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PENINGKATAN PERTUMBUHAN DAN KETAHANAN HIDUP PLANTLET KUNYIT PUTIH (*Kaempferia rotunda* Linn.) MELALUI BERBAGAI MEDIA AKLIMATISASI

ENHANCING GROWTH AND SURVIVAL OF WHITE TUMERIC (*Kaempferia rotunda* Linn.) *PLANLETS THROUGH DIVERSE ACCLIMATIZATION MEDIA*

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Cocopeat, risk husk charcoal, sand, tissue culture, vermiculite.

ABSTRACT

White turmeric (Kaempferia rotunda L.) holds significant potential due to its numerous health benefits, resulting in increasing demand. Tissue culture techniques are used to rapidly produce high-quality seedlings. This study aims to determine the optimal growth medium combination for the acclimatization phase of white turmeric plantlets.The research utilized a Randomized Block Design (RBD) with various growth medium combinations as treatments. A total of seven combinations were used, integrating soil, rice husk charcoal, cocopeat, vermiculite, and sand in equal proportions. The combinations included Soil; Soil + Rice Husk Charcoal; Soil + Cocopeat; Soil + Vermiculite; Soil + Sand; Soil + Cocopeat + Charcoal; Soil + Cocopeat + Vermiculite; Soil + Cocopeat + Sand; Soil + Vermiculite + Charcoal; and Soil + Sand + Charcoal. The results indicate that acclimatization medium combinations significantly influence plantlet growth. The Soil + Rice Husk Charcoal (1:1) medium achieved the best overall growth, with an average plant height of 17.67 cm, 2.11 leaves, a root length of 21.36 cm, and a root volume of 5.5 ml. Furthermore, the Soil + Cocopeat + Rice Husk Charcoal (1:1:1) medium produced the highest root fresh weight, at 5.31 g. These findings highlight the importance of optimizing growth medium combinations to enhance the growth and quality of white turmeric plantlets during acclimatization.

ABSTRAK

Tanaman kunyit putih (*Kaempferia rotunda* L.) merupakan tanaman yang potensial karena memiliki banyak manfaat untuk kesehatan sehingga permintaannya semakin meningkat. Metode kultur jaringan dilakukan untuk menyediakan bibit berkualitas dalam waktu singkat. Tujuan dari penelitian ini adalah memperoleh kombinasi media tanam terbaik untuk pertumbuhan plantlet kunyit putih di tahap aklimatisasi. Metode yang digunakan adalah Rancangan Acak Kelompok (RAK) dengan berbagai kombinasi media tumbuh sebagai perlakuan. Total terdapat tujuh kombinasi yang digunakan, mengkombinasikan tanah, arang sekam, cocopeat, vermikulit, dan pasir dengan perbandingan yang sama. Kombinasi tersebut meliputi Tanah; Tanah + Arang Sekam; Tanah + Cocopeat; Tanah + Vermikulit; Tanah + Pasir; Tanah + Cocopeat + Arang Sekam; Tanah + Cocopeat + Vermikulit; Tanah + Cocopeat + Pasir; Tanah + Vermikulit + Arang Sekam; dan Tanah + Pasir + Arang Sekam. Hasil penelitian menunjukkan bahwa kombinasi media aklimatisasi mempengaruhi pertumbuhan plantlet. Media Tanah + Arang Sekam (1:1) menghasilkan tinggi tanaman rata-rata 17,67 cm, jumlah daun 2,11 helai, panjang akar 21,36 cm, dan volume akar 5,5 ml, menjadikannya kombinasi terbaik untuk pertumbuhan. Selain itu, media Tanah + Cocopeat + Arang Sekam (1:1:1) memberikan bobot basah akar terbaik, yaitu 5,31 g. Temuan ini menunjukkan bahwa optimasi kombinasi media tanam sangat penting untuk meningkatkan pertumbuhan dan kualitas plantlet kunyit putih pada tahap aklimatisasi.

KATA KUNCI:
Jamur tiram, limbah, miselium, substrat.

