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Growth of Red Betel Stem Cuttings Under Planting Media and Natural Phytohormones

Pertumbuhan Stek Batang Sirih Merah dalam Media Tanam dan dengan Fitohormon Alami

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ABSTRACT

Red betel (*Piper crocatum* Ruiz & Pav.) can be propagated using stem cuttings, but cutting success is affected by planting media and phytohormone application. This study aimed to determine the effects of planting media composition and natural phytohormone type on the growth of red betel stem cuttings. The experiment was arranged in a randomized block design with two factors. The first factor was planting media composition, consisting of husk charcoal and sand at ratios of 1:1, 1:2, and 2:1. The second factor was phytohormone type, consisting of a control, shallot extract, aloe vera extract, and bean sprout extract. The observed variables were cutting success percentage, days to shoot emergence, plant length, shoot length, root length, and number of leaves. The results showed that the interaction between planting media composition and phytohormone type had no significant effect on all observed variables. However, the husk charcoal and sand medium at a ratio of 2:1 tended to produce better growth, with cutting success reaching 100% in several phytohormone treatments, root length reaching 7.00 cm, plant length reaching 18.53 cm, and shoot emergence occurring as early as 32 days after planting. Among the phytohormones, aloe vera extract tended to improve cutting success, shoot length, and number of leaves compared with the other treatments. These findings indicate that a planting medium with a higher proportion of husk charcoal, combined with natural phytohormones, particularly aloe vera extract, has potential to support the early growth of red betel stem cuttings.

Keywords: planting media; phytohormones; red betel; stem cuttings.

ABSTRAK

Sirih merah (Piper crocatum Ruiz & Pav.) dapat diperbanyak menggunakan stek batang, namun keberhasilan perbanyakan dipengaruhi oleh media tanam dan pemberian fitohormon. Penelitian ini bertujuan untuk mengetahui pengaruh komposisi media tanam dan jenis fitohormon alami terhadap pertumbuhan stek batang sirih merah. Percobaan disusun dalam rancangan blok acak dengan dua faktor. Faktor pertama adalah komposisi media tanam, yang terdiri dari arang sekam dan pasir dengan perbandingan 1:1, 1:2, dan 2:1. Faktor kedua adalah jenis fitohormon, yang terdiri dari kontrol, ekstrak bawang merah, ekstrak lidah buaya, dan ekstrak kecambah kacang. Variabel yang diamati meliputi persentase keberhasilan stek, hari hingga munculnya tunas, tinggi tanaman, panjang tunas, panjang akar, dan jumlah daun. Hasil menunjukkan bahwa interaksi antara komposisi media tanam dan jenis fitohormon tidak memiliki pengaruh yang signifikan terhadap semua variabel yang diamati. Namun, media arang sekam dan pasir dengan perbandingan 2:1 cenderung menghasilkan pertumbuhan yang lebih baik, dengan keberhasilan stek mencapai 100% pada beberapa perlakuan fitohormon, panjang akar mencapai 7,00 cm, tinggi tanaman mencapai 18,53 cm, dan munculnya tunas terjadi paling cepat 32 hari setelah *penanaman. Di antara berbagai fitohormon, ekstrak lidah buaya cenderung meningkatkan tingkat keberhasilan perbanyakan stek, panjang tunas, dan jumlah daun dibandingkan dengan perlakuan lainnya. Temuan ini menunjukkan bahwa media tanam dengan proporsi arang sekam yang lebih tinggi, dikombinasikan dengan fitohormon alami—terutama ekstrak lidah buaya—memiliki potensi untuk mendukung pertumbuhan awal stek batang sirih merah.*

Kata kunci: ***media penanaman; fitohormon; sirih merah; stek batang.***

I. INTRODUCTION

Red betel (Piper crocatum) is both a medicinal and ornamental plant, valued for its distinctive patterned leaves and high antioxidant content. The leaves contain essential oils, saponins, tannins, flavonoids, and alkaloids that provide various health benefits (Lister, 2020). Along with increasing public interest in herbal remedies, the demand for red betel planting material has also increased; therefore, effective propagation techniques are needed. Red betel is generally propagated vegetatively through stem cuttings. However, a major constraint in its propagation is the low success rate of cuttings. Marliana et al. (2022) reported that many red betel cuttings fail to form a stable root system, causing the cuttings to dry out and die. Improving the success of stem cuttings is therefore essential to support the wider cultivation of this species.

