

Effect of different growing media and PGPR concentrations on the growth performance of basil in substrate hydroponic system

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ABSTRACT

Basil (*Ocimum basilicum* L.) is classified as a vegetable and aromatic plant used in health, culinary, and essential oil production. The main challenges in basil cultivation include limited land availability, soil degradation, water scarcity, and land conversion caused by urban development. A promising alternative to overcome these constraints is soilless culture, commonly known as hydroponics, which enables efficient plant production without soil. Various substrates can be used in hydroponic systems, including organic media derived from agricultural residues. In addition, PGPR play an important role in enhancing plant growth through nutrient mobilization and phytohormone production. This study aimed to evaluate the optimal growing medium and PGPR concentration to support basil growth in a substrate hydroponic system. The research used a factorial randomized block design (RBD) with two factors: planting media (three levels) and PGPR concentration (four levels). The results showed that cocopeat supported superior basil growth compared to rice husk and husk charcoal. Furthermore, PGPR application significantly enhanced plant growth compared with treatments without PGPR. Regression analysis indicated that each type of planting medium required a different optimum PGPR concentration to achieve maximum biomass production. Specifically, cocopeat required 8.87 mL/L, husk charcoal required 9.3 mL/L, and fresh husk required 14.4 mL/L. Considering both yield performance and production cost efficiency, cocopeat combined with PGPR at 8–10 mL/L was recommended as the most effective treatment.

Keywords: agricultural waste, biofertilizer, *Ocimum basilicum*, soilless culture, urban farming

INTRODUCTION

Basil (*Ocimum basilicum* L.) is an aromatic herb belonging to the Lamiaceae family, widely used in medicinal, culinary, and aromatic applications. It is an annual, sun-loving plant that grows optimally under high-light conditions and is extensively cultivated in Mediterranean regions, Asia, Africa, and Europe (Jimayu, 2021; Qazizadah et al., 2023). Phytochemical analyses reveal that basil contains several bioactive compounds, including alkaloids, saponins, flavonoids, triterpenoids, tannins, steroids, and phenols (Rukmana et al., 2019; Shahrajabian et al., 2020). These constituents contribute to the

plant's diverse biological activities, such as antioxidant, immunomodulatory, anti-inflammatory, antibacterial, anticancer, and antidiabetic effects (Ch et al., 2015; Kamelnia et al., 2023). Traditionally, basil has been used in ethnomedicine to alleviate various ailments, including rheumatism, hypertension, diabetes, gout, bronchitis, and certain types of cancer (Eid et al., 2023).

Limited land availability, land degradation, water scarcity, and rapid urban expansion have become major constraints in agricultural production (Saha et al., 2016). One promising approach is soilless culture, a cultivation technique that eliminates the use of soil as a

rooting media commonly referred to as hydroponics (Savvas & Gruda, 2018). Previous studies have shown that basil plants exhibit superior growth and productivity under hydroponic systems compared to conventional soil-based cultivation (Mangmang et al., 2016; Saha et al., 2016). The success of hydroponic cultivation largely depends on the choice of planting media and nutrient availability. Planting media provide physical support for the roots while regulating water and oxygen availability (Joshi et al., 2022; Savvas & Gruda, 2018). Rockwool is the most widely used media due to its high water-holding capacity and excellent root support. However, its use poses several limitations, including high cost, low nutrient content, and poor biodegradability, which contribute to environmental concerns (Tuxun et al., 2025).

Local organic materials such as cocopeat, rice husks, and husk charcoal can be used as low-cost, sustainable hydroponic media while supporting agricultural waste recycling. Cocopeat is widely used due to its favorable physical properties high porosity, good water retention, low permeability, and slow biodegradation (Marjenah et al., 2016). Biochar contains micropores that enhance nutrient and water retention and is resistant to microbial decomposition (Awad et al., 2017). Globally, rice production exceeds 750 million tons of grain annually, generating approximately 150 million tons of husks as by-products (Kordi et al., 2024). The use of organic substrates not only substitutes inorganic media but also adds nutrients and organic matter that enhance plant growth and crop quality (Chusniasih et al., 2023; Lamasrin et al., 2023).