1. INTRODUCTION

Medicinal plants hold great significant, having been used as herbal remedies since ancient times. Even today, they are preferred for treating various ailments due to the minimal side effects associated with herbal medicine (Gharge *et al*., 2021). One such commonly used medicinal plants in traditional medicine is white turmeric (*Kaempferia rotunda* Linn.), a rhizomatous plant belonging to the Zingiberaceae family.

The rhizomes of white turmeric contain secondary metabolites, including flavonoids and curcumin. Flavonoids act as antioxidants and antibacterial agents, while curcumin is an anti-inflammatory and antitumor compound (Syamsuri & Alang, 2021). These bioactive compounds enhance the value of white turmeric in the pharmaceutical industry. White turmeric can be propagated both generatively through seeds and vegetatively through rhizomes. However, seed propagation is rarely used due to the difficulty in obtaining seeds. Conventionally, propagating white turmeric takes at least nine months from planting, followed by a dormancy period of 2-3 months before the rhizomes can be used as planting material (Yulizar *et al*., 2014). Moreover, obtaining high-quality rhizomes in sufficient quantities to meet market demand poses a challenge (Rusmin *et al*., 2018).

Given these challenges, a more efficient propagation method for white turmeric is needed. Tissue culture propagation presents an effective alternative. This method offers several advantages, including the ability to produce uniform, high-quality plants in large quantities within a short time and ensure genetic consistency with the parent plant (Putri *et al*., 2021).

Tissue culture propagation involves several stages, starting with the initiation of white turmeric explants, followed by multiplication, rooting, and acclimatization. The acclimatization phase is crucial for adapting in vitro-propagated plants to a controlled environment before transferring them to an external environment. Plantlets selected for acclimatization must be healthy, without bacterial or fungal contamination, and have well-developed roots. A key factor at this stage is the selection of the growing medium, which supports the growth and development of plantlets derived from tissue culture. Choosing an appropriate growing medium is essential, as it provides a foundation for seedlings to develop into mature plants. This study aims to determine the best combination of growing media for the growth of white turmeric plantlets during the acclimatization stage.

2. MATERIAL AND METHODS

2.1 Experimental Design

The plantlet acclimatization experiment was conducted at the Screen House of the Bale Tatanen Experimental Garden, Faculty of Agriculture, Universitas Padjadjaran, Jatinangor, Sumedang Regency. The experiment took place from March to May 2024. The research method applied was a Randomized Block Design (RBD) using a single factor with ten planting media treatments~~,~~ that are Soil; Soil + Rice Husk Charcoal (1:1); Soil + Cocopeat (1:1); Soil + Vermiculite (1:1); Soil + Sand (1:1); Soil + Cocopeat + Rice Husk Charcoal (1:1:1); Soil + Cocopeat + Vermiculite (1:1:1); Soil + Cocopeat + Sand (1:1:1); Soil + Vermiculite + Rice Husk Charcoal (1:1:1); and Soil + Sand + Rice Husk Charcoal (1:1:1). The treatments applied consisted of combinations of planting media ratios at 10 levels with 3 replications, each containing 3 units, resulting in a total of 90 experimental units.

2.2 Experimental Stages

The experimental stages include the preparation of the screen house and planting media, hardening, planting, and maintenance.

2.2.1 Screenhouse Preparation

Screenhouse preparation involved cleaning the screenhouse of debris. Afterward, wire and additional shade netting were installed above the tables to hold the pots containing the plantlets.

2.2.2 Planting Media Preparation

Planting media preparation involved mixing soil, sand, rice husk charcoal, cocopeat, and vermiculite in volume ratios according to each treatment combination. The planting media were then placed in heat-resistant plastic and steamed for 30 minutes. After steaming, the media were cooled to room temperature. Each planting medium was then placed into 10 x 10 cm pots and labeled according to the treatment. The weight of each component per pot was as follows: 335 g of soil, 125 g of cocopeat, 60 g of rice husk charcoal, 60 g of vermiculite, and 370 g of sand. Consequently, the total weight of the media varied depending on the specific treatment combination.

