growth rate (RGR) at 8-12 WAP of 41.22 mg/month.This research produces the best combination of planting media and foliar fertilizer for orchid seedlings at the acclimatization stage.* **Contribution:** *The findings contribute to a more systematic understanding of how substrate physical properties and foliar nutrient supply interact to influence survival and growth performance during orchid acclimatization, offering a scientifically grounded framework for improving ex vitro propagation efficiency.*

Keywords: *Acclimatization; Dendrobium Orchids; Planting media; Foliar fertilizer*

https://doi.org/10.36987/jpbn.v11i4.8174

INTRODUCTION

Dendrobium orchids are one of the most sought-after and cultivated ornamental plants among various orchid genera (Haniva et al., 2020). The superiority of orchid plants is determined by various morphological characteristics of the flowers, including color, size, shape, arrangement, number of flowers per stem, stem length, and the durability of the flower freshness (Widiastoety et al., 2010). Public interest in Dendrobium orchids continues to increase, indicated by an increase in export volume of 129.12% or 80.80 thousand kilograms (Center for Agricultural Data and Information Systems, Ministry of Agriculture, 2020). The increasing demand for Dendrobium orchid seedlings drives the need to provide large quantities of high-quality, uniformly grown seedlings through tissue culture techniques. Acclimatization is a major challenge in orchid cultivation and is a critical phase in seedling growth, with a survival rate of only 5% (Erfa et al., 2020; Mirani, et al., 2017). The main causes of failure during the acclimatization stage include a growing medium that is unable to absorb and retain water and nutrients, as well as low nutrient levels in the foliar fertilizer used. Low seedling survival rates are also caused by extreme environmental conditions experienced by seedlings during acclimatization, such as excessive transpiration (Bani et al., 2022).

The ideal growing medium for orchids should be resistant to decay or decay, free from disease, have good aeration and drainage, and be able to bind and store water and nutrients optimally to support seedling growth (Herliana et al., 2018). Types of growing media frequently used in plant acclimatization include black moss, fern roots, charcoal, rice husk charcoal, cocopeat, and coconut fiber (Kismayanti et al., 2023). Fertilization is also important to support orchid growth during the acclimatization stage. Fertilization through the leaves is more quickly absorbed by plants than through the root media (Maera, 2015). Fertilizers containing nitrogen can support seedling growth during the vegetative period (Irsyadi & Wulanjari, 2023). The N element also plays a role in increasing photosynthesis, chlorophyll formation, and other organic compounds that support plant physiology (Ivani & Wahyuni, 2024). Types of foliar fertilizers commonly used in orchid nurseries include Gandasil D, Gaviota 63, and Grow Quick LB.

Research by Indiriani (2019) showed that cocopeat growing media produced the best growth in Phalaenopsis orchid seedlings during the acclimatization stage. Nugroho & Raden (2021) reported that the use of cocopeat resulted in the highest survival rate in orchids *C. pandurata* by 88.89%, while the rice husk charcoal medium was only 11.11%. Research Putri et al., (2022) stated that the use of Grow Quick LB foliar fertilizer resulted in the highest average height of Dendrobium seedlings, namely 6.72 cm. Good foliar fertilizer content will be able to maximize orchid plant growth (Ali et al., 2024). Another study conducted by Aulia et al., (2025) found that it is effective in increasing the overall growth of Dendrobium orchids, starting from plant height, number of leaves, leaf width, and number of shoots in the phase seedling. Meanwhile, Agustiar et al., (2021) stated that Gandasil D significantly affected plant height, leaf number, stem diameter, and root number and length. Good foliar fertilizer content can significantly support optimal orchid growth (Astutik et al., 2022).

Based on this description, research is needed that combines the use of various types of planting media and foliar fertilizers to increase the survival rate and growth of Dendrobium orchid seedlings during the acclimatization stage. This research is expected to provide recommendations for the most effective combination of planting media and foliar fertilizers for orchid cultivators and the ornamental plant industry to increase the success of Dendrobium orchid seedling acclimatization.