In hydroponic systems, AB Mix is commonly used to supply essential macro- and micronutrients; however, it is relatively costly and mainly provides inorganic nutrients with limited physiological benefits for plant health (Miranti et al., 2023). The integration of *Plant Growth Promoting Rhizobacteria* (PGPR) has been proposed as a promising strategy to enhance nutrient efficiency and plant resilience. PGPR facilitate nutrient acquisition through nitrogen fixation, phosphate solubilization, potassium mobilization, and siderophore production (Aini et al., 2019; Andrade et al., 2023), and improve

plant resistance via *induced systemic resistance* (ISR), pathogen inhibition, phytohormone production, and biofilm formation (Ikiz et al., 2024; Iqbal et al., 2024; Jaoudé et al., 2025). Although numerous studies have reported the benefits of PGPR in soil-based cultivation, limited information is available regarding their synergistic effects with AB Mix in substrate-based hydroponic systems, particularly in basil production. Moreover, the optimal combination of planting media and PGPR concentration under hydroponic conditions remains unclear. Therefore, this study aimed to evaluate the effects of different planting media and PGPR concentrations in substrate-based hydroponic systems to promote sustainable basil production with enhanced growth and productivity.

MATERIALS AND METHODS

The experiment was conducted in a greenhouse located at an altitude of 65 meters above sea level from December 2024 to February 2025. During the study period, ambient air temperature ranged from 23–28°C, with relative humidity of 70–95%. The hydroponic system used in this study was a simple passive circulation setup constructed from galvalume frames with horizontally arranged PVC pipes (Figure 1).

This system operated without electrical pumps, relying on capillary action for nutrient absorption and allowing plant roots to access nutrients directly from the planting media. The design was energy-efficient and economically practical. Each row consisted of five planting holes per treatment, with net pots containing the respective planting media. Basil seeds were germinated in a nursery and transplanted after two weeks, when seedlings had developed three to four true leaves.

The nutrient source was an AB Mix solution applied at 50% of the standard concentration. Typically, optimal nutrient concentrations for basil in hydroponic systems range from 700–1200 ppm, depending on the growth stage (Damayanti et al., 2018). The reduced dosage accommodated the addition of PGPR, which acted as a complementary treatment to enhance nutrient utilization efficiency (Ikiz et al., 2024).

Basil plants were harvested eight weeks after transplanting (WAT).

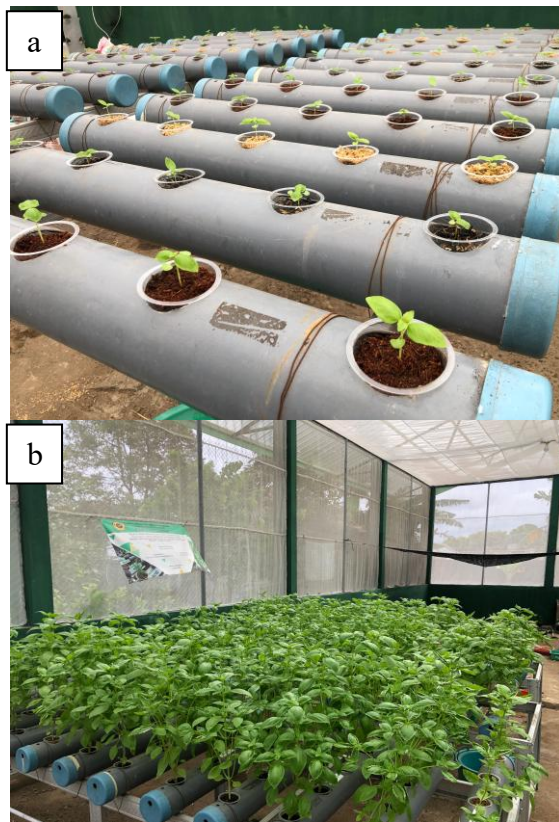


Figure1. Substrate hydroponic trial installation in a greenhouse. (a) Initial growth of basil plants on various types of planting media; (b) Vegetative phase growth of basil after application of AB Mix and PGPR

Research Method: Planting Media and PGPR Application

The experiment used a randomized block design (RBD) arranged in a factorial pattern with two treatment factors. The first factor was the type of planting media, consisting of three levels: M1=rice husk, M2=husk charcoal, and M3=cocopeat. The second factor was the PGPR application rate, consisting of four levels: P0=no application, P5=5 mL/L, P10=10 mL/L, and P15=15 mL/L. Each treatment combination was replicated three times, resulting in a total of 36 experimental units.

