Effect of growing media and natural plant growth regulators on the growth of tea stem cutting

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Abstract. Cuttings may generate plants with the same characteristics as the parent. However, there are issues with root formation and shoot development. Coconut water may function as a natural growth regulator due to auxin, which stimulates root and shoot development. The condition of the growing media, in addition to growth regulators, influences the development of plant cuttings. This study aims to determine the immersion time of tea stem cuttings into coconut water and the composition of the growing media for the growth of tea stem cuttings. This research was conducted from February to June 2019 at Sarana Mandiri Mukti, Tangsi Baru Village, Kabawetan District, Kepahiang Regency, Bengkulu Province, Indonesia, at an altitude of 1000 meters above sea level. The study was conducted using a completely randomized design (CRD) with two factors. The first factor was the immersion time of coconut water, namely 2, 4, 6, 8, and 10 hours. The second factor was the growing media, which consisted of 1000 g soil (Control), 750 g soil + 250 g cow dung, 750 g soil + 250 g chicken manure, and 750 g soil + 250 g goat manure. The findings revealed that 5 hours 53 minutes of immersion in coconut water on a mixed medium of 750 g soil + 250 g cow dung resulted in the longest root being 13.73 cm. The duration of immersion in coconut water influenced the shoot and root length of tea stem cuttings, whereas the growing medium influenced the dry weight of the roots.

1 Introduction

Applying a Plant Growth Regulator (PGR) can assist in promoting shoot and root growth of plant. PGR can speed up the process and increase the number of roots. Coconut water, a natural PGR, can be utilized to speed up the formation of plant roots. Coconut water contains several growth hormones, including cytokinin, auxin and gibberellin [1–3].

According to Leliana et al [4] coconut by-product extracts, particularly the immature mesocarp, can be used as an alternative natural antioxidant. Coconut water has the potential to have a substantial impact on human health due to its pharmacological activities as well as plant growth and development in vitro propagation [1]. Coconut water increased the survival rate of transplanted olive plantlets (Olea europaea L.) from about 85% [5], and In spinach, coconut water promoted callus proliferation and shoot regeneration [6].

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Besides PGR, the planting medium is a determining factor for the success of plant growth because it serves as both a place to grow plants and a source of nutrients for plants [7]. Organic substances, such as organic fertilizer, compost, manure, can improve the soil's physical qualities, and stimulating the growth and development of plant. Manure contains a variety of nutrients. The different nutrient content is because each animal has observable traits that are determined, among other things, by the livestock's food source [8].

Soybean root fresh weight and number of pods are affected by weed-based liquid organic fertilizer [9]. Setyowati et al [10] reported that 15 tons/ha of chicken manure produced the highest plant height and fruit weight of eggplant (Solanum melongena, L.) in Ultisols. Compost application enhances soybean growth, including stem diameter, number of leaves, productive branches, and dry root weight [11]. According to Suprijono et al [12], increases in vermicompost dose were followed by increases in shallot plant growth and yield. Both vermicompost and biourine increased Ultisol pH, which led to higher shallot growth and yield. The utilization of chicken manure enhanced corn growth and yield [13].

2 Research methods

2.1 Research design

The study was conducted at PT Sarana Mandiri Mukti, Tangsi Baru Village, Kabawetan District, Kepahiang Regency, Bengkulu Province, 1000 m above sea level using a factorial, completely randomized design (CRD) with two treatment factors. The first factor was the duration of immersion in young coconut water, which consisted of 5 treatment levels, namely 2, 4, 6, 8, and 10 hours. The second factor is the type of growing medium in polybags consisting of 4 treatments of 1000 g of soil (Control); 750 g soil + 250 g cow manure, 750 g soil + 250 g chicken manure, and 750 g soil + 250 g goat manure. Thus, there were 20 treatment combinations, each repeated three times for a total of 60 experimental units. Each experimental unit has four plants as samples, for a total of 240 plants.

