Molecular Soil Biology 2026, Vol.17, No.2, 127-140
http://bioscipublisher.com/index.php/msb

Feature Review Open Access

Effects of Biofertilizers on Soil Biological Activity in Vegetable Production Systems

Yan Yang
1 Zhejiang Fengyu Eco-Technology Co.,Ltd.，Pujiang 322200，Zhejiang, China
2 Zhejiang Agronomist College，Hangzhou 310021, Zhejiang, China
Corresponding email: 5984930@qq.com

Molecular Soil Biology, 2026, Vol.17, No.2 doi: 10.5376/msb.2026.17.0011
Received: 07 Feb., 2026
Accepted: 13 Mar., 2026
Published: 28 Mar., 2026

Preferred citation for this article:
Yang Y., 2026, Effects of biofertilizers on soil biological activity in vegetable production systems, Molecular Soil Biology, 17(2): 127-140 (doi: 10.5376/msb.2026.17.0011)

Abstract As a green agricultural input, biofertilizer plays a pivotal role in fostering soil health and promoting sustainable vegetable production. This paper systematically reviews the various types of biofertilizers and their underlying mechanisms of action, with a particular focus on their impact on soil biological activity within vegetable production systems. Investigations into key indicators-such as soil microbial community structure, enzyme activity, and soil respiration-reveal that biofertilizers can significantly enhance soil microbial diversity, boost the activity of critical enzymes, and facilitate nutrient cycling and transformation, thereby improving the soil ecological environment. Furthermore, by optimizing the rhizosphere micro-environment, biofertilizers indirectly contribute to improvements in both vegetable yield and quality. Through the analysis of representative case studies, the practical efficacy and potential of biofertilizers in actual production settings are further validated. Finally, this paper identifies current research gaps and outlines future directions for development, providing a theoretical foundation for the broader adoption and application of biofertilizers in vegetable production.

Keywords Biofertilizer; Soil biological activity; Vegetable production system; Microbial community; Soil enzyme activity

1 Introduction

Vegetable production systems are among the most input-intensive components of global agriculture, characterized by short rotations, high fertilizer application rates and frequent soil disturbance to achieve high yields and quality demanded by expanding populations and changing diets (Mahmud et al., 2021). Reliance on synthetic fertilizers has certainly contributed to yield gains, but it has also accelerated soil degradation, disrupted nutrient cycles and contributed to water and air pollution, raising concerns for environmental sustainability and food safety. These impacts are particularly acute in intensively managed vegetable systems, where excessive nitrogen and phosphorus inputs, coupled with high irrigation, can impair soil structure, reduce biodiversity and increase greenhouse gas emissions (Chaudhary et al., 2022). In the context of climate change, finite mineral nutrient resources and persistent food insecurity, there is a pressing need for nutrient management strategies that sustain productivity while restoring soil function. Biofertilizers-microbial inoculants that enhance nutrient availability and plant growth-are increasingly viewed as a key component of sustainable intensification pathways for high-value horticultural crops, including vegetables (Mącik et al., 2020).

Biofertilizers are typically defined as formulations containing living or dormant microorganisms that colonize the rhizosphere or plant interior and directly or indirectly stimulate plant growth by improving nutrient acquisition, modulating hormonal balance or protecting against stress and disease (Chaudhary et al., 2022). Common functional groups include nitrogen-fixing bacteria (e.g., Rhizobium, Azotobacter, Azospirillum), phosphate- and potassium-solubilizing microorganisms, plant growth-promoting rhizobacteria (PGPR) and arbuscular mycorrhizal fungi, often applied singly or as consortia (Mącik et al., 2020). These microbes mobilize nutrients through biological nitrogen fixation, solubilization or mineralization of phosphorus and other nutrients, production of siderophores and organic acids, and stimulation of root growth and architecture via phytohormones such as indole-3-acetic acid (Kour et al., 2020). Over the past four decades, research and development have evolved from simple rhizobial inoculants to diverse, microbially enhanced products, including encapsulated formulations and