PGPR was applied three times during the basil growth period. The first application was conducted during seed soaking (biopriming) prior to sowing, the second application was carried out two weeks after transplanting, and the third application was performed four weeks after transplanting. The PGPR formulation used contained four primary bacterial strains

Lactobacillus sp. (4.4×10^6 CFU/mL), *Azotobacter* sp. (5.1×10^7 CFU/mL), *Rhizobium* sp. (8.4×10^7 CFU/mL), and *Pseudomonas* sp. (8.3×10^7 CFU/mL) as well as two additional beneficial microorganisms, *Trichoderma* sp. (9.3×10^7 CFU/mL) and *Actinomycetes* sp. (3.1×10^7 CFU/mL). The PGPR solution was adjusted to each treatment concentration and applied at 100 mL per plant.

Observation Parameters

The parameters observed in this study consisted of growth, yield, and supporting parameters. Growth observations included plant height and number of leaves, which were recorded periodically at 2, 4, 6, and 8 weeks after transplanting (WAT). Plant height was measured from the base of the stem to the apical growing point using a ruler (cm). The number of leaves was determined by counting all fully expanded leaves per plant.

Yield parameters included plant fresh weight and dry weight, which were measured destructively at the end of the 8-week observation period. All plant samples were carefully uprooted, and residual planting media adhering to the roots were removed. Fresh weight was measured immediately after harvesting using a digital balance. For dry weight determination, plant samples were oven-dried at 80°C until a constant weight was achieved, after which they were weighed.

Supporting parameters included measurements of total dissolved solids (TDS) in the nutrient solution to assess the concentration of dissolved particles. TDS was measured at 2 and 8 WAT using a TDS meter, with results expressed in parts per million (ppm).

Data Analysis

The data obtained from observations were analyzed using analysis of variance (ANOVA) at a 5% significance level to evaluate treatment effects. When significant differences were detected, Duncan's Multiple Range Test (DMRT) was used at a 5% error rate to compare means among treatments. In addition, quadratic polynomial regression analysis was performed to determine the relationship between PGPR concentration and plant growth parameters for

each planting medium. The model was expressed as $Y = a + bX + cX^2$, where Y represents the observed response variable, X denotes PGPR concentration, and a , b , and c were regression coefficients. The optimum PGPR concentration was estimated from the vertex of the quadratic equation ($-b/2c$).

RESULTS

Plant Height

Based on the results of the analysis of variance, there was no interaction between the type of planting media and PGPR concentration on the height of basil plants at any observation age. The average height of basil plants was presented in Table 1. Plant height measurements were taken at 2, 4, 6, and 8 weeks after planting. There was no interaction between the two treatments, but each treatment had a separate effect. Overall, fresh husks showed the lowest results compared to charcoal husks and cocopeat. At observations 2, 4, and 6 WAT, the cocopeat planting media showed the best plant height, while at 8 WAT, the charcoal husk and cocopeat treatments showed no significant difference in

plant height. PGPR application showed a significant difference in basil plant height. At 2 and 6 WAT, PGPR applications at 10 and 15 mL/L produced the greatest plant height. At 4 and 8 WAT, applying PGPR at 5, 10, and 15 mL/L showed no significant difference in plant height.

Number of Leaves

Based on the results of the analysis of variance, there was no interaction between the type of planting media and PGPR concentration on the number of basil leaves at all observation ages. Table 2 presents the average number of basil leaves observed. The type of planting media had an effect on all observation periods. The cocopeat planting media showed the highest number of leaves compared to the husk and charcoal husk media. The use of fresh husk showed the lowest number of leaves. PGPR concentration affected the number of leaves at 4 WAT and had no effect at 2.6 and 8 WAT. PGPR application resulted in a higher number of leaves than no PGPR. Application at concentrations of 5, 10, and 15 mL/L showed no significant difference in the number of leaves.