The success of cuttings is influenced by both external and internal factors. External factors include temperature, humidity, planting medium, and plant growth regulators (Hartmann & Kester, 1975; Setyayudi, 2018). Planting media may consist of a single material or a combination of several components, such as compost, rice husks, and sand (Yelli et al., 2021). Commonly used materials include husks, husk charcoal, compost, soil, and sand. Husk charcoal improves soil structure and contributes organic carbon, nitrogen, phosphorus, potassium, sodium, calcium, and magnesium, and can increase soil pH (Harahap et al., 2020). Sand, on the other hand, has a loose texture with good aeration and drainage, which can support root development in cuttings (Fitriania et al., 2020). An appropriate combination of husk charcoal and sand is therefore expected to create a favorable physical and chemical environment for root and shoot growth.

Internal factors related to cutting success are mainly associated with growth hormones or phytohormones. Phytohormones are organic compounds, produced naturally or synthetically, that influence plant growth and development even at low concentrations (Abdullah et al., 2019). In recent years, there has been growing interest in natural plant growth regulators derived from plant extracts. Shallot extract contains growth-regulating substances with activity similar to indole-3-acetic acid (IAA) and has been reported to affect time to shoot emergence, number of leaves, shoot length, and success percentage in several crops (Tuhuteru et al., 2020). Aloe vera functions as a natural growth stimulant because it contains auxin- and gibberellin-like compounds, as well as vitamins (A, B2, B6, B12, C, and E) and minerals such as zinc, selenium, copper, sodium, and chromium (Nindia, 2021). Bean sprout extract is also known to contain gibberellins and auxins that can stimulate cell division, root and shoot growth, and germination (Sulardi & Siregar, 2017; Nuzul et al., 2022). These natural phytohormone sources may therefore serve as low-cost and environmentally friendly alternatives to synthetic growth regulators (Asra et al., 2020).

Several studies have examined the use of natural plant growth regulators and different planting media on various crops, including red betel. For example, Marliana et al. (2022) evaluated the effect of soaking time in shallot extract and planting media composition on the growth of red betel stem cuttings. However, information is still limited regarding the combined effect of different husk charcoal-sand ratios and various types of natural phytohormones, particularly shallot, aloe vera, and bean sprout extracts, on the success and early growth of red betel stem cuttings.

Based on the above considerations, this study aimed to determine the effects of planting media composition, phytohormone type, and their interaction on the success and growth of red betel stem cuttings.

II. METHODOLOGY

The research was conducted in the greenhouse of the Faculty of Agriculture, Universitas Muhammadiyah Makassar. The plant material used was healthy red betel (Piper crocatum Ruiz & Pav.) stem cuttings. Each cutting was prepared from healthy shoots and cut into a uniform length of approximately 10-15 cm, with 2-3 nodes per cutting. The basal end of each cutting was cut obliquely to increase the absorption surface area.

The planting media consisted of husk charcoal and sand. Before use, the sand was cleaned from debris, while husk charcoal was sieved to obtain a relatively uniform texture. The two materials were then mixed according to the treatment ratios and placed into polybags. Each polybag contained one stem cutting. The experiment was arranged in a randomized block design with two treatment factors and three replications. The first factor was planting media composition, consisting of three levels: M1 = husk charcoal:sand at 1:1, M2 = husk charcoal:sand at 1:2, and M3 = husk charcoal:sand at 2:1. The second factor was type of natural phytohormone, consisting of four levels: H0 = without phytohormone, H1 = shallot extract, H2 = aloe vera extract, and H3 = bean sprout extract. Therefore, there were 12 treatment combinations with three replications, resulting in 36 experimental units.

1. Preparation of natural phytohormone extracts

Shallot extract was prepared by peeling and chopping 300 g of shallots and then blending them with 100 mL of distilled water. The mixture was filtered using a clean cloth or filter paper to obtain a 100% shallot extract stock solution.