METHOD

This research was conducted in Penambangan Village, Semanding District, Tuban Regency, East Java Province (-6.943199, 112.060280), from November 2024 to February 2025. The research location is at an altitude of 38 meters above sea level with daily temperatures ranging between 28–33 °C and humidity between 62–80%. Average annual rainfall is 1,368 mm/year. Average daily light intensity is around 1,500 µmol/m²/s in an open space with 11–12 hours of exposure per day. The study was conducted in a shaded house with 75% shade netting.

The materials used in the research were cross-bred Dendrobium orchid plantlets (D. affine × D. gamalama) tissue culture results ready for acclimatization, black moss planting media, rice husk charcoal, cocopeat, Gandasil D leaf fertilizer, Gaviota 63, and Grow Quick LB and Antracol fungicide. The study used a factorial experiment with two factors arranged in a completely randomized design (CRD) and repeated four times,so that 36 experimental units were obtained and each experimental unit consisted of 10 sample plants so that there were 360 Dendrobium orchid seedlings whose percentage of live seedlings would be observed, while observations of the growth parameters of live seedlings would be observed on 3 sample plants in each experimental unit.The first factor is the treatment of the type of planting media with 3 levels, namely Black Moss (M1), Husk Charcoal (M2) and Cocopeat (M3). The second factor is the type of leaf fertilizer with 3 levels, namely Gandasil D (P1), Seagull 63 (P2) dan Grow Quick LB (P3).

The research implementation procedure begins with the preparation of the planting media. Preparation of the planting media, including black moss, rice husk charcoal, and cocopeat, is carried out by washing them with clean water and air-drying them. The acclimatization process is then carried out by carefully removing the orchid seedlings from the sterile bottle using wire. The orchid seedlings are then planted in soft pots with a diameter of 5 cm with a planting media volume of 20 grams. Orchid seedling care is carried out by watering them twice a day, morning and evening, using a hand pump spray. Antracol fungicide application is carried out once a week with a concentration of 2 ml/liter. Foliar fertilizer solution is applied with a concentration of 1 g/L in the first month of planting, 2 g/L in the second month of planting, and 3 g/L in the third month of planting. Fertilization is carried out once a week for 12 weeks after planting and is carried out in the morning. Observed variables include the percentage of live seedlings, plant height, leaf area (cm²), number of shoots, number of roots, and relative growth rate. The tools used include a ruler, calipers, analytical scales, millimeter paper, and an oven. The observation data were then analyzed using analysis of variance (ANOVA) and if the F test results were significantly different, then it was continued with the HSD (Honestly Significant Difference) test at the 5% level.

RESUT AND DISCUSSION

Percentage of Live Seeds

The results of the analysis of the variance of the effect of the combination of treatments of types of planting media and types of leaf fertilizer on the percentage of live seedlings showed that there was no significant interaction, but the single treatment of types of planting media and types of leaf fertilizer had a significant effect on the percentage of live seedlings (Table 1).

Table 1. Average Percentage of Living Orchid Seedlings in Treatments of Planting Media Types and Types of Leaf Fertilizer

Treatment	Percentage of Live Seeds (%)
Types of Growing Media	
M_1(Black Moss)	70.83 b
M_2(Husk Charcoal)	63.33 a
M_3 (Cocopeat)	88.33 c
BNJ 5%	6.09
Types of Foliar Fertilizer	
P_1 (Gandasil D)	73.33 ab
P_2 (Gaviota 63)	70.00 a
P_3 (Grow Quick LB)	79.17 b
BNJ 5%	6.09

Description: Numbers followed by the same letter in the same treatment show no significant difference in the 5% BNJ test.

Table 1 shows that during the acclimatization stage, cocopeat planting media produced the highest percentage of living Dendrobium orchid seedlings at 88.33% and was significantly different from other types of planting media with an increase in the percentage of living Dendrobium orchid seedlings by 25.00% compared to rice husk charcoal planting media. Cocopeat planting media has excellent water retention capacity so it helps maintain high humidity in the planting media around the roots of orchid seedlings which allows for more optimal seedling growth compared to other planting media (Ezperanza et al., 2023).