2.2 Planting media

Weeds and shrubs have been eliminated from the nursery's research area. Establish a shade height of 2 meters, then cover it with a paranet with a light intensity of 70%. The tea nursery dome approximately 5 m x 1.5 m x 0.8 m in length, width, and height. The growing medium was sifted with a sieve size of 5 mm x 5 mm (l x w). The sifted soil is mixed with cow manure, chicken manure, and goat manure according to the treatment, then put into polybags. The cow, chicken, and goat manure used has been composted first.

2.3 Planting materials

The tea plants used were taken from a tea garden at PT Sarana Mandiri Mukti, Bengkulu, Indonesia with a branch length of ± 10 cm and green-brown. The cuttings utilized in the study were 6 cm in length, had one leaf, and were selected from the middle of the branch. Cuttings are conducted with a 45° slope 0.5 cm above the internode and 3 - 4 cm below the internode. The trimmed cuttings are then immersed in a pail of water, adding Dithane at a concentration of 2 g/liter for 2-3 minutes to ensure that the seeds are fungi-free.
2.4 Planting

Polybags containing growing medium were placed under the lid, then irrigated to field capacity. Each polybag made a planting hole with a depth of approximately 3 cm and planted tea cuttings. The tea cuttings that were planted were soaked in coconut water according to the treatment. Weed control is carried out manually by removing weeds that grow around the cuttings 60 days after planting (DAT). Watering was undertaken to keep the soil moist, and pest and disease control was not conducted because there were no pests or diseases.

2.5 Data analysis

The data was statistically analyzed using analysis of variance (ANOVA). Polynomial Orthogonal (PO) was employed to test variables that exhibited significant differences in the single factor of immersion time and the interaction between soaking time and media type. At the same time, DMRT level 5% was utilized to test the type of growing medium.

3 Results and discussion

3.1 Interaction of immersion time and growing medium on root length

The interaction between the length of immersion in the control treatment, chicken manure, and goat manure resulted in a positive linear relationship with root length. However, it formed a quadratic relationship in the cow manure treatment. This finding suggests that cow manure can supply more nutrients than chicken or goat. The slow decomposition of organic matter is due to the composition of organic matter in cow dung and the organic fiber content of plant feed for livestock such as cattle. Consequently, cow manure nutrients are slowly absorbed throughout plant growth and development. Thus, nutrients required by plants will be available throughout the process of plant growth and development. Furthermore, Prasetyo [14] states that cow manure has a higher water-holding capacity than other types of manure, allowing the nutrients in cow manure to be readily absorbed by plants.

An increase in the immersion duration of young coconut water up to 10 hours was followed by an increase in root length, as indicated by a positive linear pattern on soil growing media (control treatment), chicken manure, and goat manure. Aside from root length, immersion duration affects shoot length. According to the findings of Pranata et al [15] the application of young coconut water can enhance root length. Yulse and Ratih [16] reported root formation occurs due to auxin moving to the bottom of the cuttings, followed by carbohydrates and auxin-integrated compounds. These compounds accumulate at the base of the cuttings, stimulating the growth of roots, shoots, and leaves. The increasing auxin concentration in plants will activate root formation.

The findings indicate that the combination of young coconut water immersion duration and media type produced root lengths ranging from 5.67 cm to 15.25 cm, with an average of all combination treatments of 10.02 cm. Thus, using coconut water PGR and planting media with cow manure resulted in a longer root length.

3.2 The effect of immersion period on the growth of tea cuttings

The duration of immersion in young coconut water significantly affected shoot length. Polynomial analysis revealed that the immersion time and shoot length formed a positive linear relationship. The determination (R2) value was 0.8264, indicating an 82.64% strong
correlation between immersion time and shoot length. Figure 1 shows the relationship between immersion time and bud length.

![Figure 1](image1.png)

**Fig. 1.** The relationship between young coconut water immersion time and bud length.

According to the findings of this study, the longer coconut water was immersed, the more PGR, particularly auxins and cytokinins, were absorbed by plant roots, resulting in increased plant physiological activities. The length of cutting branches will expand as plant physiological processes progress. Karimah et al [17] assert that the cytokinin content of coconut water performs as a regulator. Cytokinins work in conjunction with auxins to promote bud formation and cell division. Cytokinins can trigger budding by increasing nucleic acid metabolism and protein synthesis. Auxin in coconut water promotes cell enlargement and elongation, cell division and differentiation, and shoot growth.