Table 1. The effect of planting media and PGPR concentration on basil plant height

Treatment	Plant height (cm) at observation age (WAT)			
	2	4	6	8
Types of Planting Media				
Husk	13.83 _a	25.34 _a	31.50 _a	42.73 _a
Husk charcoal	21.25 _b	37.21 _b	45.94 _b	57.86 _b
Cocopeat	23.22 _c	40.12 _c	48.55 _c	59.92 _b
PGPR Concentration				
0 mL/L	17.61 _a	25.34 _a	39.67 _a	50.64 _a
5 mL/L	19.22 _b	37.21 _{ab}	41.65 _{ab}	52.87 _{ab}
10 mL/L	21.07 _{bc}	40.12 _b	43.90 _c	55.56 _b
15 mL/L	19.82 _c	25.34 _b	42.77 _{bc}	54.94 _b
CV (%)	8.45	9.63	5.15	6.17

Note: Numbers followed by the same letter in the same column and under the same treatment indicate no significant difference based on the DMRT 5% test; CV: Coefficient of variation; WAT: Weeks After Transplanting

Table 2. The effect of planting media and PGPR concentration on the number of basil leaves

Treatment	Number of leaves at observation age (WAT)			
	2	4	6	8
Types of Planting Media				
Husk	6.87 _a	12.53 _a	34.00 _a	56.85 _a
Husk charcoal	11.17 _b	28.81 _b	57.67 _b	98.92 _b
Cocopeat	13.27 _c	35.01 _c	68.85 _c	119.2 _c
PGPR Concentration				
0 mL/L	9.33	20.64 _a	49.02	87.11
5 mL/L	9.91	25.82 _b	52.36	86.20
10 mL/L	11.20	27.70 _b	57.31	101.3
15 mL/L	11.29	27.63 _b	55.33	92.08
CV (%)	18.58	20.62	14.44	20.04

Note: Numbers followed by the same letter in the same column and under the same treatment indicate no significant difference based on the DMRT 5% test; CV: Coefficient of variation; WAT: Weeks After Transplanting

The type of planting media had an effect on all observation periods. The cocopeat planting media showed the highest number of leaves compared to the husk and charcoal husk media. The use of fresh husk showed the lowest number of leaves. PGPR concentration affected the number of leaves at 4 WAT and had no effect at 2.6 and 8 WAT. PGPR application resulted in a higher number of leaves than no PGPR. Application at concentrations of 5, 10, and 15 mL/L showed no significant difference in the number of leaves.

Fresh Weight

Based on variance analysis, there was no interaction between planting media type and PGPR concentration on the fresh weight of basil plants. The fresh weight of basil plants was influenced by the type of planting media and PGPR concentration, as shown in Figure 2.

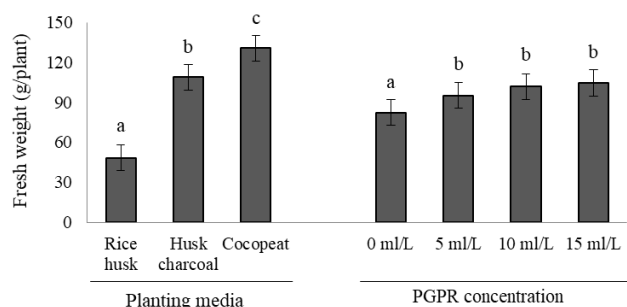


Figure 2. Results of observations on the fresh weight of basil plants due to the effects of planting media and PGPR concentration

The type of planting media and PGPR concentration affected the fresh weight of basil plants. Cocopeat planting media produced the highest fresh weight compared with other planting media. Fresh rice husks showed the lowest fresh weight per plant. The application of PGPR resulted in higher fresh weight compared to without PGPR. At 2 WAT, concentrations of 5, 10, and 15 mL/L showed that cocopeat media had the highest TDS compared with husk and charcoal husk media. Fresh husk showed the lowest TDS value. PGPR application showed higher TDS compared to without PGPR. Applications at 5, 10, and 15 mL/L showed no significant difference in TDS. At 8 WAT, there was an interaction between planting media type and PGPR concentration on TDS. In husk and cocopeat media, PGPR concentration had no effect on basil plant TDS; all PGPR

concentrations showed no significant differences. In rice husk charcoal media, the lowest TDS was found in the treatment without PGPR application. TDS increased at a concentration of 5 mL/L and then decreased at concentrations of 10 and 15 mL/L showed no significant difference in fresh weight.

