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Microbial Compost Fertilisation: A Technique to Increase Plant Stress Resilience

Tamoor Merdian*

Department of Bioinformatics and Biotechnology, Government College University, Faisalabad, Pakistan

Introduction

In a world facing growing challenges related to climate change, soil degradation, and food security, sustainable agricultural practices are more crucial than ever. Among these practices, microbial compost fertilization has emerged as a powerful technique for enhancing plant stress resilience and promoting sustainable farming. Microbial compost fertilization involves the use of compost enriched with beneficial microorganisms to improve soil health and enhance plant growth. This technique not only aids in nutrient recycling and organic matter enrichment but also plays a significant role in mitigating abiotic and biotic stresses that crops face. This article delves into the concept of microbial compost fertilization, its mechanism, and its impacts on plant stress resilience. We will explore how microbial compost fertilization enhances soil health, nutrient availability, and disease suppression, all of which contribute to increasing the ability of plants to withstand environmental stressors [1].

Microbial compost fertilization, often referred to as compost tea or microbial inoculants, is a method that capitalizes on the power of beneficial microorganisms. These microorganisms are typically bacteria, fungi, and other beneficial microbes that help break down organic matter in compost and enrich it with nutrients. The key steps involved in microbial compost High-quality compost are the foundation of microbial compost fertilization. Compost is created by decomposing organic materials such as kitchen waste, yard trimmings, and crop residues. During the composting process, a wide variety of microorganisms naturally colonize the compost pile. Microbial Inoculation: Microbial inoculants, often referred to as compost tea or biofertilizers, are prepared by extracting microorganisms from mature compost or specialized inoculum sources. This inoculum is then mixed with water and other nutrients to create a solution rich in beneficial microbes [2].

The resulting compost tea is applied to the soil or plant surfaces. It can be sprayed onto the soil, drenched into the root zone, or foliar-sprayed directly onto the plant's leaves. Microbial compost fertilization operates through several mechanisms that promote soil health, enhance nutrient availability, and increase plant stress resilience. Microbial compost fertilization enhances soil structure by increasing the aggregation of soil particles. This improved soil structure helps water infiltration and retention, reducing the risk of water stress for plants. Beneficial microorganisms break down organic matter in compost and convert it into forms that plants can readily absorb. This process, called mineralization, releases nutrients such as nitrogen, phosphorus, and potassium, making them available to plants. Beneficial microorganisms in compost tea compete with harmful soil-borne pathogens for space and resources. This competitive exclusion reduces the incidence of diseases in crops.

Description

The application of microbial compost tea to plant roots encourages the development of a robust and diverse root microbiome. A healthy root microbiome can help plants absorb nutrients more efficiently and improve their overall stress resilience. Microbial compost fertilization has been shown to enhance a plant's tolerance to abiotic stresses such as drought, salinity, and temperature extremes. This is partly attributed to the improved water retention, nutrient availability, and overall plant health resulting from the technique.One of the fundamental benefits of microbial compost fertilization is its ability to enhance soil health. Healthy soil is the cornerstone of a productive and resilient agricultural system. When soil is rich in organic matter and teeming with beneficial microorganisms, it provides a stable environment for plant organic matter, which improves soil structure and water-holding capacity. This is particularly important in arid regions where drought stress is a constant concern. Microbial compost fertilization increases the diversity of microorganisms in the soil. This diversity contributes to better nutrient cycling and the suppression of harmful pathogens. Improved soil structure and increased vegetation cover resulting from microbial compost fertilization reduce soil erosion, another factor that can stress plants. Microbial compost fertilization significantly improves the availability of essential nutrients to plants. The process of mineralization, facilitated by beneficial microorganisms, transforms organic matter in compost into plant-available forms of nutrients. This increase in nutrient availability is especially vital for plant growth under stress conditions.

Plants can absorb essential nutrients more efficiently, which is crucial during periods of stress when their nutrient demand may increase. The improved nutrient retention in the soil reduces the leaching of nutrients into groundwater, making the agricultural system more sustainable. The use of microbial compost fertilization also aids in the suppression of soil-borne pathogens and plant diseases. Beneficial microorganisms in compost tea and enriched soil outcompete and antagonize harmful pathogens, reducing the incidence of diseases. This mechanism is particularly relevant for plant stress resilience because diseases can weaken plants, making them more vulnerable to environmental stresses. Abiotic stresses, such as drought, salinity, and extreme temperatures, are becoming more frequent and severe due to climate change [3-5].

Conclusion

Improved soil structure, enhanced water retention, and efficient nutrient uptake enable plants to withstand drought conditions more effectively. High salinity in soils can stress plants by limiting their water uptake. The enhanced nutrient availability and improved root health resulting from microbial compost fertilization can help plants manage salt stress. Plants treated with microbial compost fertilization have been observed to exhibit greater resilience to temperature extremes. The root microbiome plays a significant role in helping plants adapt to temperature fluctuations.

Research conducted in drought-prone regions has shown that maize plants treated with compost tea exhibited increased drought tolerance compared to control plants. This effect was attributed to improved soil structure and enhanced water retention. Tomato plants infected with soil-borne pathogens such as fusarium were significantly less affected when grown in soil treated with microbial compost fertilization. The beneficial microorganisms outcompeted the pathogens, reducing disease incidence. Rice, a staple crop

***Address for Correspondence:** Tamoor Merdian, Department of Bioinformatics and Biotechnology, Government College University, Faisalabad, Pakistan; E-mail: tamoormerdian@gmail.com*

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in many parts of the world, is highly susceptible to salinity stress. Studies have demonstrated that rice plants grown in soil enriched with compost tea exhibited improved growth and grain yield in saline conditions. In grassland ecosystems, the application of microbial compost fertilization has been linked to increased resilience to heat stress. The diverse root microbiome fostered by compost tea promotes better nutrient absorption and stress tolerance in grasses.

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Conflict of Interest

There is no conflict of interest by author.

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