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# The Utilization *Vigna radiata* Extract, Coconut Water, and Root-Up on The Growth of *Bruguiera gymnorrhiza* Seedlings

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***Abstract.*** *Mangrove forests are declining significantly. Hence, artificial rehabilitation through plant seedlings is necessary. However, failure often occurs due to the low quality of available seedlings. One solution to improve the seedling's quality is the application of growth regulators during mangrove rehabilitation. This study aimed to examine the effect of natural plant growth regulators, namely coconut water and V. radiata extract, as well as the synthetic plant growth regulator root up on the growth of Brugueira gymnorrhiza seedlings. The research method employed was a Completely Randomized Design (CRD) with a single factor consisting of four treatments and five replications, as follows: P0 = Control, P1 = 100% coconut water, P2 = 10% root up, and P3 = 100% Vigna radiata extract. The observation parameters included plant height, number of leaves, root length, number of roots, stem diameter, and wet weight. Data analysis was conducted with ANOVA and Duncan's Multiple Range Test., natural plant growth regulators (PGRs) considerably improved the growth characteristics of Bruguiera gymnorrhiza seedlings compared to the control and synthetic PGR treatment (Root-Up) ($p < 0.05$). Among the treatments, Vigna radiata extract had the most impact, with the maximum plant height (51.2 cm), stem diameter (15.264 mm), number of roots (10.6), and fresh weight (33.8 g). Furthermore, the application of coconut water resulted in a considerable rise in the number of leaves, reaching an average of 5.8, as well as increased root elongation with an average length of 10.188 cm. In contrast, using root up at a 10% concentration resulted in no statistically significant improvement in any of the evaluated metrics.*

***Keywords:*** *Bruguiera gymnorrhiza, growth, plant growth regulators*

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## INTRODUCTION

Mangrove forests thrive along coastlines and are enormously affected by tidal fluctuations rather than climatic conditions. Mangrove plants have a distinctive morphology with a strong root system and the presence of mangrove forests plays a crucial role in preventing coastal erosion, acting as a barrier against ocean waves, also serving as a breeding ground for various marine organisms (Montgomery et al., 2018). However, the current amount of mangrove vegetation in Indonesia is declining significantly because the natural growth of mangroves is challenging (Yona et al., 2018). According to data from the Ministry of Environment and Forestry, from 1980 to 2020, the area of mangrove forests had decreased by 6 million hectares, from 9.36 million hectares to 3.31 million hectares. Of these data, 48%, or 4.51 million hectares are classified as moderately damaged, meanwhile 23%, or 2.15 million hectares are classified as severely damaged. Mangroves require suitable habitat conditions to grow propagules when they fall onto the substrate (Indonesia Maritime Institute, 2012). Therefore, efforts are needed to rehabilitate mangroves through artificial regeneration so that their ecological function can be restored (Kusmana et al., 2018).

Mangrove rehabilitation can be carried out by planting mangrove seedlings (Amelia et al., 2023). Nonetheless, this process have various problems such as low seed quality and limited seed supply, limited availability of ready-to-plant seedlings, improper timing for transplanting, inadequate care, and the low quality of available seedlings (Budiadi et al., 2022). One solution to improve the quality of seedlings and propagules is to apply plant growth regulators (PGR) during the nursery (Maesyaroh, 2018). The growth and production of plants can be enhanced by applying PGRs at the correct dosage and composition The addition of plant growth regulators (PGRs) and nutrients during the seedling stage can enhance the quality of seedlings such as *Bruguiera gymnorrhiza*, as well as improve plant growth characteristics (Suriani et al., 2023).

Previous studies have indicated that the application of plant growth regulators (PGRs), both natural and synthetic can enhance the quality and growth of mangrove seedlings (Maesyaroh, 2018) However, few studies have directly compared the effectiveness of natural PGRs such as coconut water and *V. radiata* extract with synthetic PGRs in the growth of *Bruguiera* mangrove seedlings. Therefore, this study aimed to examine the effects of *V. Radiata* extract, coconut water, and synthetic auxin on the growth of *Bruguiera gymnorrhiza* seedlings. This research seeks to support mangrove forest rehabilitation efforts by improving the quality of planting material through the use of effective growth-enhancing treatments.

## MATERIALS AND METHODS

This study was conducted September to December 2022, Biology Laboratory of Plant Structure and Function, Faculty of Science and Mathematics. Two months old *B. gymnorrhiza* were raised in a planting medium of 100% coconut water, 100% green bean sprout extract, and 10% root-up. The tools needed for this research include pots, polybags, knives, measuring cups, beakers, scales, glass funnels, stirring rods, mortar and pestle, sieves, Horiba, measuring tapes. *B. gymnorrhiza*. Additionally, there are growing media, coconut water, Vigna radiata extract, and root-up. The research design used is a Completely Randomized Design (CRD) with a single factor consisting of one treatment,

which involves the application of plant growth regulators (PGRs) that include 100% coconut water, 100% *Vigna radiata*, 10% Root-up, and a control. Each treatment consists of 5 replications.

**Preparation of Natural and Synthetic Plant Growth Regulators**

Organic materials i.e. coconut water, *Vigna radiata* extract, and synthetic materials in the form of root up were used as PGRs. The first organic solution was prepared by extracting 3500 ml of 100% pure coconut water, of which 30 ml was administered to each seedling *B. gymnorrhiza* sample every two weeks (Mowidu et al., 2021) . The second organic solution was prepared by weighing 280 g of three-day-old sprouts for pulverizing, then 1400 ml water was added. The finished extract was filtered, and the filtrate was heated until the boiling point and allowed to cool (Watu et al., 2017). Finally, the synthetic solution was prepared by weighing 10 mg root up powder and adding 120 ml water (Kieber & Schaller, 2018).

**Application of Natural and Synthetic PGRs to *Bruguiera gymnorrhiza***

This study used a total of 20 healthy and fresh seedling *B. gymnorrhiza* which were physiologically ripe, as shown by greenish-red or brownish-red hypocotyl color (Nursinar et al., 2023). Each treatment consisted of five repetitions and a single factor Completely Randomized Design (CRD) was applied. This design consisted of 1 treatment in the form of PGRs, namely P0 = control, P1 = 30 ml of 100 % coconut water concentration, P2 = 60 ml of 100% green bean sprout extract, and P3 = 10 ml of 10% root-up. The prepared PGRs were applied to *B. gymnorrhiza* planting medium. Plant maintenance included watering twice daily for three months to suffice water needs and maintain water availability in the medium. Watering was adjusted to the level of water requirement in each treatment for each pot and poly bag to be in a balanced condition.

**Data Analysis**

Observational data were analyzed using one-way analysis of variance (ANOVA) with a significance level set at 0.05 to determine whether there were statistically significant differences between treatment groups. When significant differences were found, Duncan's Multiple Range Test (DMRT) was used at a significance level of 5% to further identify which specific groups differed from each other. This statistical approach was chosen because it allows for effective comparisons between different treatment means. Through this method, it was possible to determine which treatments—such as *Vigna radiata* extract, coconut water, or Root up—had the most significant impact on the growth performance of *Bruguiera gymnorrhiza* seedlings.