Dry Weight

The analysis of variance showed a significant interaction between planting media type and PGPR concentration on the dry weight of basil plants. Figure 3 presents the mean dry weight values influenced by both factors.

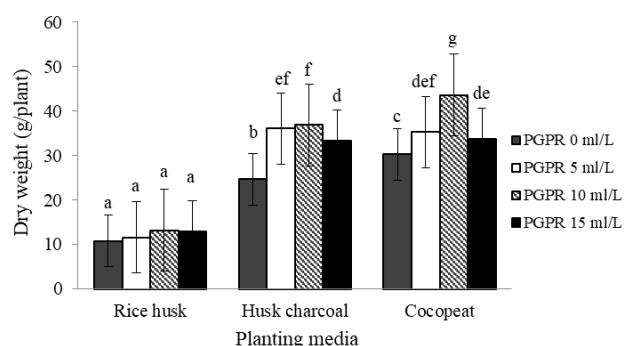


Figure 3. Interaction between planting media type and PGPR concentration on the dry weight of basil plants

In general, fresh husks showed the lowest dry weight compared to charcoal husk and cocopeat media. In husk media, PGPR concentration did not affect basil dry weight. When using charcoal husk media, the lowest dry weight was found in the treatment without PGPR. Dry weight increased at PGPR concentrations of 5 and 10 mL/L, then decreased at a PGPR concentration of 15 mL/L. In cocopeat planting media, the lowest dry weight was found in the treatment without PGPR application. The dry weight increased at a PGPR concentration of 10 mL/L and decreased at 15 mL/L. PGPR concentrations of 5 mL/L and 15 mL/L showed no significant difference in results.

TDS (Total Dissolved Solids)

Dissolved solids were observed twice, at 2 WAT and 8 WAT. This was done to compare the total dissolved solids at the beginning and end of the treatment. At 2 WAT, there was no interaction between planting media type and PGPR concentration (Figure 4). Interaction was observed in the total dissolved solids at 8 WAT (Figure 5).

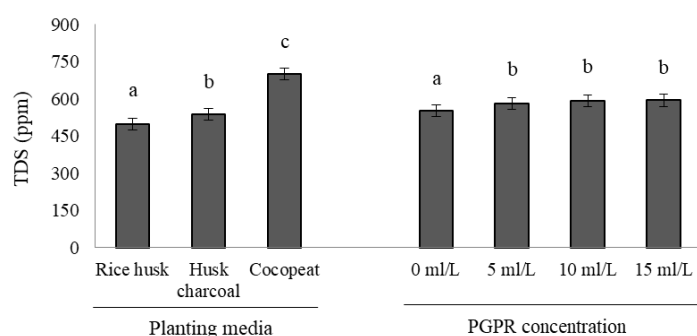


Figure 4. The effect of planting media type and PGPR concentration on total dissolved solids in 2 WAT observations

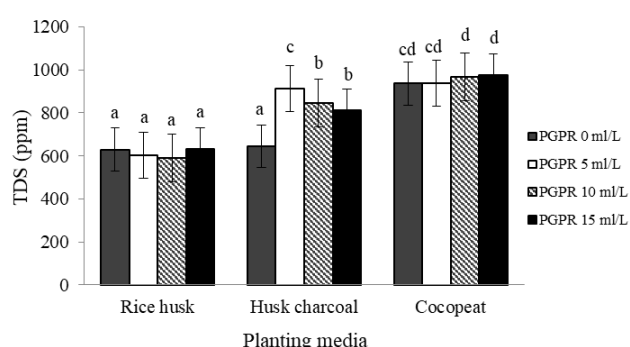


Figure 5. Interaction between planting media type and PGPR concentration on total dissolved solids at 8 WAT observation

Plant Phenotypes and Regression Curves

Figure 6 shows basil plant phenotypes under different planting media types and PGPR concentrations. Visually, it was evident that the use of fresh husk as a planting media resulted in inferior growth performance compared to charcoal husk and cocopeat media. Plants grown in fresh husk appeared smaller in size, shorter in stature, and produced fewer leaves. In addition, the foliage color tended to be lighter and more yellowish green, indicating suboptimal growth. In contrast, plants cultivated in charcoal husk and cocopeat media showed more vigorous growth, with denser root systems, broader leaves, and overall larger plant size.