The treatment of Grow Quick LB leaf fertilizer produced the highest percentage of Dendrobium orchid seedling survival at 79.17% and was significantly different from Gaviota 63 leaf fertilizer, but not significantly different from Gandasil D leaf fertilizer with an increase in the percentage of orchid seedling survival of 9.17% compared to Gaviota 63 leaf fertilizer treatment. The content of Grow Quick LB leaf fertilizer with more complete macro and micro nutrients has been proven to be able to make Dendrobium orchid seedlings adapt to environmental changes fromin vitro the ex vitro.The nitrogen content in Grow Quick LB plays an important role in stimulating the formation of functional leaves and roots which increases the survival percentage of Dendrobium orchid seedlings (Surtinah & Mutryarny, 2013).

Plant Height

The combination of planting medium type and foliar fertilizer did not show a significant interaction on the height of Dendrobium orchid seedlings. However, the single treatment of planting medium type and foliar fertilizer significantly affected the height of Dendrobium orchid seedlings at 2–12 weeks after planting (Table 2).

Table 2. Average Height of Orchid Seedlings in Treatments of Planting Media Types and Types of Leaf Fertilizer

	Plant Height (cm)					
	2 MST	4 MST	6 MST	8 MST	10 MST	12 MST
Types of Growing Media						
M_1(Black Moss)	5.13 ab	5.37 ab	5.69 ab	5.92 ab	6.29 ab	6.65 ab
M_2(Husk Charcoal)	4.85 a	5.08 a	5.28 a	5.53 a	5.87 a	6.26 a
M_3 (Cocopeat)	5.27 b	5.69 b	5.91 b	6.22 b	6.52 b	6.93 b
BNJ 5%	0.27	0.38	0.42	0.40	0.39	0.40
Types of Foliar Fertilizer						
P_1 (Gandasil D)	4.98 ab	5.35 ab	5.61 ab	5.87 ab	6.20 ab	6.55 ab
P_2 (Gaviota 63)	4.90 a	5.14 a	5.41 a	5.65 a	5.92 a	6.31 a
P_3 (Grow Quick LB)	5.36 b	5.65 b	5.87 b	6.14 b	6.56 b	6.99 b
BNJ 5%	0.27	0.38	0.42	0.40	0.39	0.40

Description: Numbers followed by the same letter in the same column and treatment show no significant difference in the 5% BNJ test; Code MST= Weeks After Planting.

Table 2 shows that the cocopeat planting media treatment produced the highest Dendrobium orchid seedling height at all observation ages and was significantly different from the rice husk charcoal planting media, but not significantly different from the black moss planting media treatment. There was an increase in the height of Dendrobium orchid seedlings aged 12 weeks after planting by the influence of the cocopeat planting media treatment by 10.70% compared to the rice husk charcoal planting media treatment.

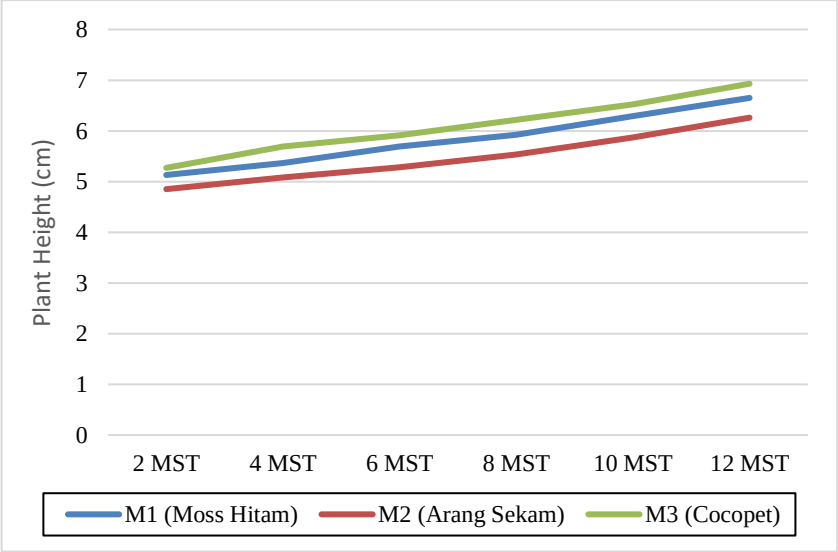

Figure 1. Graph of Average Height of Orchid Plant Seedlings in Planting Media Type Treatments

Graph on figure 1 shows a 10.70% increase in seedling height compared to rice husk charcoal, proving that cocopeat is able to provide more optimal root moisture. Rice husk charcoal media tends to dry out quickly, so nutrient and water absorption is more hampered, thus affecting the growth of orchid seedlings. Orchid seedlings are very sensitive to water shortages. A planting medium with good water absorption will help maintain root zone moisture (rhizospheer) remains high, allowing the seedlings

to adapt to the new environment and avoid drought stress. This aligns with research findings Nuzullah & Firgiyanto (2021), which found that the use of cocopeat media tends to result in the highest plant height increase in Vanda orchid acclimatization.