2.2.3 Hardening

Hardening was conducted for 2 weeks by placing culture bottles containing plantlets in the screenhouse. This step was necessary to strengthen root growth, enhance stomatal resistance, and help the plantlets adapt to the humidity conditions of the new environment (Putri & Ermawati, 2023).

2.2.4 Planting

White turmeric plantlets prepared for acclimatization were carefully removed from the culture bottles. The plantlet roots were cleaned of any residual media using running water, and the root tips were trimmed by approximately 25% to stimulate new root growth. The roots were then soaked in a fungicide solution (2 g L^{-1}) for 5 minutes. Afterward, the plantlets were planted in the respective planting media, covered with clear plastic, and secured with rubber bands or tape. The coverings were kept in place for 2 weeks and were gradually opened by progressively enlarging the cuts in the plastic each day.

2.2.5 Maintenance

Maintenance for the plantlets included daily watering. Fertilizer was applied 4 weeks after planting using NPK 15:15:15 solution (2 g L^{-1}) at a rate of 80 ml per pot, administrated once a week (Cacaï *et al*., 2021). Any weeds that grew around the plantlets were manually removed.

2.3 Main Parameter

2.3.1 Survival Percentage of Plantlets (%)

Observation were conducted weekly, from one week after planting until the end of the observation period at 8 weeks after planting. Surviving plantlets were identified by the presence of fresh, green leaves, sturdy stems, and no signs of wilting. The formula for calculating the survival percentage of plantlets is as follows (Nurcahyani *et al*., 2014).

$$\text{\% Survival Percentage of Plantlets} = \frac{\Sigma Live\ planlets}{\Sigma Total\ plantlet} \times 100\% \qquad (1)$$

2.3.2 Plant Height Increment (cm)

Measured by calculating the difference in plant height between the end of the observation period (8 weeks after planting) and the height at the beginning of acclimatization (0 weeks after planting).

2.3.3 Leaf Number Increment

This is determined by comparing the number of leaves at the end of the observation period (8 weeks after planting) to the number of leaves at the start of acclimatization (0 weeks after planting).

2.3.4 Root Length Increment (cm)

Calculated by destructively sampling plants and measuring the difference in root length between the end of the observation period (8 weeks after planting) and the start (0 weeks after planting).

2.3.5 Root Fresh Weight (g)

Measured at 8 weeks after planting, starting with cleaning the roots of soil, and then detaching the roots from the plant. The fresh weight of the roots is determined using an analytical balance (Munthe, Pane and Panggabean, 2018).

2.3.6 Root Volume (ml)

Measured as the difference in water volume before and after adding the roots to a measuring cylinder. This measurement is conducted at 8 weeks after planting.

2.4 Supplementary Parameter

2.4.1 Temperature (°C) and Relative Humidity (%)

Measured three times a day in the morning (09:00 WIB), noon (12:00 WIB), and afternoon (15:00 WIB) using a thermo hygrometer. The daily average temperature and humidity are calculated using the following formulas (Rustam, Fauzanah and Ardan, 2019):

Daily Average Temperature (T): $\frac{\Sigma(2 \text{ x T morning}) + \text{T noon} + \text{T afternoon}}{4}$ (2)

Daily Average Relative Humidity (RH): $\frac{\Sigma(2 \text{ x RH morning}) + \text{RH noon} + \text{RH afternoon}}{4}$ (3)

2.5 Analysis Method

Normality tests were conducted on the data to evaluate distribution. If the data were normally distributed, further analysis was performed using ANOVA (Analysis of Variance) based on a 5% F-test. Significant differences were further analyzed using Duncan's Multiple Range Test (DMRT). The analysis was conducted using SPSS version 25 software.

3. RESULT AND DISCUSSION

3.1 Survival Percentage

During the acclimatization period, the percentage of survival of white turmeric plantlets reached 100%. This success was due to the well-executed hardening and covering stages. During the hardening process, the plantlets will adjust both physiologically and morphologically. Plantlets form thicker cuticles to reduce transpiration, develop a more extensive and strong root system, and make stomatal adjustments to be more responsive to environmental changes (Rahmi *et al.*, 2021). The hardening period, which is carried out for 2 weeks, provides optimal results for the hardening stage. This period provides time for the plantlets to perform before being transferred to the treatment media (Figure 1).