Mayura et al [18] reported that the auxin contained in coconut water could enhance water entry into cells and increase N, Mg, Fe, and Cu absorption. Auxin also increases osmotic pressure, decreases cell wall pressure, increases protein synthesis, and increases plasticity and cell wall development. Coconut water is one of the most commonly utilized natural PGRs. Coconut water is inexpensive and widely available. Because coconut water contains the hormones auxin and cytokinin, it is utilized in plant propagation to promote the formation of shoots and roots. Pamungkas et al [19] experiment show that auxin can enhance cell pressure and protein synthesis, allowing plant cells to expand, elongate, and absorb water.

A plant immersed in young coconut water significantly affects its root growth. The value of determination ($R^2$) was 0.8283 between the immersion time and the length of the roots, which formed a positive linear relationship. The relationship pattern of immersion time and root length is presented in Figure 2.

![Figure 2](image2.png)

**Fig. 2.** The relationship between immersion time of young coconut water and root length.
The positive linear finding implies that the longer the cuttings are immersed in coconut water, the more PGR, particularly auxins and cytokinins, are absorbed by plant roots, resulting in increased root development. According to Guniarti and Sukartiningrum [20] using growth regulators can speed up the formation and elongation of root cells and increase the number of roots compared to those that do not utilize growth regulators. PGR coconut water absorbed by plants can provide active natural cytokinins. These cytokinins are thought to induce root and shoot formation by increasing nucleic acid metabolism and protein synthesis [21].

Table 1 shows the study's findings on the effect of immersion time on the average percentage of live cuttings, time of budding, bud diameter, number of leaves, fresh and dry weight of leaves, and root dry weight.

<table>
<thead>
<tr>
<th>Immersion time (hour)</th>
<th>Live cuttings (%)</th>
<th>Time of budding (days)</th>
<th>Bud diameter (cm)</th>
<th>Number of leaves</th>
<th>Leaf fresh weight (g)</th>
<th>Leaf dry weight (g)</th>
<th>Root dry weight (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>70.83</td>
<td>15.13</td>
<td>2.19</td>
<td>3.73</td>
<td>4.19</td>
<td>0.24</td>
<td>0.19</td>
</tr>
<tr>
<td>4</td>
<td>85.42</td>
<td>14.79</td>
<td>2.20</td>
<td>3.69</td>
<td>4.31</td>
<td>0.30</td>
<td>0.25</td>
</tr>
<tr>
<td>6</td>
<td>81.25</td>
<td>15.02</td>
<td>2.41</td>
<td>3.92</td>
<td>4.35</td>
<td>0.32</td>
<td>0.26</td>
</tr>
<tr>
<td>8</td>
<td>81.25</td>
<td>15.04</td>
<td>2.32</td>
<td>4.13</td>
<td>4.56</td>
<td>0.36</td>
<td>0.30</td>
</tr>
<tr>
<td>10</td>
<td>83.33</td>
<td>15.10</td>
<td>2.42</td>
<td>4.31</td>
<td>4.75</td>
<td>0.38</td>
<td>0.32</td>
</tr>
</tbody>
</table>

According to the findings, increasing the immersion time was associated with an increase in root dry weight, leaf number, leaf fresh weight, leaf dry weight, shoot diameter, shoot emergence time, and percentage of live cuttings. This increase in yield is thought to be due to the more prolonged immersing time of coconut water; the plant roots absorb more growth regulators. Young coconut water contains various substances, including cytokinin and auxin hormones, vitamin C, vitamin B, a little fat, Ca, and P [2]. The growth regulators in coconut water stimulate cells in the explant tissue to divide and differentiate to form shoots [17]. Linda and Mukarlina [22] reported that coconut water at a concentration of 20% enhanced the shoot's emergence and shoot growth. Sitorus et al [23] observed that the treatment of young coconut water enhanced the growth of dragon fruit cuttings.