Variation in PGPR concentration also influenced the phenotypic appearance of basil plants. Plants treated with PGPR showed visibly better growth than those grown without PGPR application. Among the tested concentrations, PGPR applied at 10–15 mL/L produced the most favorable growth performance. Overall, across all planting media, PGPR applied at 10 mL/L consistently resulted in healthy and vigorous plant development.

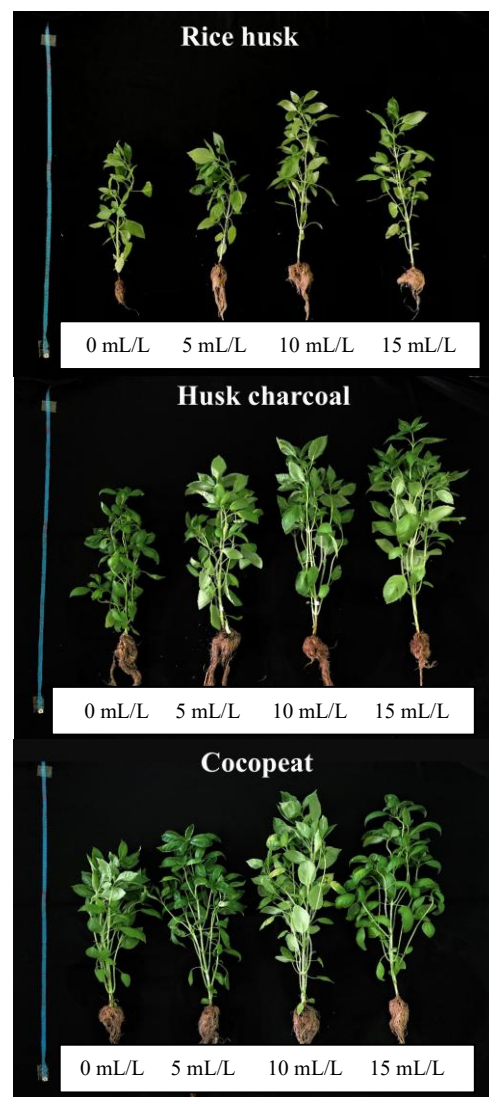


Figure 6. The effect of differences in planting media types and PGPR concentrations on basil plant growth performance

The relationship between PGPR concentration and plant dry weight can be seen from the regression curve (Figure 7). The graph shows the effect of PGPR concentration on plant dry weight in three planting media types: fresh husk, charcoal husk, and cocopeat. In general, plant response followed a quadratic pattern, where increasing PGPR concentration up to a certain point increased plant dry weight. The coefficient of determination (R^2) value showed the appropriate model for each planting medium. The R^2 values for cocopeat, husk charcoal, and fresh husk planting media were 0.7615, 0.9803, and 0.8863, respectively. Husk charcoal and cocopeat media provide a better growth response than regular husk. From the dependent variable equation (y), the optimum PGPR concentration for each planting media (x) can be calculated.

The maximum point occurs when the first derivative was equal to 0 ($2ax + b = 0$), so that the optimum concentration of fresh husk was 14.4 mL/L, charcoal husk was 9.3 mL/L, and cocopeat was 8.87 mL/L.

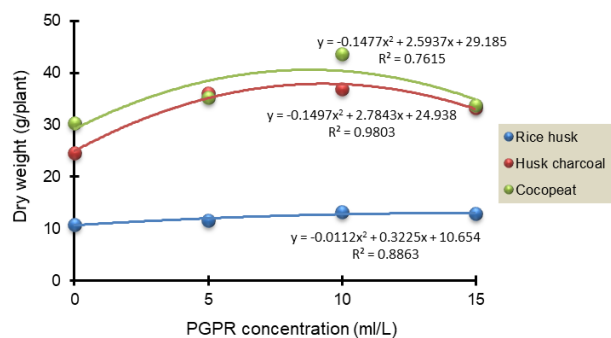


Figure 7. The relationship between PGPR concentration and dry weight of basil plants in each type of planting media