## RESULTS AND DISCUSSION

The purpose of this study was to evaluate the effects of natural plant growth regulators (PGRs), specifically coconut water and *Vigna radiata* extract, to a synthetic PGR (root up) on the growth of *Bruguiera gymnorrhiza* seedlings. The results showed that treatment with *V. radiata* extract had the greatest impact on practically all growth metrics, including plant height, number of leaves, root length, number of roots, stem diameter, and fresh weight. *V. radiata* extract contains auxin (1.68 ppm), gibberellin (39.94 ppm), and cytokinin (96.26 ppm), all of which work together to promote cell elongation, division, and tissue differentiation (Rahmadea, 2024).

Among all treatments, *V. radiata*

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extract produced the tallest seedlings, with an average height of 51.2 cm. This extract has significant potential as a natural source of auxin, specifically indole-3-acetic acid (IAA). Adequate auxin concentrations aid in the mobilization of cytokinins during shoot initiation and contribute to the correct root system development. Furthermore, optimum auxin administration promotes overall plant growth across several species (Nugroho, 2023). Auxin therapy has also been shown to boost the production of particular enzymes by increasing protein synthesis activity (Wang et al., 2024) . Furthermore, prior research has shown that mung bean and shallot sprout extracts greatly improve plant height, leaf quantity, and overall seedling quality index (Jayanti et al., 2019). The results of the research concentrate on the utilization *Vigna radiata* extract, coconut water, and root up on the growth of *Bruguiera gymnorrhiza* seedlings.

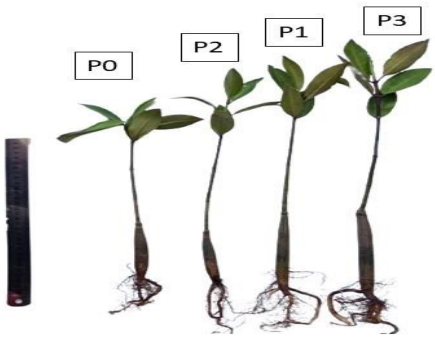


**Figure 1.** The roots of *Bruguiera gymnorrhiza* seedlings after three months. Description: P0 = Control, P1 = 100% Coconut Water, P2 = 10% Root-Up, and P3 = 100% *Vigna radiata* Extract.

Based on the image in Figure 1, *B. gymnorrhiza* seedlings that have grown for three months show significantly developed root morphology according to the treatment given. Seedlings treated with 100% *V. radiata* extract, 100% coconut water, and 10% root up display a longer and more branched root system compared to the control. The overall morphology of the seedlings shows the development of thick main roots that spread downward (taproots), accompanied by lateral roots that begin to grow sideways as an adaptation to the conditions of the growing media. The root color looks bright and healthy, indicating a good level of root viability.

*B. gymnorrhiza* roots are a type of radicular root that is able to develop into a supporting root system (stilt roots) when the plant is mature, but in the seedling phase the roots grow longer with little branching in an effort to obtain air and nutrients efficiently (Madhavan et al., 2024) Treatment with natural growth stimulants such as coconut water and *V. radiata* extract is thought to accelerate root growth by increasing the activity of auxin and cytokinin hormones dissolved in it (Ningsih et al., 2021); Thus, the morphology of these seedlings reflects the success of early adaptation to hormonal treatments that stimulate root growth, which is an important indicator in the early stages of mangrove reforestation (Setiawati et al., 2018).

**Plant Height**

The results of the study on the utilization *V. radiata* extract, coconut water, and root up on the growth of B. gymnorrhiza seedlings can be seen in Figure 2. The ANOVA results show that the application of growth regulators, namely 100% *V. radiata* extract, 10% root-up, and 100% coconut water, has a significant effect on leaf area with a significance value of (P=0). The control treatment, which received no treatment, showed no significant difference. It is suspected that the concentration of growth regulators affects leaf formation. The treatment with V. radiata extract produced the tallest plants (51,2 cm.) (Figure 2.). The extract has great potential

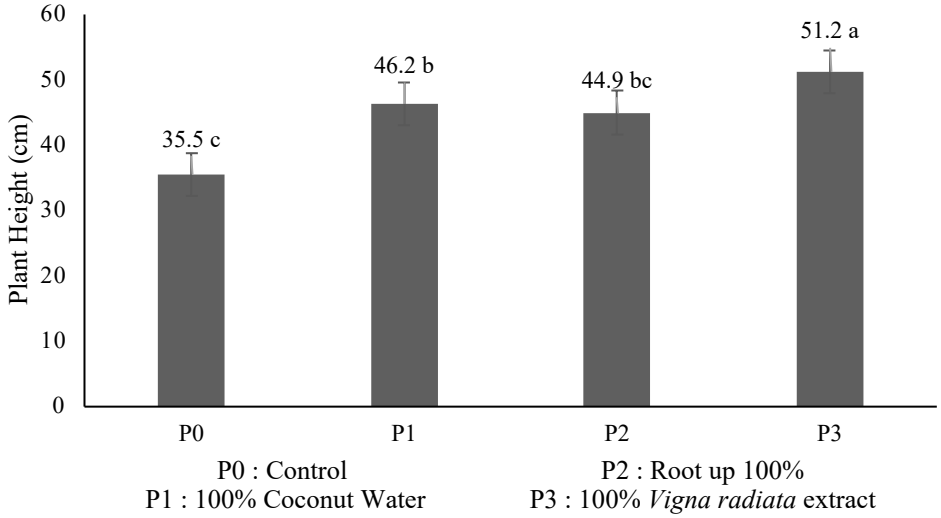


**Figure 2.** The average height of *B. gymnorrhiza* seedlings with the application of 100% *V. radiata* extract, coconut water, and root-up

as the phytohormone auxin, particularly IAA. The right concentration of auxin can assist in the transfer of cytokinins during bud initiation and proper root formation in plants, while optimal auxin application can support diverse plant growth (Nugroho, 2023). The application of auxin hormones can enhance enzyme production, which is a byproduct of protein synthesis (Wang et al., 2024). The use of *V. radiata* extract and red onion has a significant effect on height growth, leaf count, and quality index (Jayanti et al., 2019).

A balanced ratio of auxin and cytokinin can stimulate cell division and differentiation processes. Cytokinins facilitate cell division by enhancing protein synthesis, while auxins promote cell elongation, leading to stem elongation. Auxin regulates cell elongation by activating specific proteins in the cell's plasma membrane, allowing $H^+$ ions to enter the cell wall, which causes the cell to expand through osmosis. After elongation, the cell continues to expand by re-synthesizing cell wall materials and cytoplasm, emphasizing that auxin plays a crucial role in dividing meristematic cells in undeveloped tissues (Setiawan, 2017).

