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Research Article

Application of PGPR from sugarcane roots and mimosa roots on chili peppers (*Capsicum frutescens* L.)

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ABSTRACT

Chili pepper is a high-value horticultural crop that has significant nutritional and economic value. Plant growth-promoting rhizobacteria (PGPR) play a vital role in enhancing plant growth and productivity while supporting sustainable agriculture. This study evaluated the effect of PGPR derived from sugarcane roots and mimosa roots applied to chili pepper plants. The study was conducted using a factorial randomized complete block design. The first factor was the concentration of sugarcane root PGPR (0, 10, 20, 30 mL L^{-1}), and the second factor was the mimosa root PGPR (0, 10, 20, 30 mL L^{-1}). Observation variables included nitrogen uptake, plant height, flowering age, and fruit weight. The results showed that the application of sugarcane root PGPR had a significant effect on plant height and nitrogen uptake, with a concentration of 20 mL L^{-1} producing the highest nitrogen uptake (1.66 g). PGPR from *mimosa root significantly affected flowering age and fruit weight, with a concentration of 30 mL L^{-1} significantly increasing fruit weight. However, the combination of both types of PGPR did not have a significant effect on all the variables observed. Thus, the application of PGPR* from *sugarcane root and mimosa root separately effectively increased the growth and yield of chili pepper plants, while the combination of both did not show a synergistic effect.*

Keywords: chili; *Mimosa pudica*; nitrogen

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INTRODUCTION

Chili pepper (*Capsicum frutescens* L.) is one of the strategic horticultural commodities in Indonesia that has high economic value. However, the main challenge in cultivating chili pepper is low productivity due to limited nutrients in the soil. One alternative to increase the availability of nutrients in the soil and support plant growth is by applying Plant Growth Promoting Rhizobacteria (PGPR). PGPR are bacteria that live in the rhizosphere, which function to stimulate plant growth and physiology (Luvitasari & Islami, 2018). In addition, these bacteria are also able to increase plant yields and soil fertility (Shofiah & Tyasmoro, 2018) through various mechanisms such as nitrogen fixation, phosphorus solubilization, production of hydrocyanic acid compounds (HCN), and Indole Acetic Acid (IAA) compounds (Asra et al., 2024). Several genera of bacteria that are classified as PGPR include *Pseudomonas, Serratia, Azotobacter, Azospirillum, Acetobacter, Burkholderia*, and *Bacillus* (Noor & Nurhadi, 2022). PGPR with soil microbial communities can increase plant biomass and resilience (Samain et al, 2023). Sources of PGPR can be found in various types of plants, including sugar cane roots and mimosa roots.

Sugarcane roots are a habitat for various microorganisms that can act as PGPR. One of the microorganisms that is abundant in sugarcane roots is the genus *Bacillus* (Maudy et al., 2019). These bacteria utilize root exudates and dead plant debris as nutritional agents (Hartono et al., 2024). *Bacillus* bacteria also contribute to plant growth through mechanisms such as nitrogen fixation, phosphate solubilization, and phytohormone production (Miljaković et al., 2020). *Bacillus* spp. also acts as rhizobacteria that stimulate plant growth (biostimulant) (Setiaji et al., 2023). Research (Permadi et al., 2019) has shown that PGPR isolated from sugarcane roots can increase the growth of sugarcane plants.

Mimosa pudica roots are a habitat for various microorganisms that can act as PGPR. One of the microorganisms found in the PGPR mimosa pudica roots is the Rhizobium bacteria (Nufus et al., 2022). These bacteria are able to help plants fix nitrogen as well as to dissolve phosphate and potassium. Research conducted (Hamzah et al., 2020) shows that the application of PGPR from mimosa roots affects the growth and yield of mustard plants. Research (Arinong et al., 2021) also reported that the application of PGPR of mimosa roots had a positive effect on growth (plant height and number of leaves) and fresh weight of long bean plants.

Research into the benefits of PGPR has been extensively conducted, but studies on the effect of PGPR treatment of sugarcane roots and mimosa roots on nitrogen uptake, growth, and yield of chili pepper plants are still limited. This research aimed to investigate the effect of PGPR application derived from sugarcane roots and *Mimosa pudica* roots on the growth and yield of chili pepper plants (*Capsicum frutescens* L.).

MATERIALS AND METHODS

This research was conducted on agricultural land owned by residents in Krajan Hamlet, Ketapang Village, Kalipuro District, Banyuwangi Regency, East Java, Indonesia. The experiment period began in October 2023 and ended in January 2024.

