

Review Article

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Bt in Organic Farming: Benefits and Limitations

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Abstract Bt (*Bacillus thuringiensis*) is a widely used biological pesticide known for its high specificity and safety in pest control. In organic agriculture, the application of Bt provides an effective and environmentally friendly pest control method that aligns with the principles and requirements of organic farming. However, the use of Bt in organic agriculture also faces challenges such as the risk of resistance development, environmental constraints, and regulatory issues. This study systematically reviews the mechanisms of action of Bt, its benefits and limitations in organic agriculture, and successful case studies and lessons learned. The comprehensive analysis of the current application and future prospects of Bt in organic agriculture demonstrates its significant effectiveness in pest control and environmental friendliness. Nonetheless, continuous monitoring of resistance development and the implementation of effective management strategies are essential. Additionally, innovations in Bt formulations and their integration with other organic practices are key areas for future research. This study aims to provide a scientific basis for promoting the application of Bt in organic agriculture and to guide future research and development.

Keywords Bt; Biological pesticide; Organic farming; Resistance management; Environmental benefits

1 Introduction

Bacillus thuringiensis (Bt) is a gram-positive, spore-forming bacterium that has gained prominence due to its potent insecticidal properties. During sporulation, Bt produces crystal proteins (Cry proteins) that are toxic to a wide range of insect pests, particularly those belonging to the orders Coleoptera, Diptera, and Lepidoptera (Xiao and Wu, 2019; Sánchez-Yáñez et al., 2022). These Cry proteins have been extensively utilized in both microbial insecticides and genetically modified crops to enhance pest resistance (Jouzani et al., 2017; Rajadurai et al., 2023). Bt's ability to target specific pests while being safe for humans, animals, and non-target organisms has made it the most widely used biopesticide globally (Gutiérrez et al., 2019; Rajadurai et al., 2023). Additionally, Bt has shown potential in other applications such as bioremediation, plant growth promotion, and even cancer prevention (Jouzani et al., 2017; Sánchez-Yáñez et al., 2022).

Organic farming is an agricultural practice that emphasizes the use of natural inputs and processes to enhance soil fertility, biodiversity, and ecological balance. It avoids synthetic chemicals, such as pesticides and fertilizers, to produce food in a sustainable and environmentally friendly manner. The increasing consumer demand for organic products is driven by concerns over food safety, environmental sustainability, and health benefits. Organic farming practices contribute to soil health, reduce pollution, and promote biodiversity, making it a crucial component of sustainable agriculture (Loguercio and Argôlo-Filho, 2015; Rajadurai et al., 2023). Integrating biopesticides like Bt into organic farming aligns with these principles, offering an effective and eco-friendly solution for pest management (Gomis-Cebolla and Berry, 2023; Rajadurai et al., 2023).

To evaluate the benefits and limitations of using *Bacillus thuringiensis* (Bt) in organic farming, this study assesses the efficacy of Bt as a biopesticide in controlling various insect pests in organic farming systems. It explores the potential non-insecticidal benefits of Bt, such as plant growth promotion and bioremediation. It identifies the challenges and limitations associated with the use of Bt in organic farming, including the development of pest resistance and ecological impacts. Additionally, it provides recommendations for future research and practical applications to optimize the use of Bt in organic farming. By synthesizing current knowledge and research findings, this study aims to provide a comprehensive understanding of the role of Bt in organic farming and its potential to contribute to sustainable agricultural practices.