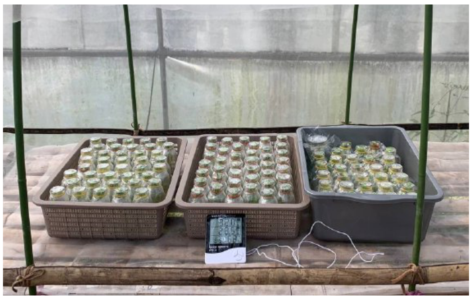

Figure 1. Hardening

The cover greatly affects the survival rate of the plantlets. The process of transferring plantlets from in vitro to ex-vitro environmental conditions can cause plantlets to experience stress. The covering stage is carried out for 2 weeks which aims to maintain plant moisture and prevent pest and disease attacks at the beginning of the acclimatization period. On day 11, the leaves looked too wet due to steam, so the plastic lid was cut at both ends so that the plantlets could gradually adapt to the actual temperature and humidity in the screen house. The success of this method demonstrates the importance of providing the right time and environment for plantlets to adjust from in vitro culture conditions to the field environment.

3.2 Plant Height Increment (cm)

Plant height increase results from enhanced cell division driven by improved assimilate translocation (Rosalina *et al.*, 2020) Statistical analysis showed that planting media significantly influenced the height increase of white turmeric plants. The treatments with soil + husk charcoal (1:1) and soil + vermiculite + husk charcoal (1:1:1) demonstrated significantly greater plant height gain compared to other planting media combinations (Table 1) The soil + husk charcoal (1:1) treatment had an average height increase of 17.67 cm and the soil + vermiculite + husk charcoal (1:1:1) treatment had an average height increase of 15.97 cm, both media were the most effective treatments for increasing the height of white turmeric plants. In Figure 2, it can be seen that the soil + husk charcoal (1:1) treatment is the tallest plant.

The combination of soil and husk charcoal (1:1) can provide sufficient structure and porosity for the growth of white turmeric plants. The mixture of soil and husk charcoal helps retain soil water, then release it into micro pores to be absorbed by plants and foster the growth of beneficial microorganisms that support plants and soil. In addition, husk charcoal improves the porosity of the medium so that it is good for root respiration, and helps to retain soil moisture. Husk charcoal can help improve soil drainage and aeration that support overall plant growth. Research conducted by Sudartini & Diantini (2020) on the type of husk charcoal media provides better height gain results for orchid seedlings because husk charcoal has light and rough characteristics, which promote high air circulation and provide good water retention ability.

The combination of soil, husk charcoal, and vermiculite provides optimal conditions for the height increase of white turmeric plants due to their complementary physical and chemical properties. Soil acts as the primary medium, supplying essential nutrients and microbial activity that support plant growth. Husk charcoal improves aeration, prevents soil compaction, and enhances drainage while also retaining some moisture, creating a balanced environment for root expansion. Vermiculite further enhances water retention and nutrient availability, ensuring a steady supply of moisture and essential minerals like potassium, calcium, and magnesium. The synergy between these components allows for better root development, increased nutrient uptake, and improved oxygen availability, all of which contribute to vigorous shoot elongation and overall plant height. This balanced growing medium creates a stable and nutrient-rich environment, making it ideal for white turmeric plants, especially during the critical acclimatization phase.

Table 1. Height Increase of White Turmeric Plants (cm) in Different Types of Planting Media

Treatment	*Plant Height Increment*
Soil	6,4663[ab]
Soil + Husk Charcoal (1:1)	**17,6667[d]**
Soil + Cocopeat (1:1)	6,7667[ab]
Soil + Vermiculite (1:1)	5,0110 [a]
Soil + Sand (1:1)	5,3110 [a]
Soil + Cocopeat + Charcoal (1:1:1)	11,5660[c]
Soil + Cocopeat + Vermiculite (1:1:1)	8,3557[b]
Soil + Cocopeat + Sand (1:1:1)	6.3557[ab]
Soil + Vermiculite + Charcoal (1:1:1)	**15,9777[d]**
Soil + Sand + Charcoal (1:1:1)	13,5000[c]

Note: The numbers followed by different letters in the same column show significant difference according to the Duncan Multiple Range Test at $p<0.05$.