DISCUSSION

The influence of planting media type and PGPR concentration can be evaluated through growth parameters, yield, and other supporting factors. Based on the observations, the use of rice husk as a planting media generally resulted in lower plant growth performance compared to other substrates. In contrast, charcoal husk and cocopeat media tended to promote better and more consistent plant growth, supported by their structure that enhances aeration (Irawan & Kafiar, 2015). Microscopically, rice husk charcoal possesses numerous surface micro-pores that improve water retention and nutrient absorption, thereby creating a more favorable rhizosphere environment for root development (Alam et al., 2020). Adequate water availability is essential for optimal plant growth, as water stress can inhibit photosynthesis and metabolic processes, ultimately reducing vegetative growth and productivity (Djaingsastro et al., 2021). Moreover, pores within the rhizosphere facilitate good aeration, allowing roots to grow and function efficiently. Cocopeat-based planting media are characterized by high water-holding capacity and contain organic materials beneficial for plant development (Lestari et al., 2024). Cocopeat typically has a pH of 6.10 and an electrical conductivity (EC) of 0.63, with nutrient contents of N 0.41%, P 0.81%, K 1.32%, Ca 0.21%, Mg 0.31%, Fe 23 ppm, Zn 22 ppm, Mn

17 ppm, and Cu 5 ppm (Kalaivani & Jawaharlal, 2019).

The application of PGPR significantly influenced plant height, number of leaves, fresh weight, dry weight, and TDS. PGPR promote plant growth through nutrient supply, phytohormone production, and protection against plant pathogens (Figure 8). The bacterial strains in PGPR can fix atmospheric nitrogen and convert it into plant-available forms. This process occurs through an enzymatic reaction catalyzed by nitrogenase, which enables the conversion of atmospheric N_2 into ammonia (NH_3), subsequently assimilated by plants (Vocciante et al., 2022). In addition to nitrogen fixation, PGPR enhance nutrient availability through phosphate solubilization. These bacteria secrete various organic acids such as citric, acetic, gluconic, 2-ketogluconic, glutamic, glycolic, lactic, malonic, oxalic, succinic, and tartaric acids that dissolve insoluble phosphate compounds into forms accessible to plants (Kalayu, 2019). Furthermore, PGPR synthesize siderophore compounds that chelate and convert ferric (Fe^{3+}) or ferrous (Fe^{2+}) ions into bioavailable forms, thereby improving iron uptake by plants (Timofeeva et al., 2023).

PGPR inhabiting the rhizosphere can synthesize and release various phytohormones that plants can utilize. The major hormones produced include indole-3-acetic acid (IAA), gibberellins, cytokinins, salicylic acid (SA), and jasmonic acid (JA) (Zhang et al., 2022). These phytohormones play crucial roles in stimulating root initiation, shoot elongation, cell division, and tissue differentiation in plants (Yang et al., 2024). An increase in leaf number is directly correlated with total plant biomass, as a higher leaf count enhances the photosynthetic surface area and rate, leading to greater assimilate production and biomass accumulation. PGPR strains such as *Bacillus cereus* PK6-15, *Bacillus subtilis* PK5-26, and *Bacillus circulans* PK3-109 have been reported to increase plant fresh weight by up to 50% compared to untreated controls (Bokhari et al., 2019). Furthermore, PGPR promote plant growth by forming biofilms on root surfaces through the production of extracellular polymeric substances (EPSs), which are composed of polysaccharides, proteins, nucleic acids, and lipids (Kumar et al., 2022).

These biofilms enhance bacterial colonization and root-microbe interactions, ultimately improving nutrient uptake and plant vigor.

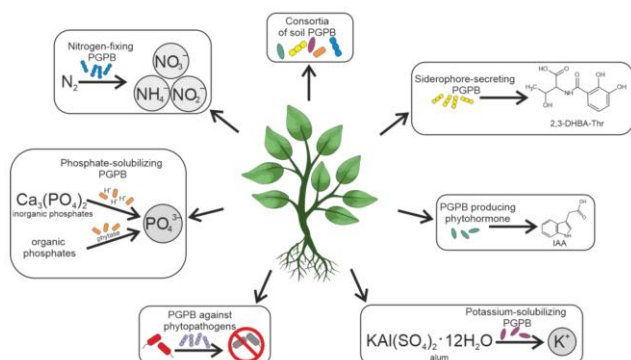


Figure 8. The mechanism of PGPR in supporting plant growth through nitrogen fixation, phosphate and potassium solubilization, siderophore and phytohormone secretion, and plant pathogen inhibition activity (Timofeeva et al., 2023).