3.3 The effect of growing medium on the growth of tea cuttings

Table 2. Effect of growing medium on the growth of tea cuttings.

<table>
<thead>
<tr>
<th>Growing medium</th>
<th>Live cuttings (%)</th>
<th>Time of budding (days)</th>
<th>Bud length (cm)</th>
<th>Bud diameter (cm)</th>
<th>Number of leaves</th>
<th>Leaf fresh weight (g)</th>
<th>Leaf dry weight (g)</th>
<th>Root length (cm)</th>
<th>Root dry weight (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>M₀</td>
<td>75.00</td>
<td>15.18</td>
<td>8.76</td>
<td>2.27</td>
<td>3.82</td>
<td>4.22</td>
<td>0.26</td>
<td>9.38</td>
<td>0.19 b</td>
</tr>
<tr>
<td>M₁</td>
<td>80.00</td>
<td>15.02</td>
<td>9.25</td>
<td>2.33</td>
<td>4.00</td>
<td>4.33</td>
<td>0.34</td>
<td>11.03</td>
<td>0.30 a</td>
</tr>
<tr>
<td>M₂</td>
<td>81.67</td>
<td>14.87</td>
<td>9.20</td>
<td>2.31</td>
<td>3.85</td>
<td>4.58</td>
<td>0.36</td>
<td>10.25</td>
<td>0.27 a</td>
</tr>
<tr>
<td>M₃</td>
<td>85.00</td>
<td>14.98</td>
<td>9.54</td>
<td>2.26</td>
<td>3.93</td>
<td>5.40</td>
<td>0.39</td>
<td>10.80</td>
<td>0.31 a</td>
</tr>
</tbody>
</table>

Note: M₀= 1000 g soil (Control); M₁= 750 g soil + 250 g cow manure; M₂= 750 g soil + 250 g chicken manure; M₃= 750 g soil + 250 g goat manure.
The analysis showed that the growing medium only had a significant effect on dry root weight and had no significant effect on other variables (Tables 1 and 3). This is most likely because the Andosol soil employed in the study provided nutrients sufficient for sufficient nutrients the growth of tea cuttings. Thus, the soil's nutrient content has satisfied the plants' nutritional needs. As a result, adding manure to the growing substrate did not affect tea growth. This study's soil has N-total = 0.42%, P-exch = 13.66 ppm, and K-exch = 0.32. The adequacy of nutrients in the soil, according to Jones [24], is one of the factors that determine the initial growth of plants. Furthermore, the need for nutrients is still low in the early stages of plant growth and development. Thus, the available nutrients in the soil are sufficient to enable optimal plant growth and development.

Although not significantly different from 750 g soil + 250 g cow manure and 750 g soil + 250 g chicken manure, the mixed media of 750 g soil + 250 g goat dung resulted in a higher root dry weight. The control treatment yielded the lowest root dry weight. This is apparently because adding manure improves the physical, chemical, and biological qualities, particularly the soil's physical properties, enabling faster root growth. A suitable growing medium can bind water and provide nutrients to plants, manage excess water (drainage), have good aeration, and preserve moisture around the roots [24].

According to Krishna [25], the soil structure preferred by plants is loose, with pore spaces that may be filled with water and air, which is essential for plant root growth. A crumb structure is a good soil structure for plant growth. The advantage is that it has good drainage and aeration and a stable temperature, which promotes the growth of soil microorganisms, which are essential in weathering organic matter in the soil. [24] stated that the planting media influences whether easily the roots penetrate the soil. Crumb medium helps roots grow deeper and broader, resulting in more root tissue and increased weight.

4 Conclusions

The conclusions of this study are: the optimum immersed time of young coconut water in a media mixture of 750 g soil + 250 g cow manure was 5.89 hours, resulting in the longest root of tea cuttings, 13.73 cm. Mixed growing medium of 750 g of soil + 250 g of goat, chicken, or cow manure resulted in higher root dry weight than the control treatment.

References

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19. F.T. Pamungkas, S. Darmanti, B. Raharjo, Jurnal Sain & Mat 17, 3 (2009)