The combination of soil and husk charcoal (1:1) has advantages in terms of economics because it only requires 2 ingredients, while the combination of soil + husk charcoal + vermiculite (1:1:1) requires 3 ingredients with vermiculite being relatively expensive.

3.3 Leaf Number Increment

The results of the analysis of variance in Table 2 show that the treatment of planting media affects the increase in the number of leaves of white turmeric plants . Leaves can increase seedling growth because they contain chlorophyll which plays a crucial role in the photosynthesis process to absorb sunlight (Sari *et al*., 2022). The photosynthesis process is enhanced by the increased number of leaves, as the chlorophyll in the leaves interacts with solar energy, thereby boosting food production and positively affecting plant growth. Differentiation of cells in the apical part of the plant results in an increase in the number of leaves. The treatment of soil + husk charcoal (1:1) gave the highest number of leaves with an average number of 2.11 leaves. Research conducted by Sugianto & Jayanti (2021) showed that the use of rice husk charcoal in the composition of planting media can increase the number of leaves of shallot plants. Rice husk charcoal can support plant growth because of its nature which can store nutrients in the soil is not easily washed away by water and will be easily released when absorbed by the roots.

The treatment with the lowest number of leaves is the soil+sand (1:1) treatment, this is because the combination of soil and sand has a low water storage capacity. According to Rohmiyati and Suryanti (2023), based on its physical properties, soil dominated by sand will tend to have more macro pores, and roots will penetrate more easily but along with that water will also be more easily lost. Planting media with low water holding capacity tend to release water from the soil surface quickly. If there is no adequate water supply, this condition can cause plants to experience water stress. As plants require efficient water usage to maintain essential functions such as survival and root growth, this will inevitably impact the overall growth of the plant, including leaf growth. Figure 2. Comparison of the Height of White Tumeric Plants during the Acclimatization periods at 7 weeks after palnting.

3.4 Root Length Increament

Root length shows the ability of plants to anchor their roots in the growing media. Longer roots enhance the plant's ability to absorb nutrients from the growing media effectively. Based on the results of the analysis of variance in Table 3, the longest root was obtained in the treatment of soil + husk charcoal (1:1) with an average of 21.36 cm, but not significantly different from the combination of soil + cocopeat + sand (1:1:1), soil + vermiculite + husk charcoal (1:1:1), and soil + sand + husk charcoal (1:1:1). The average root length results that were not significantly different were thought to be because the combination of media used tended to provide similar physical soil conditions, such as good aeration, drainage, and moisture retention. This allows the roots to grow optimally and not experience stress due to media conditions that are too dense or too porous. Research conducted by Lestari et al. (2014) showed an increase in root growth only in the treatment of soil + rice husk (1:1) and in the treatment of soil + husk charcoal (3:1), plant roots are influenced by plant genetics and plant growing media conditions. In the treatment of soil without other media mixtures tend to have a dense texture, lack of aeration, and less than optimal drainage so that it can inhibit root growth. The combination of planting media that is not suitable for plants will cause less optimal growth. The component that affects root growth is the presence of soil pore space for root respiration, these gaps allow lateral roots to penetrate the media and grow longer. The advantages of giving husk charcoal to the soil include the circulation of water and air in the soil and the supply of nutrients to stimulate plant growth (Setyawan, 2023).

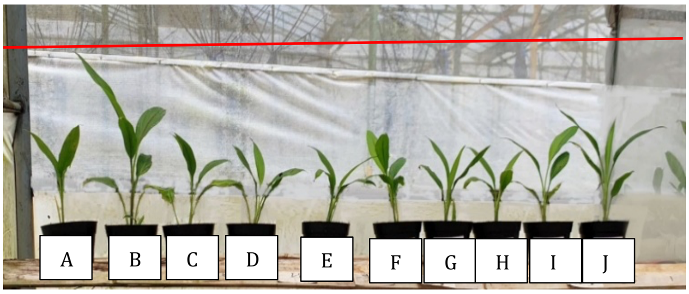

Figure 2. Comparison of the Height of White Turmeric Plants during the Acclimatization Period at 7 weeks after planting.

