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Development of *Bacillus* spp. Consortia as Phosphate-Solubilizing Biofertilizers to Enhance Plant Growth: A Sustainable Agricultural Approach

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Abstract

The global population continues to rise steadily, making it increasingly challenging to feed the growing number of people without a substantial increase in agricultural production. The concept of biofertilizers has emerged as an innovative solution to enhance soil fertility and agricultural productivity. This study aims to isolate and characterize phosphate-solubilizing bacteria (PSB) and assess their effects on plant growth promotion as a sustainable approach. Compost soil was collected from the Karadiyana open dump site (6°48′51.8″ N, 79°54′17.0″ E) to isolate PSB strains. Pikovskaya's Agar (PKV) were used to isolate PSB strains and identified through biochemical tests and 16S rRNA gene sequencing. Quantitative phosphate solubilization was measured by determining the production of available phosphorus in Pikovskaya broth medium supplemented with 0.5% tricalcium phosphate, while qualitative phosphate solubilization was assessed by calculating the Phosphate Solubilization Index (PSI) for each isolate. PSB-incorporated consortia were prepared by mixing isolated PSB strains, maintaining a concentration of 10^8 CFU/mL with absorbance values ranging from 0.5 to 0.9 at 595 nm. The effects of these consortia on plant growth were evaluated through pot experiments using salad leaves and radish plants, with growth parameters including shoot length, root length, fresh weight, dry weight, seed germination time, number of leaves, leaf area, leaf width, and leaf length measured. The isolated strains were identified as belonging to the genus *Bacillus*, with *Bacillus siamensis* strain KCTC 13613 showing the highest production of available phosphorus (171.2±0.3 µg/mL) on the fourth day of incubation. Pots inoculated with PSB consortia demonstrated a significant increase in all measured growth parameters for both salad leaves and radish compared to the control ($p<0.05$). These findings reveal the potential of *Bacillus* spp. as bio-inoculants to promote sustainable agriculture by enhancing phosphorus availability and plant growth.

Keywords: *Bacillus spp, Biofertilizers, Phosphate-solubilizing bacteria, Plant growth promotion, Sustainable agriculture*