**Length of Root**

The results of the study on the utilization *V. radiata* extract, coconut water, and root up on the growth of *B. gymnorrhiza* seedlings can be seen in Figure 3. The results of the ANOVA test on the treatment of 100% *V. radiata* extract, coconut water, and root up on the seedlings of the mangrove *B. gymnorrhiza* have a significant effect on the root length parameter, with a significance value of (P=0.116). The application of 100% *V. radiata* extract, 100% coconut water, and 10% root up showed significant differences compared to the control. Coconut water contains natural growth regulators that cause plants to have the longest roots (10,188 cm) (Figure 3.) and the most leaves (5,8 leaves) (Figure 5.). Phytohormones in coconut water can stimulate development through absorption in the seedling radicle during soaking (Miftakhurrohmat & Rohma, 2022)The treatment with 100% coconut water produced the longest roots compared to the one with 10% Root up and 100% *Vigna radiata* extract (Resigia et al., 2024). This condition was due to the presence of auxin and cytokinin

in coconut water, which worked together to increase root length efficiently. Coconut water contains gibberellins (0.460 ppm GA3, 0.255 ppm GA5, and 0.053 ppm GA7), cytokinins (0.441 ppm kinetin and 0.247 ppm zeatin), and auxins (0.237 ppm IAA) (Martana et al., 2020). Young coconut water contains 14.11 mg of potassium, 24.67 mg of calcium, and 43.00 mg of nitrogen per 100 ml. The relatively high levels of auxin and cytokinin in coconut water promote root division, allowing the roots to grow longer. Furthermore, water availability in plants influences root length; the more water absorbed according to the plant's needs, the longer the roots will be (De Stefano et al., 2022).

The provision of coconut water as a natural source of ZPT has been proven to increase plant root growth, including root length, in various types of plants. Setiawati & Keliat (2018) discovered that providing old coconut water greatly increased the root length of green mustard plants (*Brassica juncea* L.) to 24.71 cm, the maximum root length among the treatments tested. This demonstrates that the presence of natural cytokinins, auxins, and gibberellins in coconut water promotes root growth. Furthermore, Jayawardena et al. (2021) conducted in vitro research on chrysanthemum plants of the Jayanti Agrihorti type and discovered that adding 75 mL of coconut water to MS media resulted in an average of 20.6 roots per plantlet. Another study by Fatonah (2022) also supports these findings, where red water apple stem cuttings (*Syzygium aqueum*) given coconut water ZPT produced an average root length of 6.8 cm and a number of roots of 6, which was higher than the control.

The extract of *V. radiata* contains growth regulators, including auxin at 1.68 mg/L, gibberellin at 39.94 mg/L, and cytokinin at 96.26 mg/L (Tini et al., 2022).*V. radiata* can also be used to supplement nutrition, as they contain vitamins and minerals needed for growth. Mung bean protein contains essential amino acids such as tryptophan (1.35%), threonine (4.50%), phenylalanine (7.07%), methionine (0.84%), lysine (7.94%), leucine (12.90%), isoleucine (6.95%), and valine (6.25%) (Rahmadea & Yulianah, 2024a). The tips of the roots absorb water and nutrients. When plant roots absorb a significant amount of oxygen and nutrients, the volume of the roots and plant growth remain balanced. Conversely, low water availability hinders root development, causing plant roots to absorb nutrients inefficiently.

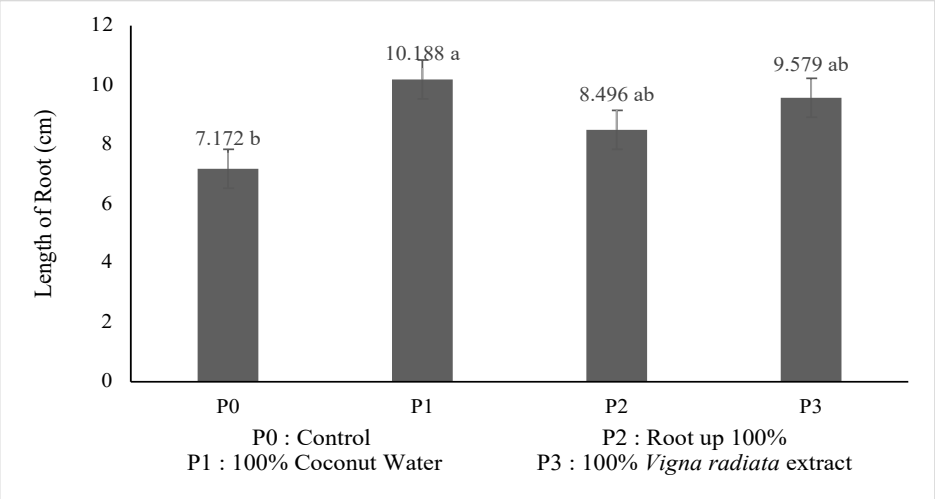


**Figure 3.** The average length of the root of *B. gymnorrhiza* seedlings with the application of 100% *V. radiata* extract, coconut water, and root-up.

**Number of Roots**

The results of the study on the utilization *V. radiata* extract, coconut water, and root up on the growth of *B. gymnorrhiza* seedlings can be seen in Figure 4. The results of the ANOVA test on the treatment of 100% *V. radiata* extract, coconut water, and root up on the seedlings of the mangrove *B. gymnorrhiza* had a significant effect on the root count parameter, with a significance value of (P=0.067). The application of 100% *V. radiata* extract, 100% coconut water, and 10% root up showed significant differences compared to the control. Plants treated with *V. radiata* extract had more numerous roots (10,6) compared to other treatments, making them ideal for use as ready-to-plant seedlings in the field (Figure 4.). A good root system helps mangroves absorb nutrients. The number of roots aids nutrient absorption (Partani et al., 2024;He et al., 2021;Arnaud et al., 2021). The development of a healthy root system results in good plant growth (Tripathi et al., 2022). Strong and wide roots firmly grip the substrate, enabling optimal mangrove growth (Masruroh & Insafitri, 2020). Research by Chiyaroh & Lukiwati (2021) found that soaking mulberry cuttings in mung bean sprout extract significantly increased the number of roots. This treatment showed better results compared to the control and other treatments, especially when combined with a planting medium containing goat manure. Research by Rahmadea & Yulianah (2024b) showed that administering mung bean sprout extract at concentrations of 75 mL/L and 100 mL/L significantly increased the number of roots (13,4 roots/planlet) in *Grammatophyllum scriptum* orchid plantlets at a concentration of 100 mL/L.