Aloe vera extract was prepared by collecting 500 g of fresh aloe vera gel. The gel was blended until homogeneous and then filtered to obtain a 100% aloe vera extract stock solution. Bean sprout extract was prepared by weighing 200 g of bean sprouts and blending them with 100 mL of distilled water. The mixture was then filtered to obtain a 100% bean sprout extract stock solution. Each extract was prepared on the day of application to maintain freshness and biological activity.

2. Application of phytohormones and planting procedure

Before planting, the basal end of each red betel cutting was immersed in the assigned phytohormone treatment solution. Cuttings in the H1, H2, and H3 treatments were soaked in shallot extract, aloe vera extract, and bean sprout extract, respectively, for 30 minutes.

Cuttings in the control treatment (H0) were soaked in distilled water for the same duration to ensure uniform treatment conditions. After soaking, the cuttings were air-dried for approximately 5 minutes and then planted in polybags containing the prepared media. Each cutting was planted with one node buried in the medium, while the remaining nodes were positioned above the medium surface. The planting depth was approximately 3-5 cm, and the medium around the cutting was gently pressed to ensure good contact between the basal end of the cutting and the planting medium.
The phytohormone treatment was applied once before planting by soaking the basal end of the cuttings. No additional phytohormone application was given during the observation period.

3. Maintenance

All experimental units were maintained under greenhouse conditions. Watering was carried out once daily or as needed to maintain the moisture of the planting media, while avoiding waterlogging. Weeds were removed manually when present. No additional fertilizer was applied during the experiment to ensure that plant responses were mainly influenced by the planting media composition and phytohormone treatments.

4. Observation variables and data analysis

Observations were conducted on environmental and growth variables. Environmental variables included greenhouse temperature, media pH, and media moisture. Growth variables included cutting success percentage, days to shoot emergence, plant length, shoot length, root length, and number of leaves. Cutting success was calculated based on the percentage of cuttings that remained alive and produced shoots at the end of the observation period. Plant length, shoot length, root length, and number of leaves were observed at 56 days after planting. The data obtained were analyzed using analysis of variance (ANOVA) according to the randomized block design. When significant treatment effects were found, mean comparisons were conducted using an appropriate post hoc test at the 5% significance level.

III. RESULTS AND DISCUSSION

The analysis of variance showed that planting media composition, phytohormone type, and their interaction did not significantly affect the main growth variables of red betel (Piper crocatum Ruiz & Pav.) stem cuttings. These variables included cutting success, days to shoot emergence, plant length, shoot length, root length, and number of leaves. Therefore, the treatment means should be interpreted as numerical tendencies rather than statistically confirmed treatment superiority. The complete ANOVA results are presented in Table 1, while the treatment means are presented in Table 2.

Environmental data should also be considered when interpreting the growth responses. Media temperature was significantly affected by planting media composition ($F = 6.693$; $p = 0.002$), phytohormone type ($F = 3.771$; $p = 0.015$), and observation week ($F = 21.388$; $p < 0.001$), but the interaction between planting media composition and phytohormone type was not significant ($F = 0.956$; $p = 0.462$). Media moisture was significantly affected by phytohormone type ($F = 9.425$; $p < 0.001$), observation week ($F = 27.780$; $p < 0.001$), and the interaction between planting media composition and phytohormone type ($F = 2.505$; $p = 0.030$), whereas planting media composition alone was not significant ($F = 0.403$; $p = 0.670$). Media pH was not significantly affected by planting media composition, phytohormone type, observation week, or their interaction. These results indicate that the growth responses occurred under environmental conditions that were not fully uniform, especially for temperature and moisture.

The average media temperature during the experiment was approximately 28-29°C. This range was close to the favorable range for cutting growth reported by Setyayudi (2018), although some daytime values were higher than the ideal range. Media pH remained around 8, indicating an alkaline condition. In addition, media moisture ranged from approximately 40% to 60%, which was lower than the approximately 90% moisture level reported by Huda et al. (2019) as favorable for cuttings. This suboptimal moisture condition may have reduced the expression of treatment effects and contributed to the non-significant growth responses.