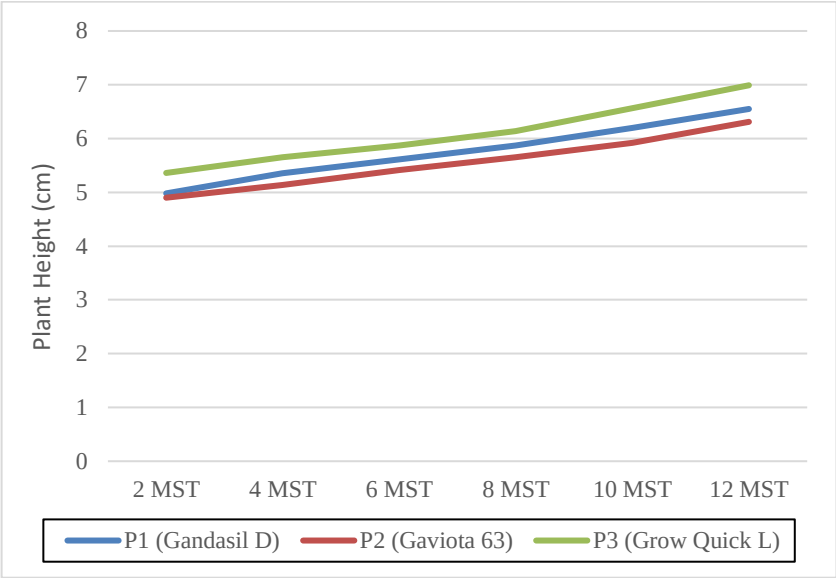

Figure 2. Graph of Average Height of Orchid Plant Seedlings in Treatment of Different Types of Leaf Fertilizer

Graph on figure 2 describe that the treatment of Grow Quick LB leaf fertilizer produced the highest height of Dendrobium orchid seedlings at all observation ages and was significantly different from the treatment of Gaviota 63 leaf fertilizer, but not significantly different from Gandasil D leaf fertilizer. There was an increase in the height of Dendrobium orchid seedlings aged 12 weeks after planting by the influence of Grow Quick LB fertilizer by 10.77% compared to the treatment of Gaviota 63 leaf fertilizer. The high nitrogen content in Grow Quick LB leaf fertilizer plays an important role in increasing the formation of protein and chlorophyll, so that photosynthesis activity takes place more intensively. The function of nitrogen for plants is for the vegetative growth process of plants. Nitrogen will affect the formation of fresh green leaves and contain enough fiber (Derantika et al., 2018). The presence of macro nutrients such as N, P, K and micro nutrients such as Fe, Mn, B, Mo, Vit B in Grow Quick LB leaf fertilizer can meet the specific needs of plants so that it facilitates various metabolic processes that support the high growth of Dendrobium orchid seedlings (Ningsih et al., 2024).

Leaf Area

The combination of planting medium type and foliar fertilizer type on leaf area of Dendrobium orchid seedlings aged 12 weeks after planting did not show a significant interaction. However, the single treatment of planting medium type and

foliar fertilizer type significantly affected leaf area of Dendrobium orchid seedlings (Table 3).

Table 3. Average Leaf Area of Orchid Seedlings Aged 12 Months After Planting in Treatment of Planting Media Type and Type of Leaf Fertilizer

Treatment	Leaf Area (cm^2)
Types of Growing Media	
M_1(Black Moss)	14.65 b
M_2(Husk Charcoal)	12.50 a
M_3 (Cocopeat)	15.91 b
BNJ 5%	1.70
Types of Foliar Fertilizer	
P_1 (Gandasil D)	14.52 b
P_2 (Gaviota 63)	12.08 a
P_3 (Grow Quick LB)	16.46 c
BNJ 5%	1.70

Description: Numbers followed by the same letter in the same treatment show no significant difference in the 5% BNJ test.