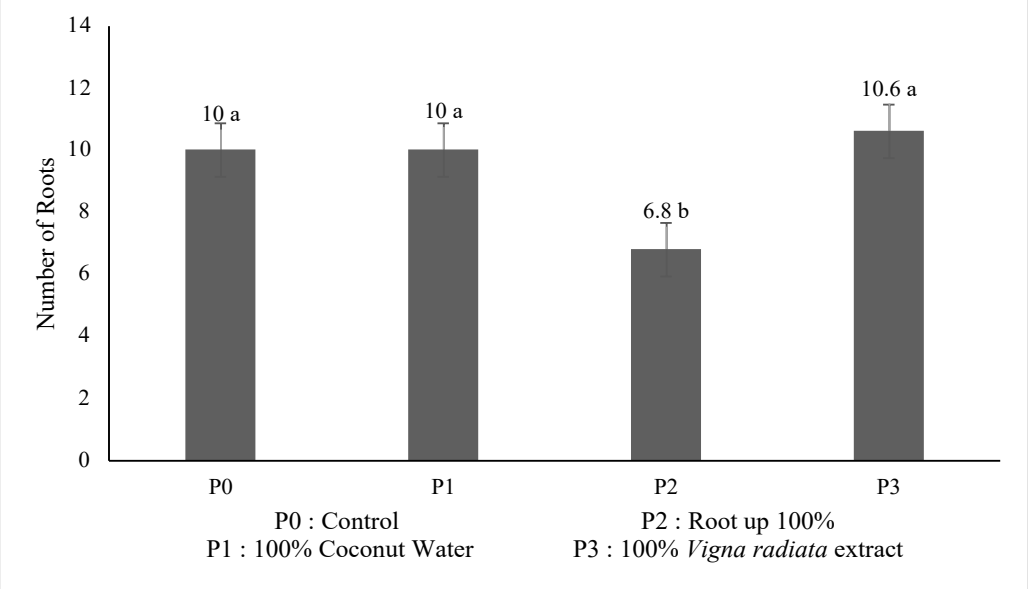


**Figure 4.** The average number of roots of *B. gymnorrhiza* seedlings with the application of 100% *V. radiata* extract, coconut water, and root-up.

**Number of Leaves**

The results of the study on the utilization *V. radiata* extract, coconut water, and root up on the growth of *B. gymnorrhiza* seedlings can be seen in Figure 5. The results of the ANOVA test on the treatment100% V. radiata extract, coconut water, and root up on the seedlings of the mangrove *B. gymnorrhiza* had a significant effect on the number of leaves parameter with a significance value of (P=0.805). The application of 100% *V. radiata* extract, 100% coconut water, and 10% root up showed significant differences compared to the control. Sepbrie (2023) discovered that feeding coconut water considerably increases the number of leaves in spinach plants (*Amaranthus tricolor* L.). In this study, treatment with 100 mL of coconut water resulted in the most leaves compared to the other treatments. Furthermore, Apriani Ningsi et al. (2021) found that feeding 200 mL of coconut water increased the number of leaves in celery plants (*Apium graveolens* L.) at 12 weeks after planting (MST). Data analysis using ANOVA revealed that this treatment had a substantial influence on celery plant development, including an increase in leaf count. Jayawardena et al. (2021) found that adding 25 mL and 75 mL of coconut water to the in vitro culture media of the chrysanthemum (*Chrysanthemum* sp.) Jayanti Agrihorti variety resulted in the highest average number of leaves, which was 18.7 strands per plantlet. Similarly, Nugrahani et al. (2019) study on fig stem cuttings (*Ficus carica* L.) found that administering young coconut water at a certain concentration increased the number of leaves significantly. Although the maximum number of leaves was not specified, the study's findings revealed that the concentration of coconut water influenced the growth of the number of leaves at 4 and 8 weeks after planting.

Coconut water also affects the number of leaves (Cartika, 2022). Auxin activates the ubiquitin ligase enzyme, which is linked to Aux proteins and degraded by the 26S proteasome. When the Aux protein is removed, the heterodimer transforms into a homodimer that binds to the early auxin gene and initiates transcription (Schepetilnikov & Ryabova, 2017). The transcribed gene produces proteins that promote the growth and differentiation of meristem cells, leading to the formation of leaf organ components. The optimal concentration of auxin growth regulators aims to facilitate the growth and development of plants, as well as hormone absorption, allowing them to grow more efficiently (Zhang et al., 2022). Synthetic plant growth regulators (PGRs), such as root up, are theoretically formulated to maintain stable hormone concentrations. However, in practice, their application does not always result in optimal plant growth. In the case of *B. gymnorrhiza*, the use of root up at a 10% concentration did not produce the best growth responses, despite the fact that synthetic plant growth regulators (PGRs) like Root up are designed to keep hormone concentrations stable. This suboptimal outcome is most likely due to a mismatch between the applied concentration and the specific physiological requirements.

**Diameter of The Stem**

The results of the study on the utilization *V. radiata* extract, coconut water, and root up on the growth of *B. gymnorrhiza* seedlings can be seen in Figure 6. The results of the ANOVA test on the treatment of 100% *V. radiata* extract, coconut water, and root up on the seedlings of the mangrove *B. gymnorrhiza* had a significant effect on the stem diameter parameter with a significance value of (*p*=0.197). The application of 100%

*V.radiata* extract, 100% coconut water, and 10% root up showed significant differences compared to the control. The diameter of the plant stem was best when treated with *V. radiata* extract (15,254 mm) (Figure 6.). The right composition and concentration of PGRs can guide the growth and development of plants. Cytokinins stimulate cell division, bud development on stems, and elongation growth (Kieber & Schaller, 2018). Besides, they are chemical substances that promote cytokinesis (cell division) and trigger various responses in conjunction with other hormones. They also play a role in chlorophyll storage, the accumulation of amino acids, and protein storage in leaves (Fathy et al., 2022). Gibberellin helps plants by promoting enzyme synthesis in seeds, encouraging cell elongation, and enhancing flowering. Gibberellin is a growth regulator that increases the number and size of cells (Castro-Camba et al., 2022). It promotes the hydrolysis of starch, fructan, and cellulose into glucose and fructose molecules. The produced sugar supplies energy through respiration and aids in the development of cell walls (Stein & Granot, 2019). Creating a more negative water potential in certain conditions and facilitating water absorption (Malińska et al., 2016). Auxin, as a key substance regulating plant growth, influences cell growth, phototropism, geotropism, apical dominance, parthenocarpy, callus thinning, and respiration (Batista-Silva et al., 2024). Research by Miftakhurrohmat & Rohma (2022) showed that the combination of 200 g of shallot extract and 200 g of mung bean sprout extract dissolved in 1 liter of water had a significant effect on increasing the diameter of land spinach stems. The combination of 200 g of red onion extract and 200 g of green bean sprout extract in 1 liter of water had a significant effect on increasing the diameter of the land spinach stem.

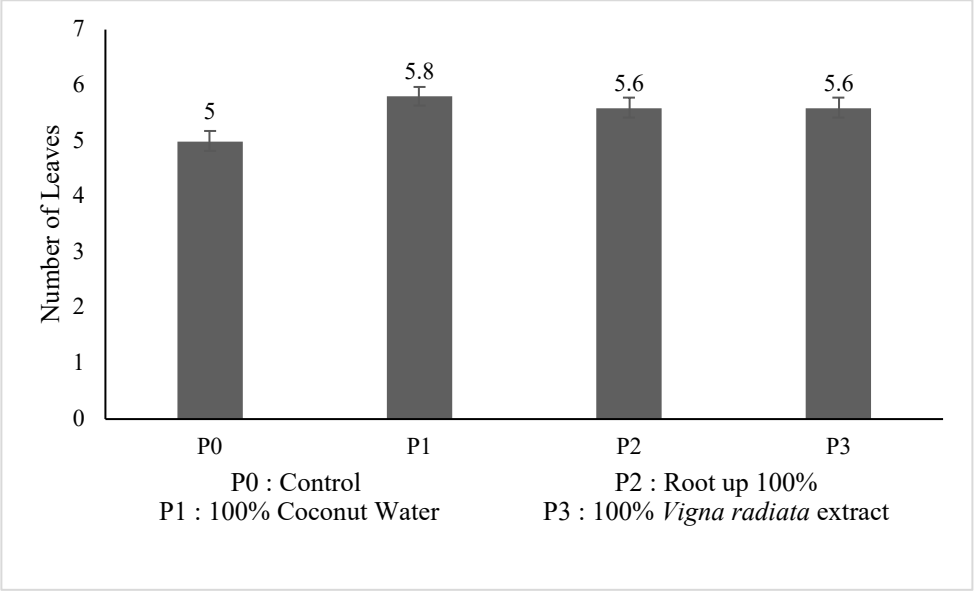


**Figure 5.** The average number of leaves of *B. gymnorrhiza* seedlings with the application of 100% *V. radiata* extract, coconut water, and root-up.

