International Journal of Academic Research
P-ISSN: 2348-7666: Impact Factor: 6.023
Homepage: https://www.ijar.org.in/
Volume-12, Issue-3(4), Jul-Sep-2025
This work is licensed under a Creative Commons Attribution 4.0 International License [CC BY 4.0]

BIOFERTILIZERS FOR A GREENER TOMORROW: REDUCING WATER POLLUTION THROUGH SUSTAINABLE AGRICULTURE

Dr.A. Padmavathi[1], Dr. Sr. Sunila Rani[2]
[1]H.O.D of Applied sciences, CH.S.D.ST.Theresa's College for Women (A), Eluru
[2]Vice- Principal, CH.S.D.ST.Theresa's College for Women (A), Eluru

Abstract:
Access to safe and potable water is increasingly under threat due to contamination from various sources such as sewage, heavy metals, pesticides, insecticides, plastics, and biomedical waste. The intensification of aquaculture practices has further escalated the use of chemical pesticides, contributing significantly to water and environmental pollution. Addressing this issue requires a shift toward sustainable agricultural practices, including the use of bio fertilizers as eco-friendly alternatives to chemical inputs. Bio fertilizers not only minimize environmental harm but also selectively enhance soil fertility and crop productivity. In line with this approach, the present study focused on the preparation of a phosphorous -solubilizing bacteria and evaluated its efficacy in promoting plant growth. The findings highlight the potential of bio fertilizers to support sustainable agriculture, reduce water pollution, and contribute meaningfully to the achievement of multiple Sustainable Development Goals
Keywords: Bio fertilizer, Pesticides, Intensification, Aquaculture, Sustainable agriculture.

1.INTRODUCTION:

Bio-fertilizers are biological preparations of efficient microorganisms that promote plant growth by improving nutrient acquisition. They enhance soil productivity by fixing atmospheric nitrogen, solubilizing soil phosphorus, and stimulating plant growth. Bio-fertilizer technology has integrated plant nutrient management for sustainable agriculture through BNK. BNK likely refers to a consortium of beneficial microorganisms often abbreviated from the names of the key microbial components:

B – Bacillus species (e.g., Bacillus megaterium, Bacillus subtilis)
N – Nitrogen-fixing bacteria (e.g., Azospirillum, Azotobacter, or Rhizobium)
K – Potassium-solubilizing bacteria (e.g., Frateuria aurantia)

The formulation of bio-fertilizers is a crucial multistep process that includes mixing of a suitable carrier with inocula11t, providing optimal conditions during storage, packaging, and dispatch and ensuring survival and establishment after introduction into soils. This focuses on different bio-fertilizer formulations: solid based, liquid inoculants, granulated, and encapsulated cells. One of the key issues is the quality control of bio-fertilizers, which is exercised under the Fertilizer Control Order (FCO, 1985). Quality assurance of bio products can go a long way in consolidating the market share for bio-fertilizers. Production of microbial formulations, transportation, and commercialization are still at the early so large age and hence production by natural means needs to be emphasized. Phosphate solubilizing microorganisms (PSMs) are a group of beneficial microbes capable of converting insoluble organic and inorganic phosphorus compounds into soluble forms. This soluble phosphorus can be readily absorbed and utilized by plants.

International Journal of Academic Research P-ISSN: 2348-7666: Impact Factor: 6.023
This work is licensed under a Creative Commons Attribution 4.0 International License [CC BY 4.0]
Homepage: https://www.ijar.org.in/
Volume-12, Issue-3(4), Jul-Sep-2025

Phosphorus is one of the major nutrients essential for plant growth, second only to nitrogen. It is a critical component of molecules such as RNA, DNA, ATP, and phospholipids. It plays a vital role in-Cell division and development, Photosynthesis, Breakdown of sugars, Energy transfer, Nutrient transportation within plants

1.1. Need for the study

Around 98% of Indian soils contain phosphorus, but it is mostly in insoluble forms, making it unavailable to plants**.** The average phosphorus content in soil is about 0.05% w/w, which is not sufficient to meet crop demands. To compensate, phosphate fertilizers are commonly applied. However, the production of these fertilizers relies on non-renewable sources, such as high- grade rock phosphate. Additionally, chemical fixation in the soil significantly limits phosphorus availability. The average utilization efficiency of added fertilizers is only about 15–25%. An alternative ecofriendly approach is production of - phosphate solubilizing bacterial (PSB) biofertilizers as they convert insoluble phosphorus into bio-available forms.

1.2. Aim

To isolate Phosphate Solubilizing Bacteria (PSB) from soil, and to know their potential use as bio-fertilizers to enhance soil phosphorous availability and promote sustainable crop production.

1.3. Objectives

1. To isolate and identify Phosphate solubilizing bacterial strains from rhizosphere soils.
2. To assess the plant growth-promoting properties (PGPR) of the selected PSB strains.
3. To conduct pot or field trials to study the impact of PSB bio-fertilizer on crop growth, yield, and soil nutrient status.