Table 1. Analysis of variance for the effects of planting media composition and phytohormone type on red betel stem cuttings

Variable	Media (M) F; p-value	Phytohormone (H) F; p-value	M × H F; p-value	Interpretation
Cutting success (%)	F = 0.524; p = 0.599	F = 0.233; p = 0.873	F = 0.757; p = 0.611	ns
Days to shoot emergence	F = 0.532; p = 0.595	F = 0.752; p = 0.533	F = 0.795; p = 0.584	ns
Plant length (cm)	F = 0.137; p = 0.873	F = 1.158; p = 0.348	F = 0.580; p = 0.743	ns
Shoot length (cm)	F = 0.418; p = 0.663	F = 1.115; p = 0.364	F = 1.037; p = 0.428	ns
Root length (cm)	F = 0.078; p = 0.925	F = 1.049; p = 0.391	F = 0.096; p = 0.996	ns
Number of leaves	F = 0.117; p = 0.890	F = 0.423; p = 0.738	F = 1.942; p = 0.119	ns

Note: ns = not significant at p > 0.05. The ANOVA values are based on the original thesis data.

Table 2. Cutting success and growth of red betel stem cuttings under different planting media and phytohormone treatments

Composition medium (husk charcoal:sand)	Extract	Cutting success (%)	Shoot emergence (day)	Plant length (cm)	Shoot length (cm)	Root length (cm)	Number of leaves
M1 (1:1)	Control (H0)	66.67	46	10.33	4.67	3.33	1.00
	Shallot extract (H1)	66.67	35	15.97	10.20	6.60	2.00
	Aloe vera extract (H2)	100.00	32	18.03	9.70	6.07	2.67
	Bean sprout extract (H3)	66.67	55	8.67	1.33	3.57	0.00
M2 (1:2)	Control (H0)	100.00	36	13.33	7.37	4.37	1.67
	Shallot extract (H1)	100.00	50	13.73	3.07	6.17	0.33
	Aloe vera extract (H2)	66.67	46	8.40	5.00	5.20	0.67
	Bean sprout extract (H3)	66.67	37	12.83	5.95	5.27	2.33
M3 (2:1)	Control (H0)	66.67	39	7.67	4.33	3.90	1.00
	Shallot extract (H1)	100.00	37	18.53	10.17	6.97	1.67
	Aloe vera extract (H2)	100.00	32	14.60	9.42	6.70	2.00
	Bean sprout extract (H3)	100.00	41	14.00	5.33	4.40	1.00

Note: M1 = husk charcoal:sand 1:1; M2 = husk charcoal:sand 1:2; M3 = husk charcoal:sand 2:1. Because ANOVA showed no significant treatment effects for the growth variables, the means indicate numerical tendencies only.

Cutting success was not significantly affected by planting media composition (F = 0.524; p = 0.599), phytohormone type (F = 0.233; p = 0.873), or their interaction (F = 0.757; p = 0.611). Numerically, cutting success reached 100% in M1H2, M2H0, M2H1, M3H1, M3H2, and M3H3. The M3 medium, which contained a higher proportion of husk charcoal, also showed a high average cutting success. This tendency is consistent with the function of husk charcoal in improving media porosity and reducing excessive compaction, while sand supports aeration and drainage (Fitriania et al., 2020; Harahap et al., 2020). Marliana et al. (2022) also reported that planting media and soaking treatment can influence the establishment of red betel stem cuttings. However, in the present study, high variability among replications and the limited number of cuttings prevented these numerical differences from becoming statistically significant.

Plant length was not significantly affected by planting media composition (F = 0.137; p = 0.873), phytohormone type (F = 1.158; p = 0.348), or their interaction (F = 0.580; p = 0.743). Numerically, the longest plant length was observed in M3H1 (18.53 cm), followed by M1H2 (18.03 cm). This pattern suggests that a higher proportion of husk charcoal and shallot extract may support stem elongation, but the statistical evidence is insufficient to confirm a treatment effect. Similar tendencies have been reported in previous studies showing that suitable media composition can support vegetative growth by improving the physical condition of the rooting environment (Yelli et al., 2021; Fitriania et al., 2020). Shallot extract has also been associated with improved vegetative growth because it contains compounds with auxin- and gibberellin-like activity (Hariani et al., 2018; Tuhuteru et al., 2020).