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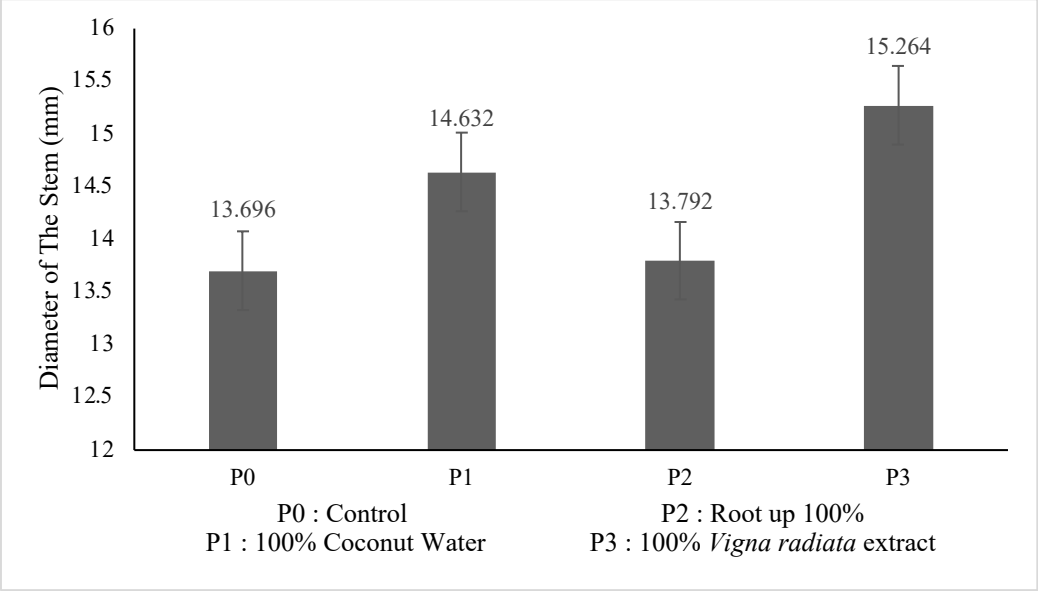


**Figure 6.** The average diameter of *B. gymnorrhiza* seedling stems with the application of 100% *V. radiata* extract, coconut water, and root-up

**Fresh Weight**

The results of the study on the utilization *V. radiata* extract, coconut water, and root up on the growth of *B. gymnorrhiza* seedlings can be seen in Figure 7. The results of the ANOVA test on the treatment of 100% *V. radiata* extract, coconut water, and root up on the seedlings of the mangrove B. *gymnorrhiza* significantly affected the fresh weight parameter with a significance value of ($p$=0.005). The application of 100% *V. radiata* extract, 100% coconut water, and 10% root up showed significant differences compared to the control. The best fresh weight of the plants was obtained from the treatment with *V. radiata* extract (33.8 g) (Figure 7.). The concentration resulted in significant differences, likely due to the optimal functioning of auxin in the extract, as evidenced by the higher fresh weight of the plants compared to other treatments. In addition to auxin's role, the fresh weight was influenced by the nutrients consumed to support plant growth. Plants require nutrients and water, which are taken up by the roots and transported to the leaves for photosynthesis (Anindya et al., 2023). Research by Praemysta & Wardiyati (2024) Administration of mung bean sprout extract at concentrations of 50 and 100 g/L significantly increased the wet weight of alfalfa microgreens. Study by Pratiwi et al. (2022) Administration of mung bean sprout extract to Murashige and Skoog (MS) media at a concentration of 5% significantly increased the wet weight of red spinach explants. In a study by Wang et al. (2018) published in Food Chemistry, application of carbon dots (CDs) to mung bean (*Vigna radiata*) sprouts significantly increased growth parameters such as fresh weight, root length, and stem length. CDs stimulate photosynthesis, increase light absorption efficiency, and improve electron transfer in chloroplasts. This directly contributes to increased fresh biomass (fresh weight) compared to the control.

In the case of *B. gymnorrhiza,* the use of root up at a 10% concentration did not produce the best growth responses, despite the fact that synthetic plant growth regulators (PGRs) like Root up are designed to keep hormone concentrations stable. This suboptimal outcome is most likely due to a

mismatch between the applied concentration and the specific physiological requirements. Although Root up is commercially marketed as a synthetic PGR designed to enhance plant development, its performance was inferior compared to natural PGRs such as coconut water and *V. radiata* sprout extract. These natural alternatives demonstrated better outcomes in key morphological parameters, including plant height, leaf number, root length and count, as well as fresh biomass. One possible explanation is that synthetic PGR formulations like Root up typically contain only one or two dominant hormones, such as indole-3-butyric acid (IBA) or naphthaleneacetic acid (NAA), and lack the complementary nutrients or the diverse phytohormonal profile present in natural extracts. This absence of hormonal diversity may limit the synergistic interactions required for optimal cell division and elongation processes (Ningsih et al., 2021).

Unlike synthetic formulations, natural plant growth regulators (PGRs) comprise a variety of bioactive chemicals that work together to promote plant development. For example, mung bean (*Vigna radiata*) sprout extract contains auxins, gibberellins, cytokinins, vitamins, and vital amino acids, all of which play important roles in plant metabolism and growth (Zhang et al., 2022). These components aid in the absorption and transfer of nutrients and water into plant tissues, which is especially useful in harsh conditions like mangrove habitats. The low efficacy of the synthetic PGR Root up may potentially be due to the low concentration used. In this investigation, Root up was applied at a 10% concentration, which seemed insufficient to generate substantial physiological responses in *B. gymnorrhiza*. This contrasts with the natural PGRs coconut water and *V. radiata* extract applied at full power (100%), which had a greater impact on plant development (Ningsih et al., 2021). These data indicate that the content and concentration of PGRs are important factors of their efficacy.