Table 3 shows that the cocopeat planting media treatment produced the best leaf area of 15.91 $cm^2$and significantly different from the treatment of rice husk charcoal planting media but not significantly different from the treatment of black moss planting media. There was an increase in the leaf area of Dendrobium orchid seedlings by 27.28% by the treatment of cocopeat planting media compared to the treatment of rice husk charcoal planting media. The ability of cocopeat planting media to retain water and high nutrients is able to provide a more stable supply of nutrients and moisture. Cocopeat planting media has good quality for orchid acclimatization planting media due to the nature of cocopeat planting media which easily absorbs water, as a good water storage, has a macro nutrient content of K, P (Phosphorus), N (Nitrogen), Ca (Calcium), Mg (Magnesium) and is easy to obtain (Andiani, 2018).

Table 3 also shows that Grow Quick LB leaf fertilizer produces the best leaf area of 16.46 $cm^2$and significantly different from other foliar fertilizer treatments. There was an increase in the leaf area of Dendrobium orchid seedlings by 36.25% by the influence of the Grow Quick LB foliar fertilizer treatment compared to the Gaviota 63 foliar fertilizer treatment. Wider leaves mean greater photosynthetic capacity, so that plants are able to produce more assimilates to support vegetative growth. The nutrient content in foliar fertilizers applied directly to the surface of plant leaves allows nutrients such as micronutrients and vitamins to be absorbed quickly through the stomata and leaf cuticles so that they can improve plant physiological processes, such as photosynthesis, respiration, and cell division, so that overall it can encourage vegetative growth of orchid plants more optimally and maximally (Latif et al., 2024).

Seedling Growth Rate

The combination of treatment of planting media type and type of leaf fertilizer on the growth rate of Dendrobium orchid seedlings showed a significant interaction at

the observation ages of 4-8 MST and 8-12 MST. The single factor of planting media type had a significant effect on the growth rate of Dendrobium orchid seedlings at the age of 0-12 MST, while the type of leaf fertilizer had a significant effect on the growth rate of Dendrobium orchid seedlings at the age of 4-12 MST (Table 4).

Tabel 4. Average Growth Rate of Dendrobium Orchid Seedlings Aged 4-8 and 8-12 Weeks After Planting Due to Combination Treatment of Planting Media Types and Types of Foliar Fertilizers

Seedling Growth Rate (mg/month)				
Age	**Treatment**	**Types of Foliar Fertilizer**		
	Types of Growing Media	**P1 (Gandasil D)**	**P2 (Gaviota 63)**	**P3 (Grow Quick LB)**
4-8 Week	M_1(Black Moss)	29,24 b	13,32 ab	25,82 ab
	M_2(Husk Charcoal)	11,79 a	11,14 a	14,72 ab
	M_3 (Cocopeat)	22,88 ab	29,63 b	34,72 b
	BNJ 5%		16,21	
8-12 Week	M_1(Black Moss)	34,24 b	17,32 ab	31,32 b
	M_2(Husk Charcoal)	14,79 a	13,14 a	17,47 ab
	M_3 (Cocopeat)	28,88 ab	34,63 b	41,22 b
	BNJ 5%		16,16	

Description: Numbers followed by the same letter at the same observation age show no significant difference in the 5% BNJ test.

Table 4 shows that the combination of cocopeat planting media and Grow Quick LB leaf fertilizer (M3P3) produced the best growth rate of dendrobium orchid seedlings aged 4-8 MST and 8-12 MST and was significantly different from the combination of rice husk charcoal planting media treatment with Gandasil D leaf fertilizer (M2P1) and a combination of rice husk charcoal and Gaviota 63 leaf fertilizer (M) planting media treatment (M2P2). The combination of planting media and foliar fertilizer provides a synergistic effect on increasing the relative growth rate of plants. According to Nadhiroh et al., (2022), the compatibility between aeration and water storage capacity in the planting media with the balance of macronutrients (N, P, K) in foliar fertilizer can optimize the adaptation process of orchid seedlings to the environment.in vitro the ex vitro.

