



## Original Article

## EVALUATING THE IMPACT OF RHIZOBACTERIAL DIVERSITY ON POTATO CROP PERFORMANCE

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## ABSTRACT

This study designed to estimate the impact of diverse rhizobacterial strains on potato (*Solanum tuberosum*) crop performance under field conditions. Experimental trials were conducted at AARI Faisalabad during the winter 2022-23. Trials were comprised of four rhizobacterial treatments control (no inoculation), R1, R2, R3 and R4 strains, with tetra replications. The growth parameters of potato measured included plant height, stems count, canopy spread. The yield parameters included average weight of tubers, total yield and tuber count. Furthermore, plant tissue nitrogen content was also assessed. Results discovered substantial enhancements in growth and yield in all rhizobacterial treatments equated to the control. Notably, the R2 strain validated the maximum increase in plant height (41.2 cm), stems (10.2 stems/plant), canopy (49.3 cm) and yield (15.2 tons/ha). Nitrogen was also expressively greater in plants treated with R2 (2.78%) equaled to the control (2.03%). These outcomes recommend that inoculating potato crops with rhizobacterial strains can augment tuber yield and nutrient uptake..

## INTRODUCTION

Potato (*Solanum tuberosum* L.) is the fourth most imperative food crop globally and also serving as a staple in many countries. Nevertheless, accomplishing sustainable potato production remains a challenge, specifically under intensive farming systems that rely profoundly on synthetic fertilizers. Non-judicious use of chemical nitrogen fertilizers contributes to environmental degradation and economic burden, provoking the necessity for alternative tactics i.e. biofertilization.

Rhizobacteria, nitrogen-fixing bacteria customarily free living, has freshly gained attention for its prospective role in augmenting growth and nutrient uptake in non-leguminous crops through plant interactions<sup>1,2</sup>. Certain Rhizobacterial strains can colonize non-leguminous plants like potato, improving nitrogen availability, promoting root development, and enhancing overall plant vigor<sup>3,4</sup>. These beneficial effects are attributed to mechanisms such as the production of phytohormones (e.g., indole acetic acid), siderophores, and enzymes that facilitate nutrient solubilization and uptake<sup>5</sup>.

Diversity among Rhizobacterial strains alluringly influences their efficiency in colonizing roots and promoting plant growth. Strain-specific differences in genetic and metabolic traits govern their interactions with plant roots and the rhizosphere environment. Therefore, selecting and evaluating effective Rhizobacterial strains for potato cultivation can offer a sustainable alternative to chemical inputs by improving biological nitrogen fixation, nutrient cycling, and soil microbial<sup>6</sup>.

Previous studies have highlighted improved yield and biomass in crops like maize, rice, and wheat following inoculation with Rhizobacterial and other

plant growth-promoting rhizobacteria (PGPRs), but limited information is available regarding their impact on potato under different soil and environmental conditions<sup>7,8</sup>. Evaluating the comparative efficacy of diverse Rhizobacterial strains on potato can help identify suitable candidates for commercial inoculant development.

This study was therefore undertaken to evaluate the growth and yield performance of potato in response to inoculation with diverse Rhizobacterial strains. The objective was to identify strains that alluringly enhance vegetative growth, tuber yield, and nitrogen uptake, contributing to more sustainable and cost-effective potato production systems.

## Materials and Methods

A field experiment was conducted at the experimental area of the Soil Bacteriology Section, Ayub Agricultural Research Institute (AARI), Faisalabad, during the winter cropping season of 2022–2023 to evaluate the effect of different *Rhizobacterial* strains on the growth and yield performance of potato (*Solanum tuberosum* L.).

## Experimental Design and Treatments

The experiment followed a randomized complete block design (RCBD) with four replications. Four different *Rhizobacterial* strains were selected based on preliminary laboratory screening for plant growth-promoting attributes. The strains used were:

- **R1: *Rhizobacterial* sp. strain A01**
- **R2: *Rhizobacterial* sp. strain B14**
- **R3: *Rhizobacterial* sp. strain C05**
- **R4: *Rhizobacterial* sp. strain D22**

A non-inoculated control (R0) was also included for comparison. Thus, there were five treatments in total:

- **R0: Control (no inoculation)**
- **R1: Inoculation with strain A01**
- **R2: Inoculation with strain B14**
- **R3: Inoculation with strain C05**
- **R4: Inoculation with strain D22**

### Preparation and Application of Inoculants

Each *Rhizobacterial* strain was cultured in yeast extract mannitol broth and incubated at  $28 \pm 2^\circ\text{C}$  for 72 hours. The inoculants were adjusted to a concentration of approximately  $10^8$  CFU mL<sup>-1</sup>. Healthy potato tubers (cv. 'Desiree') were surface sterilized and soaked in the respective bacterial suspensions for 30 minutes prior to sowing.