Note: (A) Soil (B) Soil + Husk Charcoal (1:1) (C) Soil + Cocopeat (1:1) (D) Soil + Vermiculite (1:1) (E) Soil + Sand (1:1) (F) Soil + Cocopeat + Husk Charcoal (1:1:1) (G) Soil + Cocopeat + Vermiculite (1:1:1) (H) Soil + Cocopeat + Sand (1:1:1) (I) Soil + Vermiculite + Husk Charcoal (1:1:1) (J) Soil + Sand + Husk Charcoal (1:1:1).

Table 2. Leaf Number Increase of White Turmeric Plants (cm) in Different Types of Planting Media

Treatment	Leaf Number Increase
Soil	1,2223 ab
Soil + Husk Charcoal (1:1)	**2,1110 b**
Soil + Cocopeat (1:1)	1,5557 ab
Soil + Vermiculite (1:1)	1,2223 ab
Soil + Sand (1:1)	0,6670 a
Soil + Cocopeat + Charcoal (1:1:1)	1,5000 ab
Soil + Cocopeat + Vermiculite (1:1:1)	1,2777 ab
Soil + Cocopeat + Sand (1:1:1)	1,3333 ab
Soil + Vermiculite + Charcoal (1:1:1)	1,6667 ab
Soil + Sand + Charcoal (1:1:1)	1,7780 ab

Note: The numbers followed by different letters in the same column show significant differences according to the Duncan Multiple Range Test at p<0.05.

Table 3. Root Length Increase of White Turmeric Plants (cm) in Different Types of Planting Media

Treatment	Root Length Increase (cm)
Soil	9,1067[a]
Soil + Husk Charcoal (1:1)	**21,3567[d]**
Soil + Cocopeat (1:1)	13,1567[abc]
Soil + Vermiculite (1:1)	13,1533[abc]
Soil + Sand (1:1)	12,0567[ab]
Soil + Cocopeat + Charcoal (1:1:1)	14,6667[cb]
Soil + Cocopeat + Vermiculite (1:1:1)	11,7433[ab]
Soil + Cocopeat + Sand (1:1:1)	17,9533[cd]
Soil + Vermiculite + Charcoal (1:1:1)	16,7900[bcd]
Soil + Sand + Charcoal (1:1:1)	16,2800[bcd]

Note: The numbers followed by different letters in the same column show significant differences according to the Duncan Multiple Range Test at p<0.05.

3.5 Root Fresh Weight

Root fresh weight shows the results of plant metabolic activity which is influenced by tissue water content, metabolic products, and nutrients. Based on the results of the analysis of variance in Table 4, it was found that the treatment of the combination of planting media affected the fresh weight of the roots of white turmeric plants and the treatment of soil + cocopeat + husk charcoal with a ratio of (1:1:1) gave the highest average of 5.31 g, which was significantly different from the soil-only treatment, which had the lowest average of 2.06 g.

The soil, cocopeat, and husk charcoal treatments were good for root fresh weight development because of the large number and distribution of pores in these media mixtures, allowing root tips to enter easily and allowing root expansion. This root expansion was much faster than the other media treatments and resulted in greater wet and dry weights. In contrast, the soil-only treatment is prone to compaction, which restricts root growth and results in the lowest average fresh root weight increase.

The addition of cocopeat to the combination of planting media is well used to support the fresh weight of the roots because it can bind and store water strongly and contains calcium (Ca), magnesium (Mg), potassium (K), sodium (Na), and phosphorus (P) (Nora *et al*., 2020). The addition of soil with husk charcoal gives the best results for moringa seedling growth, this is influenced by the composition of the husk charcoal media, namely SiO2 (52%), C (31%), Fe2O3, K2O, MgO, CaO, MnO, and Cu with small levels and organic matter (Sawaludin *et al*., 2018). Whereas in the control treatment (100% soil) it is suspected that the compaction of the media makes it difficult for the roots to develop.