In addition to functioning as nutrient providers and phytohormone producers, PGPR also play an important role in protecting host plants from pest and disease attacks. Observations from this study revealed that using fresh husk media and not applying PGPR were associated with a higher incidence of disease symptoms. The infected plants exhibited basal stem rot, resulting in lodging and abnormal growth. In contrast, plants grown in charcoal husk and cocopeat media showed minimal to no occurrence of such diseases. PGPR contribute to plant protection against both biotic and abiotic stresses through multiple mechanisms, including the synthesis of antifungal compounds (such as phenylalanine ammonia-lyase [PAL], phenolics, and flavonoids), siderophores, antibiotics, hydrogen cyanide, and lytic enzymes that inhibit the growth and activity of phytopathogens (Alori et al., 2017). Although fresh husks are relatively inexpensive and readily available, they have limited water-holding capacity and a higher risk of pathogen contamination. Therefore, sterilization is a crucial step in the preparation of planting media to eliminate potential pathogens (Li et al., 2019). The reduced efficiency of PGPR activity observed in husk media may be attributed to these unfavorable physical and biological conditions compared to charcoal husk and cocopeat media. Consequently, the effectiveness of PGPR is determined not only by its concentration or dose but also by the

physicochemical and biological properties of the planting media in which it is applied.

In the TDS observations, measurements at 8 WAT showed higher dissolved solid levels than at 2 WAT, indicating increased nutrient availability as a result of PGPR application. PGPR inoculation enhances nutrient dynamics by fixing atmospheric nitrogen, solubilizing essential nutrients such as phosphorus (P) and potassium (K), and accelerating the decomposition of organic matter (Zhang et al., 2023). Over time, the gradual decomposition of organic matter within the planting media further contributes to nutrient release. Among the tested media, charcoal husk and cocopeat exhibited higher TDS values than fresh husks. This can be attributed to the superior water-holding capacity of these media and the inherent nutrient content of cocopeat, which contains macronutrients such as K, P, N, Ca, and Mg, as well as micronutrients including B, Mn, and Zn (Aprianto et al., 2023). The combination of an appropriate planting medium and PGPR application can therefore enhance nutrient-use efficiency in basil cultivation. Charcoal husk, produced through pyrolysis, provides several agronomic benefits, including the reduction of nutrient leaching (particularly nitrogen), improvement of soil quality, increased crop yield, and mitigation of N₂O and CH₄ emissions (Asadi et al., 2021). Moreover, the microporous structure of rice husk charcoal serves as a habitat and nutrient reservoir for beneficial microorganisms (Li et al., 2023). Consequently, incorporating PGPR into hydroponic substrates facilitates optimal bacterial colonization and activity, improving nutrient availability and plant growth.

Regression analysis of the relationship between PGPR concentration and plant dry weight revealed a quadratic response pattern. Increasing PGPR concentrations enhanced dry weight up to a certain threshold, beyond which the plant response declined. Regression modeling is an effective approach for determining optimum treatment levels by examining the relationship between independent and dependent variables (Çalışkan & Kurt, 2017). The calculated optimum PGPR concentrations were 14.4 mL/L for fresh husk, 9.3 mL/L for charcoal husk, and 8.87 mL/L for cocopeat. These findings indicate

that the optimal PGPR requirement varies across planting media, depending on their water-holding capacity and nutrient availability.

CONCLUSION

Substrate-based hydroponics represents a promising alternative for enhancing agricultural productivity, particularly on suboptimal land. The findings of this study demonstrate that the interaction between planting media type and PGPR concentration significantly influences the growth performance of basil plants. Among the tested media, cocopeat consistently produced superior vegetative growth and biomass accumulation compared to charcoal husk and fresh husk media. PGPR application markedly improved plant performance relative to treatments without PGPR, with optimal concentrations varying across media types. The optimum PGPR concentration was 8.87 mL/L in cocopeat, 9.3 mL/L in charcoal husk, and 14.4 mL/L in fresh husk. These results suggest that the efficiency of PGPR application is closely associated with the physicochemical characteristics of the growing substrate.

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