



Field efficacy of *Trichoderma viride*, *Pseudomonas fluorescens*, and consortia of microbial agents against tomato late blight, *Phytophthora infestans* (Mont.) de Bary in Indo-Gangetic Plain of Bihar

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ABSTRACT

Late blight of tomato, caused by *Phytophthora infestans*, leads to substantial yield losses and significant reduction in crop production, if not managed effectively. Management of tomato late blight largely relies on chemical treatments, which poses a huge risk to the environment. Assuming that biological control is an alternative for late blight management, *Trichoderma viride* (Tv), *Pseudomonas fluorescens* (Pf), Arka Microbial Consortium (Bc₁) and PUSA Sampurn Microbial Consortium (Bc₂) in different combinations were evaluated in present investigation. Among all tested combinations of biocontrol agents, Pf + Bc₁ + Tv + Bc₂ was the most effective with lowest disease incidence (7.41 and 8.85 %) followed by Tv + Bc₂ (10.01 and 11.52 %) during 2022-23 and 2023-24, respectively. During both years, biocontrol agents lowered the disease index by 33–72 % as compared to the control. Furthermore, application of Pf + Bc₁ + Tv + Bc₂ resulted in a marked reduction in the area under disease progress curve (71.7 and 73.4 %) and enhanced the tomato yield (32.9 and 35.5 %) significantly over control. Findings from the present study indicate that the integrated application of *T. viride*, *P. fluorescens* and microbial Consortia provides a highly effective and cost-efficient biocontrol strategy for managing late blight in tomato crops. This approach combines multiple beneficial microorganisms that work synergistically to suppress the disease, making it a sustainable and economically viable option for tomato growers.

1. Introduction

The tomato (*Lycopersicon esculentum* Mill.) is one of the most important crops grown globally. In India, it is economically important among small scale farmers providing cash income throughout the year due to its long fruiting and harvesting period. Tomato is cultivated over an area of 0.85 million ha with a production of 20.4 million tonnes in India. Bihar is a major tomato-producing state, producing around 1.17 million tonnes of tomato from an area of 0.06 million ha (Agricultural Statistics at a Glance, 2023). The productivity of tomato in Bihar is merely 18.6 MT ha⁻¹ that is 22.6 percent lower than the national average (24.0 MT ha⁻¹).

The prevalence of plant diseases is a major challenge faced by the tomato-growers all around the world (Sharma et al., 2004). Among these, tomato late blight caused by the oomycete pathogen, *Phytophthora infestans* (Mont.) de Bary stands out as a particularly widespread and highly destructive disease, severely impacting the tomato production in

tropical, subtropical, and warm temperate regions (Ramesh et al., 2014). It is one of the most devastating diseases of tomato in India, causing substantial losses in quality and quantity of tomato crop, if not managed properly (Fry et al., 2015). Crop losses as much as 100 percent have been reported during severe epidemics in India (Chowdappa et al., 2013). Tomato late blight is one of growing concern for tomato cultivation in Bihar.

Late blight thrives in cool, moist conditions. Air-borne sporangia or oospores harbouring the soil and seed serve as inoculums for initiation of disease (Rubin and Cohen, 2004; Govers, 2005). The secondary spread of the pathogen occurs through wind and rain, which can lead to rapid and widespread outbreaks. *Phytophthora infestans* can infect every part of tomato plant viz., leaves, petioles, stems, fruits and even the seeds (Irzhansky and Cohen, 2006). Pale green, water-soaked lesions on leaves, bordered by yellowish-green margins, turn dark brown to black under favorable conditions. High humidity promotes cottony white mold, which disappears in dry weather. On stems, appearance of brown

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