3.6 Root Volume (ml)

Table 4. Root Fresh weight of White Turmeric Plants (cm) in Different Types of Planting Media

Treatment	Root Fresh weight (g)
Soil	2,0583^{a}
Soil + Husk Charcoal (1:1)	4,8236^{de}
Soil + Cocopeat (1:1)	3,6848^{bcd}
Soil + Vermiculite (1:1)	3,9903^{cde}
Soil + Sand (1:1)	2,2015^{ab}
Soil + Cocopeat + Charcoal (1:1:1)	**5,3132**^{e}
Soil + Cocopeat + Vermiculite (1:1:1)	3,4970^{abcd}
Soil + Cocopeat + Sand (1:1:1)	3,2159^{abc}
Soil + Vermiculite + Charcoal (1:1:1)	4,8812^{de}
Soil + Sand + Charcoal (1:1:1)	4,1242^{cde}

Note: The numbers followed by different letters in the same column show significant differences according to the Duncan Multiple Range Test at p<0.05.

Table 5. Root Volume of White Turmeric Plants (cm) in Different Types of Planting Media

Treatment	Root volume (ml)
Soil	2,5000
Soil + Husk Charcoal (1:1)	5,5000
Soil + Cocopeat (1:1)	4,5000
Soil + Vermiculite (1:1)	4,0000
Soil + Sand (1:1)	2,6667
Soil + Cocopeat + Charcoal (1:1:1)	4,5000
Soil + Cocopeat + Vermiculite (1:1:1)	4,0000
Soil + Cocopeat + Sand (1:1:1)	4,0000
Soil + Vermiculite + Charcoal (1:1:1)	3,3333
Soil + Sand + Charcoal (1:1:1)	4,0000

Note: The numbers followed by different letters in the same column show significant differences according to the Duncan Multiple Range Test at p<0.05.

Root volume is parameter for water and nutrient absorption by plants. Based on the results in Table 5, the combination of planting media did not significantly affect the root volume of white turmeric plants. A high root volume enables plants to absorb more water, thereby enhancing their ability to survive under water shortage conditions (Liu *et al*., 2024). The lack of significant differences in root volume suggests that water absorption across all media combinations is sufficient to meet the plants needs to survive under acclimatization conditions, as further indicated by a 100% survival rate observed for all treatment combinations. However, data trends indicate that media containing highly porous materials, such as husk charcoal, cocopeat, and vermiculite, tend to result in greater root volume compared to pure soil or soil mixed with sand. This observation is consistent with the fresh weight data shown in Table 4.

3.7 Temperature and Relative Humidity

Temperature plays a crucial role in plant growth as it influences water content and enzyme activity in plants. The transpiration rate increases when the air temperature around the plant is high, resulting in reduced water content within the plant. Temperatures that align with a plant's optimal growing conditions support better growth and development. The daily average temperature in the screen house during the observation period, from 0 MST to 8 MST, was 27.8°C. Weekly averages were as follows: the first week, 26.7°C; the second week, 26.9°C; the third week, 28.1°C; the fourth week, 27.1°C; the fifth week, 27.4°C; the sixth week, 28.5°C; the seventh week, 28.6°C; and the eighth week, 29°C. The ideal temperature for white turmeric plant growth ranges between 25°C and 30°C, which is similar to the optimal temperature range for *Kaempferia galanga* L., known to thrive at 20°C to 30°C (Sulistyaningsih and Pradono, 2023).

During the acclimatization stage, temperature fluctuations were observed in the screen house (Figure 3). The average temperature during this stage generally met the growing requirements for white turmeric plants, remaining within the range of 20°C to 30°C. However, newly acclimatized plants experienced stress due to these temperature fluctuations. This stress likely occurred because, during the in vitro stages of multiplication and rooting, the plantlets were kept in relatively stable air temperature conditions. Relative humidity is the ratio of vapor contained in the air (absolute humidity) to the maximum amount of water in the air at the same temperature and air pressure (Harlina & Rizaldy, 2019).