The materials used in this study included: 45-day-old chili pepper seedlings of the Grogolan variety, PGPR solution from sugarcane roots and *Mimosa pudica* roots, young coconut water, potatoes, granulated sugar, monosodium glutamate (MSG), shrimp paste, rainwater, manure, rice husk charcoal and NPK fertilizer (16:16:16). The tools included: spray tanks, calipers, meters, digital scales, pH meters, and documentation equipment.

The research used a factorial randomized complete block design (RCBD) with two factors. The first factor was PGPR of sugarcane roots (A), which were composed of four treatment levels: A0 (0 mL L^{-1}), A1 (10 mL L^{-1}), A2 (20 mL L^{-1}), and A3 (30 mL L^{-1}). The second factor was PGPR of mimosa roots (B), consisting of four treatment levels, namely B0 (0 mL L^{-1}), B1 (10 mL L^{-1}), B2 (20 mL L^{-1}), and B3 (30 mL L^{-1}). Each treatment combination of treatments was replicated three times, resulting in 48 experimental units.

Chili pepper seeds were sown in polybags containing a soil and compost mixture and kept in a shaded area until they were 45 days old. Land preparation involved clearing weeds, hoeing the soil, and adding manure and rice husk charcoal, followed by making beds sized 140 cm × 80 cm, 20 cm high, and spaced 50 cm apart.

Seedlings were transplanted three days after land preparation into planting holes spaced 60 cm × 60 cm, with one seedling per hole. PGPR treatments were applied to sugarcane and mimosa roots at concentrations of 0, 10, 20, and 30 mL L^{-1} by pouring 500 mL of the solution per plant at 28, 35, and 42 DAP.

Maintenance activities included replanting dead plants up to 30 DAP, routine watering until 35 DAP, shoot pruning at 14 and 28 DAP, and manual weed control every three weeks. Fertilization application with NPK (16:16:16) was conducted using 25 mL per plant of a 20 g L^{-1} solution at 14, 30, and 45 DAP. Harvesting was performed at 60, 70, and 80 DAP, when the fruits reached physiological maturity.

Observation variables consisted of plant height, stem diameter, flowering age, number of fruits, fruit weight per harvest, total harvest weight, and nitrogen uptake. Plant height was measured from the soil surface to the highest growing point using a meter at 14, 28, and 42 DAP. Stem diameter was measured at the base of the stem ±1 cm from the soil surface using a vernier caliper. Flowering age was determined by recording the time the first flower appeared since planting. The number of fruits was counted manually from the first to the third harvest, then added up. Fruit weight per harvest was weighed each time using a digital scale, while the total harvest weight was obtained from the accumulation of the three harvests. Nitrogen uptake was observed by taking leaf samples after the last harvest, then drying, crushing, and analyzing for nitrogen content using the dry digestion method and Kjeldahl analysis. The uptake value was calculated using the formula:

$$\text{N uptake (g)} = (\%\text{N} \times \text{dry weight of the plant})/100.$$

Data were analyzed using analysis of variance (ANOVA). If there was a significant effect, further analysis with the least significant difference (LSD) test at $\alpha = 5\%$ was performed.

RESULTS AND DISCUSSION

Analysis of variance

Analysis of variance (ANOVA) (Table 1) showed that the application of PGPR derived from sugarcane roots significantly affected nitrogen uptake and plant height of chili plants at 42 days after planting (DAP). Meanwhile, the application of PGPR from *Mimosa pudica* roots significantly influenced flowering time and chili fruit yield. However, the interaction between PGPR from sugarcane roots and PGPR from *Mimosa pudica* roots did not exhibit a significant effect.

Table 1. Analysis of variance (ANOVA) for nitrogen uptake, plant height, flowering time, and chili fruit yield.

Source	df	N-uptake	Plant height	Flowering time	Chili fruit harvest
Replication	2	3.96*	3.93*	0.12ns	1.39ns
A	3	3.20*	3.58*	1.71ns	1.91ns
B	3	1.42ns	0.98ns	4.34*	5.12**
A × B	9	1.24ns	0.98ns	1.21ns	1.28ns

Note: * = significant effect, ns = non-significant effect.

Nitrogen uptake

PGPR from sugarcane roots had a significant effect on nitrogen (N) uptake (Table 1). Table 2 shows that the PGPR at a concentration of 20 mL L^{-1} (A2) resulted in the highest N uptake, reaching 1.66 g, followed by the A3 treatment (30 mL L^{-1}) with 1.57 g. Meanwhile, the control treatment (A0) recorded an N uptake of 1.15 g, and the 10 mL L^{-1} treatment (A1) showed the lowest value at 0.95 g.