The low efficacy of the synthetic PGR Root up may potentially be due to the low concentration used. In this investigation, Root up was applied at a 10% concentration, which seemed insufficient to generate substantial physiological responses in *Bruguiera gymnorrhiza*. This contrasts with the natural PGRs coconut water and *V. radiata* extract applied at full power (100%), which had a greater impact on plant development (Setyowati et al., 2023). These data indicate that the content and concentration of PGRs are important factors of their efficacy. Mangrove species, such as *Bruguiera gymnorrhiza*, have distinct physiological and morphological adaptations that allow them to withstand saline stress and anaerobic substrate conditions. These environmental constraints need a complicated hormonal interplay in order to promote healthy growth and development. In this context, natural plant growth regulators (PGRs) are more appropriate for such species than manufactured PGRs, which are chemically homogenous and frequently target only one component of plant growth (Imamsyah et al., 2020). Given these limitations, the continued usage of synthetic PGRs like Root up requires further investigation. Future applications should include a critical reassessment of hormonal formulations, appropriate dosage levels aligned with specific plant growth stages, and potential integration with organic or natural substances to improve efficacy especially in ecologically sensitive and dynamic environments like tropical mangrove forests.

The application of *V. radiata* extract had a significant effect on the height of *B. gymnhorrhiza* plants, the number of leaves,

leaf area, root quantity, and root length (Figure 1.), as shown by the one-way ANOVA test. A significance value of less than 0.05 at a 95% confidence level indicates this result. Each parameter also underwent an additional DMRT test at 5% to ensure accurate letter notation within a column. An additional 5% DMRT test was subsequently conducted to determine the best concentration therapy. The interaction of auxin with cytokinin during cell differentiation and division produced beneficial effects. Therefore, it is expected that the concentration of *V. radiata* extract used in this study is sufficient to enhance the growth of healthy plants. When these two hormones are combined, plant growth increases because auxin and cytokinin function as stem elongation hormones and overall plant growth activators (Maesyaroh, 2018).

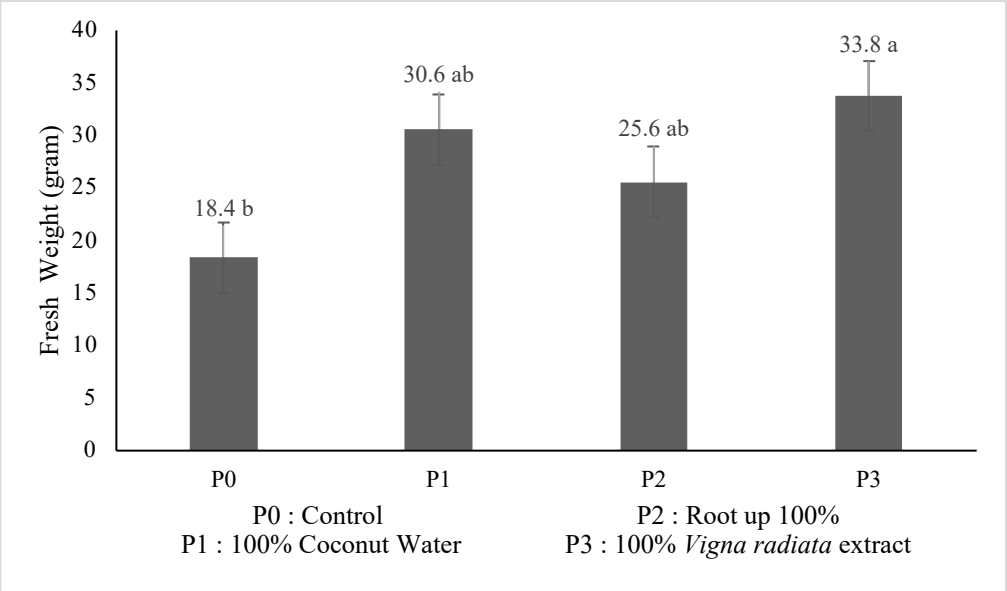


**Figure 7.** The average fresh weight of *B. gymnorrhiza* seedlings with the application of 100% *V. radiata* extract, coconut water, and root-up.

## CONCLUSION

The seedling nursery of *Bruguiera gymnhorrhiza*, with the application of plant growth regulators from young coconut water, mung bean sprout extract, and root-up, indicated a positive effect on the growth of *B. gymnhorrhiza* seedlings. This treatment enhanced plant height, root number, stem diameter, wet weight, root length, and leaf count. Among the treatments, *Vigna radiata* extract had the most impact and the best treatments.

## AUTHOR CONTRIBUTION

**D.M.** as the lead author, she was responsible for formulating the main idea of the research, developing the methodology, analysed data, interpreted the results obtained, and writing the initial draft of the manuscript. **E.P.** contributed to the data collection, provided input of the experimental design, and supported the literature review. **S.H.** assisted in statistical analysis and data modeling, technical advice in processing the results, also contributed to writing the discussion and conclusion sections. **E.D.H.** as guided in

field data collection and research document management, also compiled tables and graphs contained in the manuscript. **F.P.I**. revised the draft by ensuring clarity and consistency of the arguments presented in the manuscript.

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## CONFLICT OF INTEREST

There is no conflict of interest in this research team.

## REFERENCES

Amelia, R., Basyuni, M., Alfinsyahri, A., Sulistiyono, N., Slamet, B., Bimantara, Y., Harahap, S. S. H., Harahap, M., Harahap, I. M., Al Mustaniroh, S. S., Sasmito, S. D., & Arifanti, V. B. (2023). Evaluation of Plant Growth and Potential of Carbon Storage in the Restored Mangrove of an Abandoned Pond in Lubuk Kertang, North Sumatra, Indonesia. *Forests*, 14(1). DOI: 10.3390/f14010158

Anindya, W., Palupi, D., & Budisantoso, I. (2023). Efektivitas Pertumbuhan dan Hasil Tanam Beberapa Kultivar Kedelai (*Glycine max* (L) Merr.) dengan Pemberian Polietilena Glikol (PEG) Untuk Simulasi Cekaman Kekeringan. *Al-Kauniyah: Jurnal Biologi*, 17(1), 133–143. DOI: 10.15408/kauniyah.v17i1.29345

Arnaud, M., Morris, P. J., Baird, A. J., Dang, H., & Nguyen, T. T. (2021). Fine root production in a chronosequence of mature reforested mangroves. *New Phytologist*, 232(4), 1591–1602. DOI: 10.1111/nph.17480

Batista-Silva, W., de Paiva Gonçalves, J., Siqueira, J. A., Martins, A. O., Ribeiro, D. M., Nunes-Nesi, A., Zsögön, A., & Araújo, W. L. (2024). Auxin metabolism and the modulation of plant growth. *Environmental and Experimental Botany*, 226, 105917. DOI: 10.1016/j.envexpbot.2024.105917

Budiadi, B., Widiyatno, W., Nurjanto, H. H., Hasani, H., & Jihad, A. N. (2022). Seedling Growth and Quality of *Avicennia marina* (Forssk.) Vierh. under Growth Media Composition and Controlled Salinity in an Ex Situ Nursery. *Forests*, 13(5). DOI: 10.3390/f13050684