Relative humidity is the ratio of vapor contained in the air (absolute humidity) to the maximum amount of water in the air at the same temperature and air pressure (Harlina & Rizaldy, 2019). The daily relative humidity in the screen house during the observation period, from 0 weeks to 8 weeks after planting, showed an overall weekly average of 61.87% (Figure 4). In the first week, the average humidity was 69.50%; in the second week, 68.29%; in the third week, 58.54%; in the fourth week, 61.21%; in the fifth week, 59.64%; in the sixth week, 57.07%; in the seventh week, 60.54%; and in the eighth week, 60.19%.

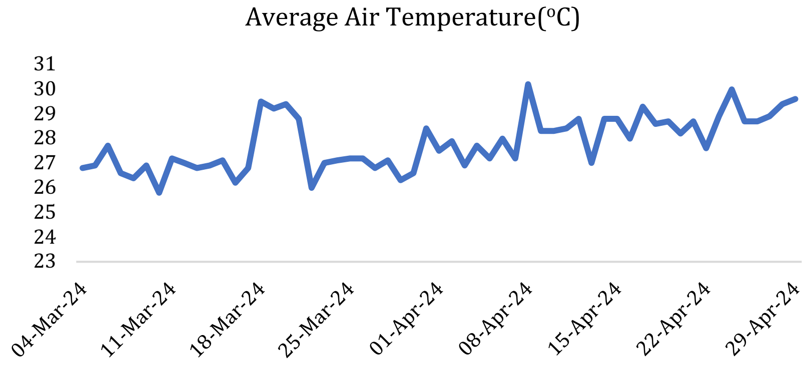

Figure 3. Graph of Average Air Temperature During 8 Weeks After Planting

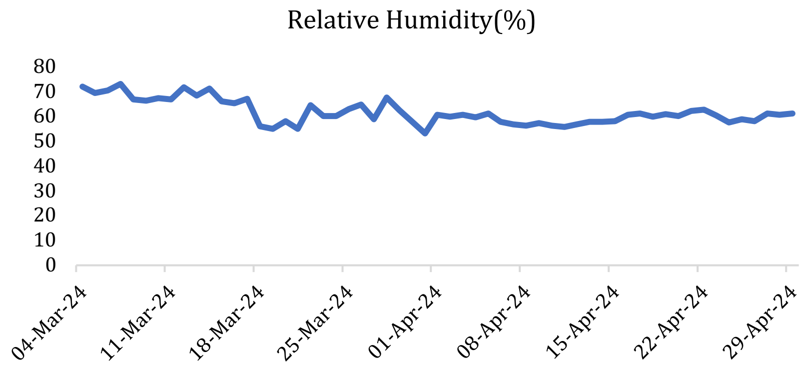

Figure 4. Graph of Relative Humidify During 8 Weeks After Planting

Kaempferia galanga plants can grow well at 80-85% air humidity. The average humidity of the screenhouse during the observation was 61.87%, which is not good enough for the growth of white turmeric plants. Shading was done to maintain the humidity of the plants when the ambient temperature was hot so as not to experience excessive transpiration. Shading was done until 2 weeks after planting, but on the 16th day after planting, there was leaf rolling in the soil + vermiculite (1:1) treatment. This occurs due to changes in water potential in epidermal cells and bulliform cells caused by changes in air temperature in the seedling growing environment (Ali *et al*., 2022). Temperature changes affect the water balance inside and outside the cell. The water potential becomes more negative when the temperature rises, as water tends to escape from the cell to a drier environment. When the temperature drops, the water potential can become less negative, as water loss is reduced. Leaf rolling is a physiological response of plants when in a hot environment to slow the transpiration rate by closing the stomata, and reducing the leaf surface area.

4. CONCLUSION

This study shows that the planting media combination has a substantial impact on the growth characteristics of white turmeric plants, such as plant height, leaf number, root length, and fresh weight of the roots. With the biggest growth in plant height, the most leaves, the longest root length, and the largest root volume, the soil and husk charcoal combination (1:1) was the most successful treatment among those evaluated. These results highlight how crucial it is to use the best planting media in order to promote the growth and development of white turmeric plants during the acclimatization stage.

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