Graph on figure 3 shows that there is an increase in the growth rate of Dendrobium orchid seedlings aged 8-12 weeks after planting due to the combined effect of cocopeat planting media + Grow Quick LB (M3P3) leaf fertilizer treatment of 213.69% compared to the combined treatment of rice husk charcoal planting media + Gaviota 63 leaf fertilizer (M2P2). Plant growth rate is the increase in total plant weight per unit area of land over a certain period of time (Anhar et al., 2022). The combination of cocopeat planting media followed by Grow Quick LB leaf fertilizer produces the best results because Grow Quick LB leaf fertilizer contains 45% N, while Gaviota 63 leaf fertilizer only contains 21%. Differences in nitrogen content in fertilizer treatments affect the growth rate of orchid seedlings. Nitrogen is an essential element in protein synthesis and several important substances that are useful in the formation of new cells in plant growth. In the vegetative growth phase, fertilizer with a higher N content is necessary, because this element is the main ingredient in compiling proteins needed for cell division (Andalasari et al., 2014).

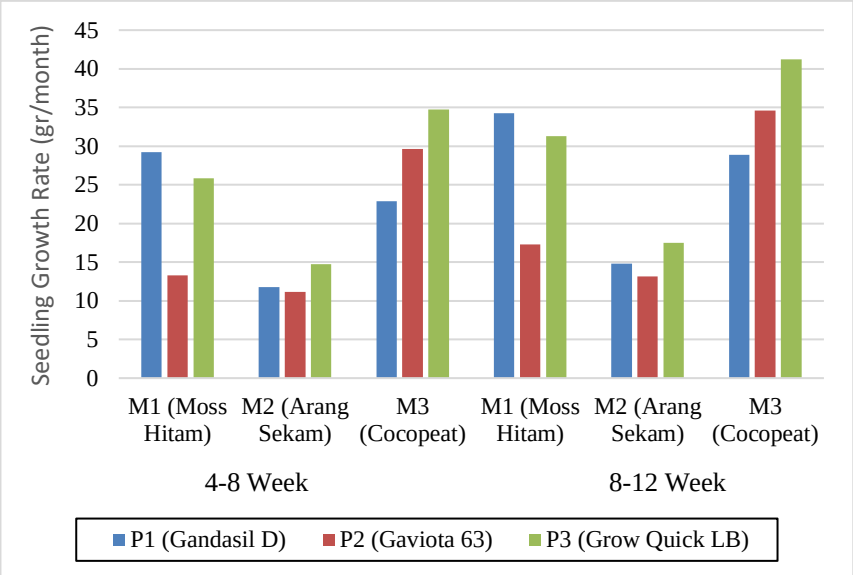

Figure 3. Graph of Average Height of Orchid Seedlings in Treatment of Different Types of Leaf Fertilizer

Number of Shoots

The combination of planting medium type and foliar fertilizer type on the number of Dendrobium orchid seedling shoots showed no significant interaction. The single factors of planting medium type and foliar fertilizer type also had no significant effect on the number of Dendrobium orchid seedling shoots at all observation ages (Table 5).

Table 5. Average Number of Orchid Seedling Shoots in Treatments of Planting Media Types and Types of Leaf Fertilizer

Treatment	Number of Shoots					
	2 MST	4 MST	6 MST	8 MST	10 MST	12 MST
Types of Growing Media						
M_1(Black Moss)	1.00	1.03	1.11	1.14	1.19	1.30
M_2(Husk Charcoal)	1.00	1.03	1.06	1.11	1.19	1.22
M_3 (Cocopeat)	1.00	1.06	1.11	1.19	1.30	1.42
BNJ 5%	tn	tn	tn	tn	tn	tn
Types of Foliar Fertilizer						
P_1 (Gandasil D)	1.00	1.06	1.11	1.22	1.28	1.30
P_2 (Gaviota 63)	1.00	1.06	1.11	1.11	1.19	1.25
P_3 (Grow Quick LB)	1.00	1.00	1.06	1.11	1.22	1.39
BNJ 5%	tn	tn	tn	tn	tn	tn

Description: tn = not significantly different; MST = weeks after planting

Table 5 shows that cocopeat growing media tends to produce a higher number of Dendrobium orchid seedlings shoots compared to other growing media at 12 weeks post-planting (WAP), with an average of 1.42 shoots compared to other growing media. The tendency to increase the number of shoots by cocopeat growing media provides a positive indication that cocopeat growing media treatment has a better effect

in supporting shoot growth. These results are in line with research by Suyanto et al., (2021) which reported that cocopeat growing media provides the best results for the vegetative growth of orchid seedlings, especially in increasing the number and area of leaves. This optimal vegetative growth implies increased meristem activity, which physiologically supports the formation of new shoots.