2.MATERIALS AND METHODS

2.1. Soil Sample Collection

Soil samples were collected from a mango field in Ratnalakunta, Eluru District, Andhra Pradesh, India. The top 1 cm layer of soil was removed, and soil was collected from four corners of the field and thoroughly mixed to form a composite sample. The collected sample was transferred to sterile polythene bags and transported to the laboratory for further processing.

2.2. Serial Dilution

Serial dilutions were performed using standard microbiological procedures. One gram of soil was added to a sterile test tube containing 10 mL of sterile distilled water and labelled as the 10^{-1} dilution. From this, 1 mL was transferred to the next tube containing 9 mL of sterile water to obtain the 10^{-2} dilution. This process was repeated until a 10^{-7} dilution was achieved. This technique reduced microbial density, allowing better isolation of individual colonies with distinct morphological features.

2.3. Isolation and Plating of Phosphate Solubilizing Bacteria (PSB)

Aliquots (1 mL) from the 10^{-4} dilution were plated in triplicate onto Pikovskaya's agar medium using the spread plate method. The medium consisted of (per liter): yeast extract (0.5 g), dextrose (10 g), tricalcium phosphate (5 g), ammonium sulfate (0.5 g), potassium chloride

(0.2 g), magnesium sulfate (0.1 g), and manganese sulfate (0.0001 g). Plates were incubated at 37 °C for 24–48 hours.

Colonies exhibiting clear halo zones around them, indicative of phosphate solubilization, were selected for further analysis. These colonies were subcultured onto fresh Pikovskaya's agar plates for purification and maintained for further testing.

2.4. Microscopic Characterization

Selected colonies were subjected to Gram staining. Only bacterial isolates showing clear zones of phosphate solubilization were retained for further studies.

2.5. Production of PSB Biofertilizer

A pure culture of the selected PSB isolate was inoculated into 1 L of sterilized liquid Pikovskaya's broth and incubated under optimal conditions until the bacterial population reached 10^6–10^8 CFU/ml. This culture was then transferred to a 250-L fermenter for large-scale submerged fermentation and production of the biofertilizer.

2.6. Pot Experiment

To evaluate the effect of PSB on plant growth, a pot study was conducted using Amaranthus seeds. Two plant pots were used: one served as the control, and the other was treated with 1 mL of the PSB inoculum. Growth parameters, including plant height and leaf development, were observed and compared after few days of treatment.

3.RESULTS

3.1. Isolation and Identification of PSB

Phosphate Solubilizing Bacteria were successfully isolated from the soil samples using Pikovskaya's agar. Colonies exhibiting clear zones around them were considered positive (Figure-1) for phosphate solubilization. Gram staining confirmed that the effective isolates were Gram-positive rods. The solubilization activity was attributed to the secretion of organic acids.

3.2. Fermentation and Biofertilizer Production

The selected PSB isolate grew efficiently in liquid Pikovskaya's medium under submerged fermentation conditions. A cell density of approximately 10^8 CFU/mL was achieved before scale-up to a 250-L fermenter, indicating successful optimization of growth conditions for biofertilizer production.

3.3. Effect of PSB on Plant Growth (Pot Study)

After four days of PSB application, germination of the seedling was observed. The treated Amaranthus seeds grew exhibited a significant increase in height (approximately 4 cm) compared to the control after twelve days. Additionally, the leaves appeared greener and more abundant, suggesting enhanced chlorophyll production and overall plant vigor. These observations demonstrate that the PSB biofertilizer positively influenced plant growth and nutrient uptake.

4.DISCUSSION

The present study highlights the successful isolation, characterization, and application of Phosphate Solubilizing Bacteria (PSB) from agricultural soil collected from a mango field in Ratnalakunta, Eluru District. The isolates demonstrated the ability to solubilize inorganic phosphate on Pikovskaya's agar medium, as evidenced by the formation of clear halo zones surrounding bacterial colonies. This phosphate solubilization ability is primarily attributed to the secretion of organic acids, such as gluconic and citric acid, which lower the pH of the surrounding environment and mobilize bound forms of phosphorus. These findings are consistent with earlier reports that underscore the role of PSB in enhancing phosphorus availability in soil (Rodríguez and Fraga, 1999).

The Gram-positive nature of the isolates, as revealed by microscopic examination, suggests a probable dominance of genera such as Bacillus sps, known for phosphate solubilization. The ability to scale up PSB production using submerged fermentation demonstrates its potential for commercial biofertilizer development. A viable cell count of 10^8 CFU/mL was achieved, indicating that the culture conditions and media composition were conducive for optimal bacterial growth.

The pot study conducted using Amaranthus plants further confirmed the bio efficacy of the PSB isolate. The treated plants showed enhanced vegetative growth, including a measurable increase in height and improved leaf pigmentation compared to the control. These effects are likely the result of improved phosphorus uptake, which is crucial for energy transfer, nucleic acid synthesis, and root development in plants. Similar studies have documented the plant growth-promoting effects of PSB on a variety of crops including wheat, rice, and legumes (Chen et al., 2006; Zaidi et al., 2009).