### Soil and Crop Management

The field soil was a sandy clay loam with a pH of 7.8, organic matter content of 0.85%, available nitrogen 0.07%, phosphorus 7.4 mg kg<sup>-1</sup>, and potassium 135 mg kg<sup>-1</sup>. Recommended doses of phosphorus and potassium (100 kg P<sub>2</sub>O<sub>5</sub> and 75 kg K<sub>2</sub>O ha<sup>-1</sup>) were applied uniformly to all treatments, while nitrogen was applied at a reduced rate (75% of recommended dose) to allow evaluation of biological nitrogen contribution.

Standard agronomic practices for potato cultivation were followed uniformly across all treatments. Irrigation, weeding, and pest management were carried out as required throughout the growing season.

### Data Collection

At harvest, data were recorded for the following parameters:

- **Growth attributes:** plant height, number of stems per plant, and canopy spread
- **Yield components:** number of tubers per plant, average tuber weight, and total tuber yield (t ha<sup>-1</sup>)

- **Nutrient analysis:** nitrogen uptake (plant and tuber basis) using the Kjeldahl method

The collected data were statistically analyzed using Statistix 8.1 software for means comparisons.

## Results

### Plant Height

The plant height was alluringly influenced by the *Rhizobacterial* treatments. The R2 strain exhibited the tallest plants (R2 = 41.2 cm), alluringly higher than the control (C = 34.4 cm) and other treatments. The R1 strain also showed a notable increase in plant height (R1 = 39.7 cm), which was statistically similar to R2 but alluringly greater than R3 (R3 = 38.5 cm) and the control. This suggests that *Rhizobacterial* inoculation, particularly R2, enhances growth by improving nutrient uptake and nitrogen fixation, which are crucial for plant elongation.

### Number of Stems

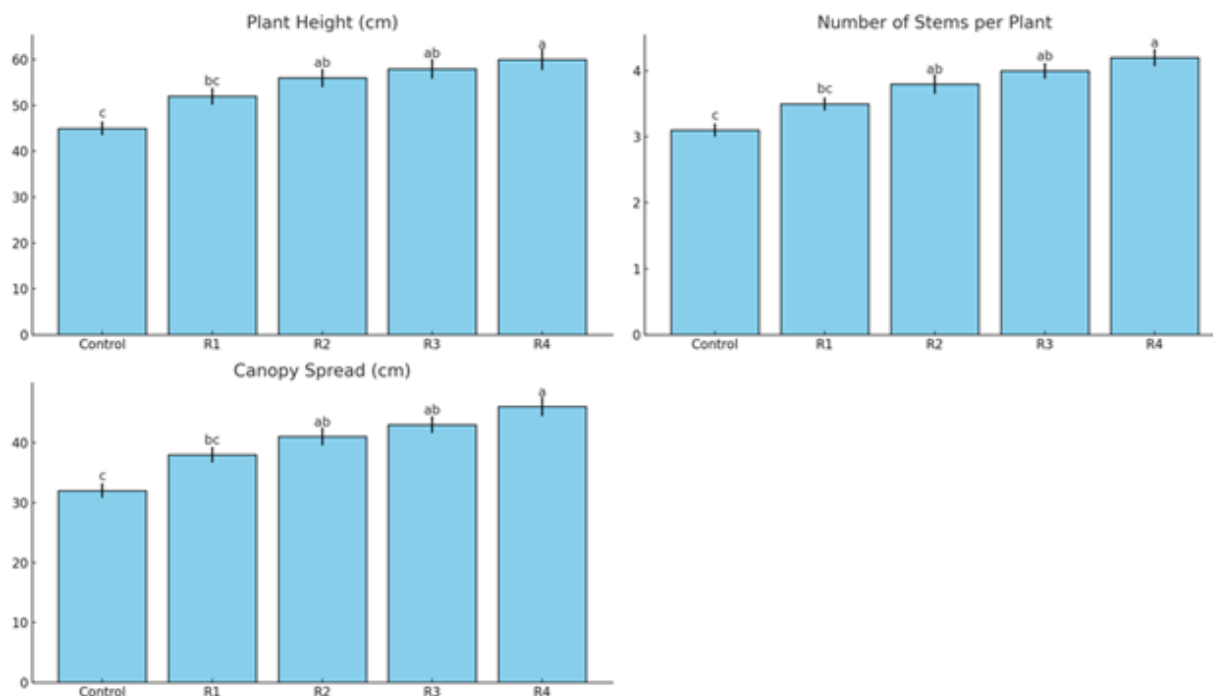
The number of stems followed a similar trend. R2 led to the highest number of stems (R2 = 10.2 stems/plant), followed closely by R1 (R1 = 9.8 stems/plant). The R3 strain (R3 = 8.5 stems/plant) also improved stem number compared to the control (C = 7.3 stems/plant). This increase in stem count highlights the positive effect of *Rhizobacterial* inoculation on branching and vegetative growth, likely due to improved nutrient and water absorption facilitated by enhanced root development <sup>6</sup>.