This indicates that the application of PGPR from sugarcane roots at certain concentrations can increase N uptake by chili pepper plants. The increase in N uptake in treatments A2 and A3 is likely related to the ability of PGPR to increase nutrient availability in the soil through nitrogen fixation, phosphate solubilization, and phytohormone production (Bhattacharyya & Jha, 2012). However, at the highest concentration (A3), N uptake decreased slightly compared to treatment A2. This is likely due to a threshold effect that causes microbial imbalance in the rhizosphere or competition between microbes in utilizing nutrients. This phenomenon is in line with previous research showing that the application of PGPR in excessive doses can reduce the efficiency of nutrient uptake by plants (Lucy et al., 2004).

Interestingly, nitrogen uptake in the control (A0) was higher than in the A1 treatment (10 mL L^{-1}), although the difference was not statistically significant. This result may be explained by the possibility that at low concentrations, the PGPR inoculum was not yet effective enough to form stable colonies in the rhizosphere or was not yet able to form an optimal symbiosis with plant roots. Furthermore, at low doses, PGPR can also experience strong competition with native soil microorganisms, thus reducing its effectiveness in increasing nutrient uptake (Backer et al., 2018).

Table 2. Nitrogen uptake of chili plant from PGPR of sugarcane roots treatment.

PGPR from sugarcane roots (mL L^{-1})	Nitrogen uptake (g per plant)
0	1.15ab
10	0.95a
20	1.66b
30	1.57b

Note: Numbers followed by the same letters are not significantly different according to 5% LSD test.

Table 3 shows that the results of the variance analysis indicate that the treatment of PGPR from *Mimosa pudica* roots did not have a significant effect on nitrogen (N) uptake in chili pepper plants. The effectiveness of PGPR depends on environmental conditions, soil microbial interactions, and the availability of N in the soil (Glick, 2012). PGPR works through nitrogen fixation, phosphate solubilization, and phytohormone production (Bhattacharyya & Jha, 2012). However, its effectiveness can be influenced by dosage, interaction with plants, and soil conditions (Lucy et al., 2004).

Table 3. Nitrogen uptake of chili plant from PGPR of mimosa roots.

PGPR from mimosa roots (mL L^{-1})	Nitrogen uptake (g per plant)
0	1.34
10	1.29
20	1.56
30	1.13

Plant height

Table 4 shows that the application of PGPR from sugarcane roots at a concentration of 30 mL L^{-1} (T3) significantly increased the height of chili pepper plants at the age of 42 DAP, reaching 35.17 cm, compared to other treatments, which ranged from 29.28 cm to 29.65 cm. These results are consistent with research showing that the application of PGPR derived from bamboo roots at a concentration of 40 mL L^{-1} significantly enhances the growth of chili pepper plants. PGPR is known to be able to increase plant growth through the production of phytohormones and increasing nutrient availability (Purnamasari et al., 2023).

Table 4. Plant height of chili from PGPR of sugarcane roots treatment at 42 days after planting (DAP).

PGPR from sugarcane roots (mL L^{-1})	Plant height at 24 DAP (cm)
0	29.37a
10	29.65a
20	29.28a
30	35.17b

Note: Numbers followed by the same letters are not significantly different according to 5% LSD test.

Table 5 shows that the treatment of PGPR from *Mimosa pudica* roots did not provide a significant difference in the height of chili pepper plants at the age of 42 DAP. The average plant height ranged from 28.42 to 32.57 cm. This lack of difference is likely due to environmental factors or the insignificant efficacy of PGPR in this growth phase.

Table 5. Plant height of chili from PGPR of mimosa roots treatment at 42 days after planting (DAP).

PGPR from mimosa roots (mL L^{-1})	Plant height at 42 DAP (cm)
0	32.19
10	32.57
20	28.42
30	30.30

Flowering time

The treatment of PGPR from sugarcane roots did not significantly affect the age of chili pepper flower emergence (Table 6). The average age of flower emergence ranged from 39.83-42.58 DAP, with the lowest value in the T3 treatment (30 mL L^{-1}). This indicates that sugarcane root PGPR may not be effective enough in accelerating chili pepper flowering at the concentration used.

Table 6. Flowering time of chili from PGPR of sugarcane roots treatment.