The observed growth stimulation within a short period (4 days) post-inoculation demonstrates the rapid action of the PSB formulation, although long-term studies are necessary to assess the full agronomic potential under field conditions. Moreover, the environmental sustainability and cost-effectiveness of PSB-based biofertilizers make them attractive alternatives to chemical phosphate fertilizers, which are not only expensive but also contribute to eutrophication and other environmental issues.

5.CONCLUSION

Phosphate solubilizing bacteria (PSB) isolated from mango orchard soil significantly enhanced Amaranthus growth by improving phosphorus availability, reducing the need for synthetic fertilizers. Their use offers a sustainable, cost-effective solution that supports crop productivity while minimizing nutrient runoff and protecting water bodies from pollution. PSB-based biofertilizers represent a practical step toward greener, more environmentally responsible agriculture.

REFERENCES

1. Chen, Y. P., Rekha, P. D., Arun, A. B., Shen, F. T., Lai, W. A., & Young, C. C. (2006). **Phosphate solubilizing bacteria from subtropical soil and their tricalcium phosphate solubilizing abilities**. Applied Soil Ecology, 34(1), 33–41. https://doi.org/10.1016/j.apsoil.2005.12.002
2. Rodríguez, H., & Fraga, R. (1999). **Phosphate solubilizing bacteria and their role in plant growth promotion**. Biotechnology Advances, 17(4–5), 319–339. https://doi.org/10.1016/S0734-9750(99)00014-2
3. Zaidi, A., Khan, M. S., Ahemad, M., & Oves, M. (2009). **Plant growth promotion by phosphate solubilizing bacteria**. Acta Microbiologica et Immunologica Hungarica, 56(3), 263–284. https://doi.org/10.1556/AMicr.56.2009.3.6
4. Khan, M. S., Zaidi, A., & Wani, P. A. (2007). **Role of phosphate-solubilizing microorganisms in sustainable agriculture — A review**. Agronomy for Sustainable Development, 27(1), 29–43. https://doi.org/10.1051/agro:2006021

This work is licensed under a Creative Commons Attribution 4.0 International License [CC BY 4.0]

5. Vassilev, N., Vassileva, M., & Nikolaeva, I. (2006). **Simultaneous P-solubilizing and biocontrol activity of microorganisms: potentials and future trends**. Applied Microbiology and Biotechnology, 71(2), 137–144. https://doi.org/10.1007/s00253-006-0380-z
6. Gyaneshwar, P., Naresh Kumar, G., Parekh, L. J., & Poole, P. S. (2002). **Role of soil microorganisms in improving P nutrition of plants**. Plant and Soil, 245(1), 83–93. https://doi.org/10.1023/A:1020663914388
7. Illmer, P., & Schinner, F. (1992). Solubilization of inorganic phosphates by microorganisms isolated from forest soils. Soil Biology and Biochemistry, 24(4), 389–395. https://doi.org/10.1016/0038-0717(92)90199-8
8. Kucey, R. M. N., Janzen, H. H., & Leggett, M. E. (1989). Microbially mediated increases in plant-available phosphorus. Advances in Agronomy, 42, 199–228. https://doi.org/10.1016/S0065-2113(08)60531-2
9. Bashan, Y., Kamnev, A. A., & de-Bashan, L. E. (2013). A proposal for isolating and testing phosphate-solubilizing bacteria that enhance plant growth. Biology and Fertility of Soils, 49, 1–2. https://doi.org/10.1007/s00374-012-0727-5
10. Chhabra, D., & Dowling, D. N. (2017). Bioinoculants for sustainable agriculture: Mechanisms and applications. In D. P. Singh et al. (Eds.), Microbial Inoculants in Sustainable Agricultural Productivity (Vol. 1, pp. 67–89). Springer. https://doi.org/10.1007/978-81-322-2647-5_4
11. Mehta, S., & Nautiyal, C. S. (2001). An efficient method for qualitative screening of phosphate-solubilizing bacteria. Current Microbiology, 43, 51–56. https://doi.org/10.1007/s002840010259
12. Sharma, S. B., Sayyed, R. Z., Trivedi, M. H., & Gobi, T. A. (2013). Phosphate solubilizing microbes: Sustainable approach for managing phosphorus deficiency in agricultural soils. SpringerPlus, 2, 587. https://doi.org/10.1186/2193-1801-2-587
13. Satyaprakash, M., Nikitha, T., Reddi, E. U. B., Sadhana, B., & Vani, S. S. (2017). A review on phosphate solubilizing microbes and their role in phosphate solubilization. Current Trends in Biotechnology and Pharmacy, 11(1), 77–96. https://doi.org/10.5530/ctbp.2017.1.12