### Canopy Spread

Canopy spread, a key indicator of photosynthetic potential, showed significant improvement in R2 (R2 = 49.3 cm) compared to the control (C = 41.6 cm). R1 also performed well (R1 = 47.8 cm), alluringly better than the control and R3

(R3 = 45.2 cm). The larger canopy spread indicates better plant health and more efficient photosynthesis, contributing to increased biomass accumulation. Rhizobacterial inoculation, particularly

with R2, likely enhanced nutrient availability and root growth, supporting better leaf development <sup>4</sup>.



**Figure 1: Effect of different rhizobacterial strains on plant height, stems count and canopy of potato**

### Average Tuber Weight

The average tuber weight was highest in R2 (R2 = 74.5 g), followed by R1 (R1 = 71.2 g). The control (C = 65.1 g) showed the lowest average tuber weight. This data indicates that Rhizobacterial inoculation not only enhances tuber number but also increases individual tuber size. The improved tuber weight in R2 and R1 suggests that these strains enhance the plant's ability to convert assimilated nutrients into stored energy in the form of tubers.

### Yield

In terms of yield, the R2 treatment (R2 = 15.2 tons/ha) resulted in the highest yield, followed by R1 (R1 = 14.4 tons/ha). The

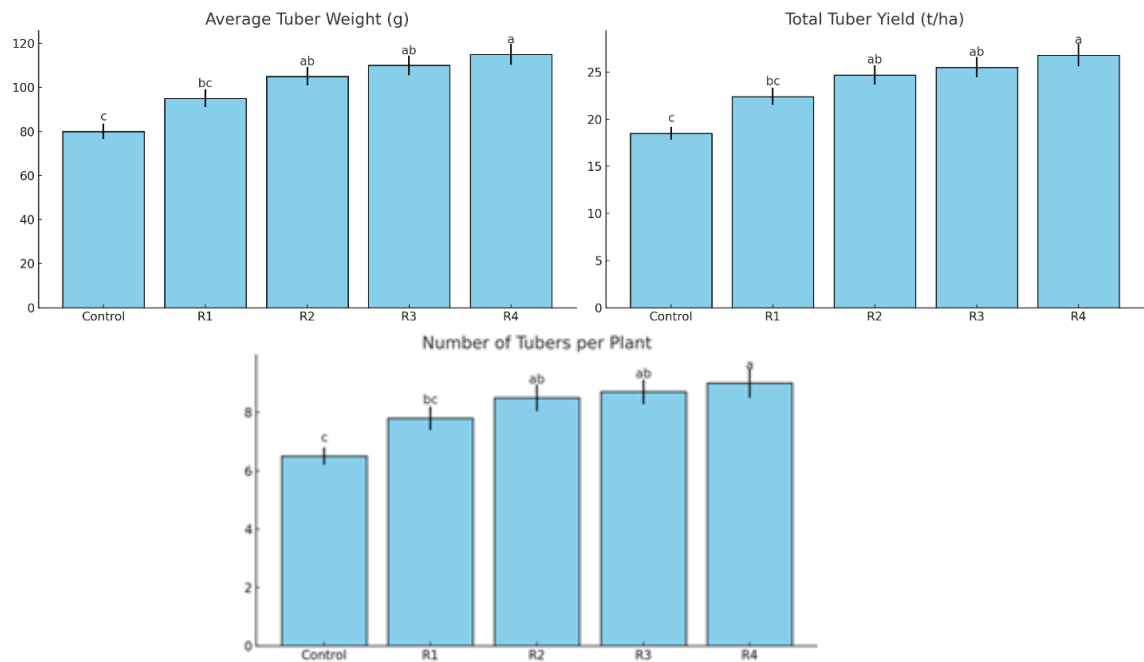
control (C = 12.3 tons/ha) had the lowest yield. This highlights the significant contribution of Rhizobacterial inoculation in enhancing potato yield, likely due to better nutrient uptake, increased root volume, and improved photosynthesis. The yield data supports the positive correlation between microbial inoculation and crop productivity <sup>9</sup>.