PGPR from sugarcane roots (mL L^{-1})	Flowering time (DAP)
0	42.58
10	41.92
20	42.13
30	39.83

Table 7 shows that the application of PGPR derived from mimosa roots at different concentrations influenced the age of flower emergence in chili pepper plants. The 20 mL L^{-1} treatment (B2) resulted in the earliest flowering at 39.79 days after planting (DAP), followed by the 10 mL L^{-1} treatment at 40.08 DAP. In comparison, the control (0 mL L^{-1}) and 30 mL L^{-1} treatments showed later flowering times of 43.42 and 43.17 DAP, respectively. These findings indicate that a moderate concentration of mimosa root PGPR may promote earlier flowering, possibly due to increased availability of growth-regulating hormones such as auxins and cytokinins (Hidayat et al., 2021).

Table 7. Flowering time of chili from PGPR of mimosa roots treatment.

PGPR from mimosa roots (mL L^{-1})	Flowering time (DAP)
0	43.42a
10	40.08bc
20	39.79c
30	43.17ab

Note: Numbers followed by the same letters are not significantly different according to 5% LSD test; DAP-days after transplanting

Total weight of fruit

Table 8 shows the total weight of chili pepper harvest with PGPR treatment from sugarcane roots, which showed variation, but there was no significant difference between treatments ($p>0.05$). The dose of 30 mL L^{-1} (A3) produced the highest harvest (61.17 g), while the control (A0) was the lowest (50.66 g). These results indicate that the application of PGPR from sugarcane roots has the potential to increase crop yields, although the increase is not statistically significant. Similar studies have shown that PGPR can increase nutrient uptake and plant growth (Glick, 2012).

Table 8. Harvest per plant of chili from PGPR of sugarcane roots treatment.

PGPR from sugarcane roots (mL L^{-1})	Chili fruit harvest (g per plant)
0	50.66
10	56.93
20	55.14
30	61.17

Results of the LSD test on PGPR concentration from mimosa root showed significant differences in the total weight of chili pepper harvest (LSD 5%) (Table 9). Treatment B2 (20 mL L^{-1}) produced the highest harvest weight (66.08 g), followed by B3 (30 mL L^{-1}) and B1 (10 mL L^{-1}), while B0 (0 mL L^{-1}) had the lowest weight (49.28 g). These results indicate that PGPR application can increase chili pepper harvest yields.

Table 9. Harvest per plant of chili from PGPR of mimosa roots treatment.

PGPR from mimosa roots (mL L^{-1})	Chili fruit harvest (g per plant)
0	49.28a
10	53.28ab
20	66.08b
30	55.06ab

Note: Numbers followed by the same letters are not significantly different according to 5% LSD test.

The combined application of PGPR from sugarcane roots and mimosa roots did not exert a significant effect on any of the observed parameters, including nitrogen uptake, plant height, flowering time, and total fruit weight of chili pepper. This lack of significance suggests that the combined application of PGPR does not necessarily result in a synergistic effect on plant growth and yield. This phenomenon is presumed to be due to incompatibility between microbial strains and plant genotypes, as well as the influence of environmental factors such as nutrient availability and microbial competition within the rhizosphere (Glick, 2012; Lucy et al., 2004; Bashan et al., 2014).

CONCLUSIONS

The effect of PGPR application could be concluded in three points: 1) PGPR from sugarcane roots increased nitrogen uptake and plant height at a concentration of 20 mL L^{-1}, 2) PGPR from *Mimosa pudica* roots accelerated flowering time and increased the weight of chili fruit at a concentration of 30 mL L^{-1}, and 3) the combination of PGPR from sugar cane roots and mimosa roots does not have a significant effect on the growth and yield of chili pepper plants.

REFERENCES

Arinong, A. R., Nispasari, N., Wahab, A., & Nurcholis, J. (2021). The application of plant growth promoting rhizobacteria (pgpr) of sensitive plant root toward the growth and production of long bean (*Vigna sinensis* L.). (In Indonesian.). *Jurnal Agrisistem*, *17*(1), 10–18. https://doi.org/10.52625/j-agr.v17i1.187

Asra, R. H., Advinda, L., Anhar, A., & Irdawati, I. (2024). The role of plant growth promoting rhizobacteria (PGPR) in sustainable agriculture peran plant growth promoting rhizobacteria (PGPR). (In Indonesian.). *Serambi Biologi, 9*(1), 1-7. https://doi.org/10.24036/srmb.v9i1.306

Backer, R., Rokem, J. S., Ilangumaran, G., Lamont, J., Praslickova, D., Ricci, E., Subramanian, S., & Smith, D. L. (2018). Plant growth-promoting rhizobacteria: context, mechanisms of action, and roadmap to commercialization of biostimulants for sustainable Agriculture. *Frontiers in Plant Science*, *9*, 1473. https://doi.org/10.3389/fpls.2018.01473