Cartika, I. (2022). Penggunaan volume dan interval irigasi yang berbeda untuk mengoptimalkan pertumbuhan dan produksi bawang putih di dataran tinggi. *Kultivasi*, 21(1). DOI: 10.24198/kultivasi.v21i1.34991

Castro-Camba, R., Sánchez, C., Vidal, N., & Vielba, J. M. (2022). Plant Development and Crop Yield: The Role of Gibberellins. In *Plants*, 11(19). MDPI. DOI: 10.3390/plants11192650

Chiyaroh, L. N., & R Lukiwati, dan D. (2021). Pengaruh jenis ekstrak kecambah dan pupuk kandang pada komposisi media tanam terhadap pertumbuhan stek murbei (*Morus alba*) (The effect of various sprouts extracts and various types of manure on the composition of the growing media on the growth of Mulberry cuttings). *J. Agro Complex*, 5(1), 32–40. DOI:10.14710/joac.5.2.32-40

De Stefano, D., Costa, B. N. S., Downing, J., Fallahi, E., & Khoddamzadeh, A. A. (2022). Micropropagation and Acclimatization of an Endangered Native Orchid Using Organic Supplements. American

*Journal of Plant Sciences*, 13(03), 380–393. DOI: 10.4236/ajps.2022.133023

Fathy, M., Saad Eldin, S. M., Naseem, M., Dandekar, T., & Othman, E. M. (2022). Cytokinins: Wide-Spread Signaling Hormones from Plants to Humans with High Medical Potential. In *Nutrients*, 14(7). MDPI. DOI: 10.3390/nu14071495

Fatonah, S., & Yani, R. (2022). Growth of Leaf Cutting of Malay Apple (*Syzygium malaccense* (L.) MERR & PERRY) With Coconut Water Treatment. *Jurnal Pertanian*. DOI: 10.30997/jp.v14i2.8534

He, Z., Sun, H., Yu, X., Yin, Z., Wu, M., Zhao, L., Hu, Z., Peng, Y., & Lee, S. Y. (2021). Monoculture or Mixed Culture? Relevance of Fine Root Dynamics to Carbon Sequestration Oriented Mangrove Afforestation and Restoration. *Frontiers in Marine Science*, 8. DOI: 10.3389/fmars.2021.763922

Imamsyah, A., Arthana, I. W., & Astarini, I. A. (2020). The influence of physico-chemical environment on the distribution and abundance of mangrove gastropods in Ngurah Rai Forest Park Bali, Indonesia. *Biodiversitas*, 21(7), 3178–3188. DOI: 10.13057/biodiv/d210740

Jayanti, F. dwi, Duryat, D., & Bintoro, A. (2019). Pengaruh Pemberian Ekstrak Tauge dan Bawang Merah Pada Pertumbuhan Bibit Gaharu (*Aquilaria Malaccensis*). *Jurnal Belantara*, 2(1), 70–75. DOI: 10.29303/jbl.v2i1.124

Jayawardena, B. M., Agampodi, V. A., & Abeywickrama, K. P. (2021). Effect of coconut (*Cocos nucifera*) water extract on the development of adventitious roots in polyscias fillicifolia stem cuttings. *Journal of Agricultural Sciences - Sri Lanka*, 16(3), 484–490. DOI: 10.4038/JAS.V16I03.9473

Kieber, J. J., & Schaller, G. E. (2018). Cytokinin signaling in plant development. Development (Cambridge), 145(4). DOI: 10.1242/dev.149344

Kusmana, C., Hidayat, T., Istomo, & Rusdiana, O. (2018). Growth performance of *Bruguiera gymnorrhiza* derived from cutpropagule seedling. *Biodiversitas*, 19(1), 208–214. DOI: 10.13057/biodiv/d190128

Madhavan, C., Meera, S. P., & Kumar, A. (2024). Anatomical adaptations of mangroves to the intertidal environment and their dynamic responses to various stresses. *Biological Reviews*, n/a(n/a). DOI: 10.1111/brv.13172

Maesyaroh, T. K. D. T. M. 1. (2018). Inspection and Diversity on Siam Orange Plants (*Citrus nobilis* l.). *Jurnal Pertanian*, 9(2), 61–121. DOI: 10.30997/jp.v9i2.1487

Malińska, L., Rybska, E., Sobieszczuk-Nowicka, E., & Adamiec, M. (2016). Teaching about water relations in plant cells: An uneasy struggle. *CBE Life Sciences Education*, 15(4). DOI: 10.1187/cbe.15-05-0113

Martana, S. B., Sofyadi, E., & Widyastuti L., S. N. (2020). Pertumbuhan Tunas dan Akar Setek Tanaman Mawar (*Rosa* sp.) Akibat Konsentrasi Air Kelapa. *Paspalum: Jurnal Ilmiah Pertanian,* 8(1), 31. DOI: 10.35138/paspalum.v8i1.150

Masruroh, L., & Insafitri, I. (2020). Pengaruh Jenis Substrat Terhadap Kerapatan Vegetasi *Avicennia marina* di Kabupaten Gresik. *Juvenil:Jurnal Ilmiah Kelautan Dan Perikanan*, 1(2), 151–159. DOI: 10.21107/juvenil.v1i2.7569

Miftakhurrohmat, A., & Rohma, N. T. (2022). Effect of Concentration and Duration of Soaking Coconut Water on Germination of Black Soybean (*Glycine max* (L.) Merril) Seeds. *Nabatia*, 10(1), 15–25. DOI: 10.21070/nabatia.v10i1.1604

Montgomery, J. M., Bryan, K. R., Horstman, E. M., & Mullarney, J. C. (2018). Attenuation of tides and surges by mangroves: Contrasting case studies from New Zealand. *Water (Switzerland)*, 10(9). DOI: 10.3390/w10091119

Mowidu, I., Paema, R., & Pangli, M. (2021). Perkecambahan benih kemi-

ri pada aplikasi perendaman dalam air kelapa muda. *Agropet*, 18(2), 20–25. DOI: 10.71127/2828-9250.356

Ningsi, R. A., Alibasyah, L. M., Achmad, M. A., & Mawaddah, H. (2021). Efek Pemberian Air Kelapa (*Cocos nucifera* L.) terhadap Pertumbuhan Tanaman Seledri (*Apium graveolens* L.) dan Pemanfaatannya sebagai Media Pembelajaran. *Journal of Biology Science and Education*, 9(1), 739-746. DOI: 10.22487/jbse.v9i1.1662

Ningsih, E.M.N., Sudiyono, & Dwi Anggraeni, F. (2021). Plant Growth Regulator of Auxin Content in Fermented Coconut Water Waste. *Journal of Physics: Conference Series*, 1908(1). DOI: 10.1088/1742-6596/1908/1/012006

Nugrahani, P., Utomo Pribadi, D., Agroteknologi, J., Timur Jl Raya Rungkut Madya, J., Anyar, G., & Penulis, K. (2019). Morfogenesis dan Induksi Kalus Tanaman Tin (*Ficus carica* L Pada Media Murashige dan Skoog (MS) Dengan Penambahan Benzylaminopurine. 13(2). DOI: 10.19184/j-agt.v13i02.13914