The Grow Quick LB foliar fertilizer treatment resulted in a higher number of shoots for Dendrobium orchid seedlings compared to other treatments, with an average of 1.39 shoots. Orchids generally have a lower rate of shoot formation than leaf or root growth during the seedling acclimatization phase. Orchids are slow-growing plants compared to other ornamental plants (Sucandra, 2015).

Number of Roots

The combination of planting medium type and foliar fertilizer type on the number of roots of acclimatized Dendrobium orchid seedlings showed no significant interaction. The single treatment of planting medium type and foliar fertilizer type also had no significant effect on the number of roots of Dendrobium orchid seedlings (Table 6).

Table 6. Average Number of Roots of Orchid Seedlings in Treatment of Planting Media Types and Types of Leaf Fertilizer

Treatment	Number of Roots (Week 12)
Types of Growing Media	
M_1(Black Moss)	6,03
M_2(Husk Charcoal)	6,31
M_3 (Cocopeat)	6,53
BNJ 5%	tn
Types of Foliar Fertilizer	
P_1 (Gandasil D)	6,25
P_2 (Gaviota 63)	6,22
P_3 (Grow Quick LB)	6,39
BNJ 5%	tn

Description: code tn = not significantly different

Table 6 shows that cocopeat growing media tends to produce a better number of roots for dendrobium orchid seedlings with an average of 6.53 compared to other growing media. In the Grow Quick LB foliar fertilizer treatment, the number of roots for dendrobium orchid seedlings was better with an average of 6.39 compared to other types of foliar fertilizer. Grow Quick LB foliar fertilizer is superior because its fast-absorbing nutrient content is more suitable for the acclimatization phase, while Gaviota 63 tends to provide less encouragement for root growth. Cocopeat growing media is also superior in providing a balance of moisture and aeration compared to black moss which is too moist. Cocopeat growing media is also more stable in retaining water compared to rice husk charcoal which dries quickly. Media with the ability to retain moisture and have a balance between water holding capacity and providing adequate aeration will support the process of optimal plant nutrient absorption (Kaveriamma et al., 2019).

CONCLUSION

Combination of cocopeat planting media treatment and Grow Quick LB leaf fertilizer (M_3P_3) produced the best relative growth rate in all observation phases, where the average growth at 4–8 WAP (34.72 mg/month) and 8–12 WAP (41.22 mg/month). Cocopeat planting media consistently provided the best growth response, marked by the highest survival rate of 88.33%, an increase in seedling height of up to 10.70%, the largest leaf area of 15.91 cm², and a tendency to increase the number of shoots at the age of 12 WAP. The use of Grow Quick LB foliar fertilizer was also able to produce the highest survival rate of 79.17%, an increase in plant height of up to 10.77%, and the highest leaf area of 16.46 cm². The combination of cocopeat planting media and Grow Quick LB foliar fertilizer has proven effective in increasing the success of Dendrobium orchid seedling acclimatization.

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How To Cite This Article, with *APA style* :

Luthfi, B. M., Hidayat, R., & Nugrahani, P. (2025). Synergystic Role of Cocopeat Matrix and Foliar Nutrient Type on Aclimatization Success of Micropropagated Dendrobium Seedlings. *Jurnal Pembelajaran dan Biologi Nukleus*, *11*(4), 1423-1436. https://doi.org/10.36987/jpbn.v11i4.8174

Conflict of interest : The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Author contributions : All authors contributed to the study's conception and design. Material preparation, data collection and analysis were performed by all authors. The first draft of the manuscript was submited by [**Baharuddin Mohammad Luthfi**]. All authors contributed on previous version and revisions process of the manuscript. All authors read and approved the final manuscript.