Shoot length was also not significantly affected by planting media composition (F = 0.418; p = 0.663), phytohormone type (F = 1.115; p = 0.364), or their interaction (F = 1.037; p = 0.428). The highest numerical shoot length was found in M1H1 (10.20 cm), followed by M3H1 (10.17 cm) and M1H2 (9.70 cm). This tendency is biologically reasonable because shallot extract has been reported to promote shoot emergence, shoot length, and leaf development in several propagation studies (Tuhuteru et al., 2020). Aloe vera extract may also contribute to shoot elongation because it contains gibberellin-like compounds, vitamins, and minerals that can support cell division and elongation (Fauzi, 2021; Nindia, 2021). Nevertheless, the absence of significant differences indicates that these physiological potentials were not strong enough to overcome environmental and experimental variability.

Days to shoot emergence showed no significant effect of planting media composition (F = 0.532; p = 0.595), phytohormone type (F = 0.752; p = 0.533), or their interaction (F = 0.795; p = 0.584). Numerically, the fastest shoot emergence occurred in M1H2 and M3H2, both at 32 days after planting. This tendency suggests that aloe vera extract may have promoted earlier bud activity. Previous studies have shown that natural growth regulators can influence the timing of shoot emergence in cuttings, especially when they contain auxin- or gibberellin-like compounds (Hariani et al., 2018; Fauzi, 2021). However, delayed shoot emergence in several treatments indicates that bud break was also influenced by cutting condition, moisture availability, and the success of early root formation.

Root length was not significantly affected by planting media composition (F = 0.078; p = 0.925), phytohormone type (F = 1.049; p = 0.391), or their interaction (F = 0.096; p = 0.996). Numerically, the longest root length was recorded in M3H1 (6.97 cm), followed by M3H2 (6.70 cm) and M1H1 (6.60 cm). This pattern is consistent with the role of husk charcoal in improving aeration and the physical environment around the basal cutting surface, thereby supporting root initiation and elongation (Fitriania et al., 2020; Harahap et al., 2020). Shallot extract may have contributed to this tendency because auxin-like compounds are closely related to adventitious root formation (Hartmann & Kester, 1975; Hariani et al., 2018). Even so, the non-significant ANOVA result indicates that root growth varied widely among experimental units.

The number of leaves was not significantly affected by planting media composition (F = 0.117; p = 0.890), phytohormone type (F = 0.423; p = 0.738), or their interaction (F = 1.942; p = 0.119). Numerically, the highest number of leaves was observed in M1H2 (2.67 leaves), followed by M1H1, M3H1, and M3H2. Leaf formation depends on successful root establishment, nutrient supply, and hormonal regulation of meristem activity. Nitrogen and potassium are important for vegetative growth and leaf formation (Darmawan et al., 2015), while natural growth regulators such as aloe vera and bean sprout extracts may support leaf development through gibberellin- and auxin-like activity (Fauzi, 2021; Nuzul et al., 2022; Sulardi & Siregar, 2017). The low leaf number across treatments shows that the cuttings were still in an early establishment stage at 56 days after planting.

Figure 1. Red betel cuttings treated with different planting media compositions and natural phytohormone types.

Overall, the results indicate that the tested planting media compositions and natural phytohormone extracts did not produce statistically significant improvements in the growth of red betel stem cuttings. The repeated numerical tendencies observed in M3 and in treatments involving shallot or aloe vera extracts may indicate potential practical value, but these tendencies should not be presented as definitive treatment effects. The lack of significance was likely related to the small number of experimental units, mortality in several treatments, variation among replications, alkaline media pH, and media moisture that was below the optimum level for cutting growth. Therefore, the findings should be interpreted cautiously and used as a basis for further experiments with better-controlled humidity, a larger sample size, and more precise evaluation of extract concentration and soaking duration.

IV. CONCLUSION

The results showed that the treatments did not significantly affect the percentage of cuttings that sprouted, shoot length, or number of leaves of red betel stem cuttings under the conditions of this experiment. Although the treatment means showed numerical tendencies, with husk charcoal:sand at 2:1 and natural extracts such as shallot and aloe vera producing some favorable values, these differences were not statistically significant. Therefore, the findings should be interpreted cautiously because the observed treatment differences were numerical only and the media moisture was below the optimal range reported for cutting growth. Further experiments with stronger environmental control and a larger sample size are needed before practical recommendations can be established.

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