Nugroho, S. A., Al Arozi, L. N., & Novenda, I. L. (2023). Pengaruh Media Tanam dan ZPT Nabati (Air Kelapa dan Bawang merah) terhadap Pertumbuhan Setek Vanili (*Vanilla planifolia* Andrews). *Jurnal Biosense*, 6(01), 83-97. DOI: 10.36526/biosense.v6i01.2837

Nursinar, S., Yapanto, L. M., & Didipu, F. (2023). Survival of Mangrove Propagules Types of *Rhizophora apiculata* with Different Media. A*dvances in Water Science*, 34(2), 11–20. DOI: 10.12911/22998993/183806

Partani, S., Danandeh Mehr, A., & Jafari, A. (2024). Enhancing nutrient absorption through the influence of mangrove ecosystem on flow rate and retention time in salt marshes. *Science of The Total Environment*, 924, 171518. DOI: 10.1016/j.scitotenv.2024.171518

Praemysta, F. H., & Wardiyati, T. (2024). Pengaruh Ekstrak Kecambah dan Media Tanam terhadap Pertumbuhan Microgreens Alfalfa (*Medicago sativa* L.). *Produksi Tanaman*, 12(6), 399–404. DOI: 10.21776/ub.protan.2024.012.06.05

Pratiwi, B. A., Rugayah, R., Sa'diyah, N., & Karyanto, A. (2022). Pengaruh Konsentrasi Air Kelapa dan Pemberian Ekstra Kecambah Kacang Hijau Terhadap Pertumbuhan Seedling Manggis (*Garcinia mangostana* L.). *Jurnal Agrotek Tropika*, 10(4), 601. DOI: 10.23960/jat.v10i4.6453

Rahmadea, A., & Yulianah, I. (2024a). Pengaruh Pemberian Ekstrak Tauge Terhadap Pertumbuhan dan Hasil Microgreen Selada (*Lactuca sativa* L.) pada Media Tanam Berbeda. *Produksi Tanaman,* 12(05), 295–304. DOI: 10.21776/ub.protan.2024.012.05.01

Rahmadea, A., & Yulianah, I. (2024b). Pengaruh Pemberian Ekstrak Tauge Terhadap Pertumbuhan dan Hasil Microgreen Selada (*Lactuca sativa* L.) pada Media Tanam Berbeda. Produksi Tanaman, 12(05), 295–304. DOI: 10.21776/ub.protan.2024.012.05.01

Resigia, E., Swasti, E., Putri, N. E., Kusumawati, A., & Hasibuan, S. P. (2024). Effect of Seed Soaking with Natural Growth Regulators on Germination of Red Rice Line SF 12-2-12. *AGRIUM: Jurnal Ilmu Pertanian*, 27(1), 44-53. DOI: 10.30596/agrium.v27i1.17636

Schepetilnikov, M., & Ryabova, L. A. (2017). Auxin signaling in regulation of plant translation reinitiation. *Frontiers in Plant Science*, 8(June), 1–15. DOI: 10.3389/fpls.2017.01014

Sepbrie Mulia Bingah Pranata, & Suparti Suparti. (2023). Growth of Red Spinach (*Amaranthus tricolor* L.) Hydroponically Using POC Tomatoes and Moringa Leaves. *Bioeduscience*, 7(2), 200–208. DOI: 10.22236/jbes/11688

Setiawan, E. (2017). Efektivitas Pemberian IAA, IBA, NAA, dan Root-

up pada Pembibitan Kesemek. *Jurnal Hortikultura Indonesia*, 8(2), 97. DOI: 10.29244/jhi.8.2.97-103

Setiawati, T., & Keliat, A. P. R. (2018). Influence of NAA and coconut water with variation of soaking duration on the growth of yellow bamboo branch cutting. *Nusantara Bioscience*, 10(3), 178–182. DOI : 10.13057/nusbiosci/n100308

Setyowati, N., Permana, I. G., & Hermansyah, H. (2023). Effect of growing media and natural plant growth regulators on the growth of tea stem cutting. *E3S Web of Conferences*, 373. DOI: 10.1051/e3sconf/202337303004

Stein, O., & Granot, D. (2019). An overview of sucrose synthases in plants. In Frontiers in Plant Science (Vol. 10). *Frontiers Media* S.A. DOI: 10.3389/fpls.2019.00095

Suriani, M., Sakbania Ulma, O., Kusumawati, I., Ilmu Kelautan, J., Perikanan dan Ilmu Kelautan, F., Teuku Umar Jl Alue Peunyareng, U., Meureubo, K., Aceh Barat, K., & Aceh, P. (2023). Analisis Kondisi Vegetasi Mangrove Menggunakan Metode Hemispherical Photography di Kabupaten Simeulue. *Journal of Marine Research*, 12(2), 323–329. DOI: 10.14710/jmr.v12i2.36308

Tini, E. W., Sakhidin, S., Saparso, S., & Haryanto, T. A. D. (2022). Perbandingkan Kandungan Hormon Endogenous Pada Beberapa Tanaman. *Jurnal Galung Tropika*, 11(2), 132–142. DOI: 10.31850/jgt.v11i2.955

Tripathi, R., Tewari, R., Singh, K. P., Keswani, C., Minkina, T., Srivastava, A. K., De Corato, U., & Sansinenea, E. (2022). Plant mineral nutrition and disease resistance: A significant linkage for sustainable crop protection. In *Frontiers in Plant Science* (Vol. 13). Frontiers Media S.A. DOI: 10.3389/fpls.2022.883970

Wang, H., Zhang, M., Song, Y., Li, H., Huang, H., Shao, M., Liu, Y., & Kang, Z. (2018). Carbon dots promote the growth and photosynthesis of mung bean sprouts. *Carbon*, 136, 94–102. DOI: 10.1016/j.carbon.2018.04.051

Wang, Y., Zhou, Z., & Liu, X. (2024). Auxin promotes chloroplast division by increasing the expression of chloroplast division genes. *Plant Cell Reports*, 44(1), 20. DOI: 10.1007/s00299-024-03415-4

Watu, R., Astuti, M., & Santoso, T. N. B. (2017). Pengaruh Konsentrasi Zat Pengatur Tumbuh (Root Up) Terhadap Pertumbuhan Stek Batang *Antigonon leptopus* Hook et Arn. *Jurnal Agromast*, 2(2), 1–11. DOI:10.35138/wanamukti.v25i2.555

Yona, D., Hidayati, N., Sari, S. H. J., Amar, I. N., & Sesanty, K. W. (2018). Teknik Pembibitan Dan Penanaman Mangrove Di Banyuurip Mangrove Center, Desa Banyuurip, Kecamatan Ujungpangkah, Kabupaten Gresik. *J-Dinamika* : *Jurnal Pengabdian Masyarakat*, 3(1). DOI: 10.25047/j-dinamika.v3i1.744

Zhang, K., Zhang, H., Pan, Y., & Niu, Y. (2022). Cell- and noncell-autonomous Auxin Response Factor3 controls meristem proliferation and phyllotactic patterns. *Plant Physiology*, 190(4), 2335–2349. DOI: 10.1093/plphys/kiac370