Bashan, Y., de Bashan, L. E., Prabhu, S. R., & Hernandez, J. P. (2014). Advances in plant growth-promoting bacterial inoculant technology: Formulations and practical perspectives (1998–2013). *Plant and Soil, 1*(2), 1-33. https://doi.org/10.1007/s11104-013-1956-x

Bhattacharyya, P. N., & Jha, D. K. (2012). Plant growth-promoting rhizobacteria (PGPR): emergence in agriculture. *World Journal of Microbiology and Biotechnology*, *28*, 1327–1350. https://doi.org/10.1007/s11274-011-0979-9

Glick, B. R. (2012). Plant growth-promoting bacteria: Mechanisms and applications. *Scientifica (Cairo)*, *2012,* 963401.

Hartono, H. P., Rokhim, S., & Faizah, H. (2024). Effect of PGPR *Bacillus* sp. and *Pseudomonas* sp. from bamboo root on maize (*Zea mays* L.) growth. (In Indonesian.). *Jurnal Membangun Desa dan Pertanian*, *9*(3), 294–303. https://doi.org/10.37149/jimdp.v9i3.1154

Hidayat, R., Sari, P., & Nugroho, A. (2021). The effect of PGPR on the growth and yield of horticultural crops. *Jurnal Agro Bioteknologi*, *9*(2), 112-120.

Lucy, M., Reed, E., & R. Glick, B. R. (2004). Applications of free living plant growth-promoting rhizobacteria. *Antonie van Leeuwenhoek*, *86*, 1–25. https://doi.org/10.1023/B:ANTO.0000024903.10757.6e

Luvitasari, D. I. & Islami, T. (2018), The effect of the concentration of PGPR (plant growth promoting rhizobacteria) on the growth and yield of two soybean (*Glycine max* L. Merril) varieties, *Jurnal Produksi Tanaman*, *6*(7), 1336-1343.

Maudy, R. N., Zulaika, E., & Shovitri, M. (2019). Characteristics of bacterial isolates p1 from sugarcane rhizosphere (*Saccharum officinarum*). (In Indonesian.). *Jurnal Sains dan Seni ITS, 8*(2), 66 -67.

Miljaković, D., Marinković, J., & Tubic, S. B. (2020). The significance of *Bacillus* spp. in disease suppression and growth promotion of field and vegetable crops. *Microorganisms*, *8*(7), 1037. https://doi.org/10.3390/microorganisms8071037

Noor, S., & Nurhadi, N. (2022). Benefits, methods of propagation and applications of plant growth promoting rhizobacteria (PGPR). *Jurnal Agriekstensia 21*(1), 64-71.

Nufus, N. H., Wangiyana, W., & Suliartiningsih, N. W. S. (2022). Isolation and characterization of *Mimosa pudica* nodule microbes indigenous from the drylands of Pringgabaya, East Lombok. *Gontor AGROTECH Science, 8*(1), 18-27. https://doi.org/10.21111/agrotech.v8i1.8115

Permadi, R. D., & Irawan, T. B. (2019). Effect of plant growth promoting rhizobacteria (PGPR) from sugarcane root on the growth of sugarcane (*Saccharum officinarum* L.) PS 862 variety at germination stage. *Agropross, National Conference Proceedings of Agriculture*. 139-146.

Purnamasari, T., Zakaria. F., & Solihin, A. P. (2023). The effect of chicken manure and plant growth promoting rhizobacteria of bamboo roots on the growth and yield of chili pepper (*Capsicum frutescens* L.). (In Indonesian.). *Jurnal Agroteknotropika, 12*(1), 69-78.

Samain, E., Duclercq, J., Barka, E. A., Eickermann, M., Ernenwein, C., Mazoyon, C., Sarazin, V., Dubois, F., Aussenac, T., & Selim, S. (2023). PGPR-soil microbial communities' interactions and their influence on wheat growth promotion and resistance induction against *Mycosphaerella graminicola*. *Biology, 12*(11), 1416. https://doi.org/10.3390/biology12111416

Setiaji, A., Annisa, R. R. R., & Rahmandhias, D. T. (2023). Bacillus bacteria as biological control agents and plant biostimulants. (In Indonesian.). *Rekayasa: Journal of Science and Technology*, *16*(1), 96–106. https://doi.org/10.21107/rekayasa.v16i1.17207

Shofiah, D. K. R., & Tyasmoro, S. Y. (2018). Application of PGPR (plant growth promoting rhizobacteria) and goat manure on growth and yield of shallot (*Allium ascalonicum* L.) Manjung variety. *Jurnal Produksi Tanaman*, *6*(1), 76-78.