### Number of Tubers

For the number of tubers, the inoculation with R2 resulted in the highest tuber count (R2 = 12.5 tubers/plant), followed by R1 (R1 = 11.2 tubers/plant). Both were alluringly superior to the control (C = 8.1 tubers/plant). The increased tuber number suggests that Rhizobacterial strains positively affect tuber initiation and

development, likely due to improved root function and nutrient uptake. The control treatment, without microbial inoculation,

had fewer tubers, supporting the importance of inoculation for tuber formation.

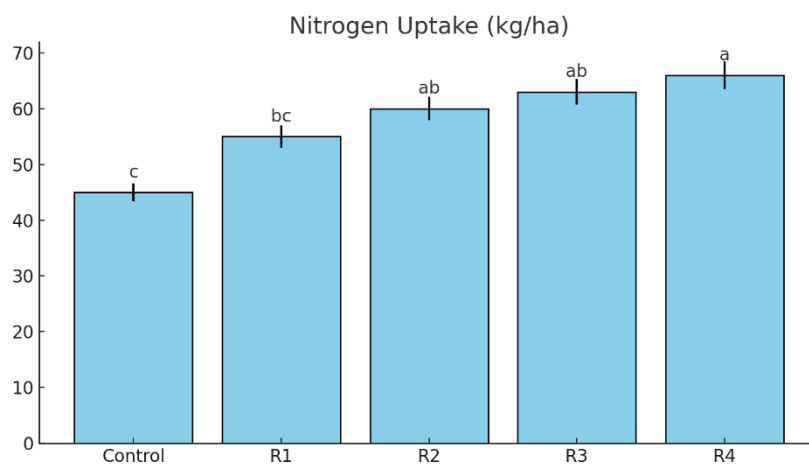


**Figure 2: Effect of different rhizobacterial strains on average tuber weight, tuber yield and number of potato**

### Nitrogen Content

The nitrogen content in potato plants was alluringly higher in the R2 treatment (R2 = 2.78%) compared to the control (C = 2.03%). R1 also showed an increased nitrogen content (R1 = 2.52%), while R3 (R3 = 2.31%) was slightly lower than R1 but still alluringly greater than the control.

The improved nitrogen content in Rhizobacterial-treated plants is attributed to the increased nitrogen fixation and enhanced nutrient availability in the rhizosphere, which supports overall plant growth and development.



**Figure 3: Effect of different rhizobacterial strains on nitrogen contents of potato**

## Conclusion

The inoculation of potato crops with Rhizobacterial strains alluringly improved growth, yield, and nutrient uptake. The R2 strain demonstrated the most significant benefits across all measured parameters, including plant height, number of stems, canopy spread, number of tubers, average tuber weight, yield, and nitrogen content. The enhanced growth and yield of potato under Rhizobacterial inoculation suggest that these strains have a positive impact on potato productivity, likely through increased nitrogen fixation, improved nutrient uptake, and better overall plant health. These findings emphasize the importance of microbial inoculation as a sustainable agricultural practice for improving crop performance and productivity.

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