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TRICHODERMA

TAXONOMY, BIODIVERSITY AND APPLICATIONS

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EDITOR

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Contents

Preface

This book contains five chapters that detail the uses of trichoderma. Chapter One focuses on a comprehensive revisit of applications of Trichoderma in agriculture and other fields with a futuristic perspective. Chapter Two aims to present the main bioproducts derived from Trichoderma and the primary benefits of these microorganisms in agriculture. Chapter Three explains a study where nine isolates of Trichoderma spp. were tested. Trichoderma spp. are known for their high mycoparasitic potential as biocontrol agents against M. maydis, the cause of late wilt disease in maize. Chapter Four discusses the potentiality of Trichoderma spp. as a biocontrol agent and its mechanism in plant disease management. Lastly, Chapter Five details how Trichoderma acts as a bioinsecticide.

Chapter 1

Applications of *Trichoderma*: Past, Present and Future

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Abstract

In the current global situation, with its ever-increasing human population and the damages generated by climate change, it is imperative that effective and sustainable methods be used to ensure high and quality harvests. Biological control has many advantages over chemical pesticides, including its reduced likelihood of creating resistant strains of pests. *Trichoderma spp*. can function as a direct and indirect biocontrol agent for plant growth and disease prevention. Mycoparasitism, nutrient competition, antimicrobial compound (antibiosis) production, and lytic enzymes are all the underlying mechanisms of these fungi in benefitting the host plants. *Trichoderma* is used as a biocontrol agent against several plant pathogens. *Trichoderma* species are capable of producing specific phytohormones such as auxins, ethylene, and gibberellins. They also produce antioxidants, phytoalexins and phenols, which boost the root system's potential for branching out. The influence that *Trichoderma* has on seed germination, plant morphology, and plant physiology results in a better field stand. Fungi, such as *Trichoderma*, are gaining popularity for their capacity to biodegrade hazardous substances in an effective manner. *Trichoderma* spp. can fix nitrogen, solubilize and mineralize phosphate, potassium, and other elements, producing iron chelates and

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making them available for plant absorption. There are around 285 products registered to contain *Trichoderma* spp. for agricultural uses. MAPK signalling pathways may play a role in mycoparasitism and biocontrol. Different *Trichoderma* strains also synthesize non-ribosomal peptides (NRPs), which trigger plant defence responses. *Trichoderma* spp. is one of the beneficial rhizospheric microorganisms that exhibit a variety of features that help plants recover from environmental stress. Several *Trichoderma* species are commercially accessible as biopesticides and biofertilizers but have no place in the farmer's field. Apart from the applications in agriculture, *Trichoderma* finds use in the bioremediation of inorganic compounds using biosorption, bioaccumulation, volatilization, and Phytobial remediation. This chapter is focused on a comprehensive revisit of applications of *Trichoderma* in agriculture and other fields with a futuristic perspective.

Introduction

In the current global situation, with its ever-increasing global population and the damages generated by climate change, it is imperative that effective and sustainable methods be used to ensure high-quality harvests. Increasing food production without causing any additional strain on the environment is a pressing problem today (Germer et al. 2011). Improved agricultural methods that raise yields and gradually boost soil quality are essential for meeting this problem (Cassman et al. 2003). Large agricultural losses are sustained yearly worldwide because crops are so vulnerable to diseases brought on by plant pathogens, negatively affecting production and the product's market value (Savary et al. 2012). Pathogens are responsible for an estimated 78% loss in fruit crops, 54% loss in vegetable crops, and 32% loss in grain crops (Tudi et al. 2021). Crops vulnerable to plant diseases can suffer significant losses both in the field (before harvest) and in storage (after harvest), and plant infections are blamed for this (Mesterházy, Oláh, and Popp 2020). Pathogens can be classified into several broad categories, including viruses, bacteria, oomycetes, fungi, nematodes, and parasitic plants (Hane et al. 2020). The F.A.O., the United Nations agency in charge of food and agriculture, reports that the most crucial crops in the world are frequently hit by plant mycoses (Bruinsma 2017). It is generally accepted that fungi are the single most important factor in the widespread destruction of important crops, including rice, beans, soybeans, corn, potatoes, and wheat (Holliday 1995).

Soil-borne diseases, of which fungi are the most prevalent species, are responsible for the greatest yearly losses in both natural and production environments, killing as much as one-third of all crops (Lambers et al. 2009). So far, scientists have identified more than 19,000 unique kinds of fungi that may cause crop diseases across the world (Antonelli et al. 2020). The use of naturally occurring organisms (antagonists) to suppress pathogenic activity is an attractive strategy for managing plant diseases (Prajapati et al. 2020). Biocontrol has many advantages over chemical pesticides, including its reduced likelihood of creating resistant strains of pests, its lack of environmental impact, its compatibility with organic production, and its ability to satisfy the demands of profitable markets with regard to maximum limits of chemical residues on fruits and vegetables (Bardin et al. 2015; Kredics et al. 2003). Here we will try to understand the function of *Trichoderma* as an alternative to traditional chemical-based pesticides, insecticides, and growth promoters and how it opens up gates for sustainable agriculture. It is a significant antibiotic producer, numerous strains of this genus are 'rhizosphere competent,' meaning they can digest hydrocarbons, chlorophenols chemicals, polysaccharides, and xenobiotic pesticides used in agriculture (Lo, Nelson, and Harman 1996; Contreras-Cornejo et al. 2016). The current chapter discusses the past, present and future of *Trichoderma* with respect to agriculture, sustainability and industries.

Trichoderma and Sustainability in Agriculture

Christiaan Hendrik Persoon provided a description of the genus *Trichoderma* in the year 1794 (Rahimi Tamandegani et al. 2020). The ability of *Trichoderma* species to act as biocontrol agents against plant diseases was first identified in the early 1930s, and in the years that followed, the list of diseases that could be controlled by *Trichoderma* was significantly expanded (Howell 2003). This has resulted in the commercial production of several species of *Trichoderma* around the globe for the purpose of protecting and enhancing the growth of a variety of crops, as well as the production of species of *Trichoderma* and mixtures of species in India, Israel, New Zealand, and Sweden (Woo et al. 2014; KUMAR Sanjeev, Manibhushan, and Archana 2014; López-Bucio, Pelagio-Flores, and Herrera-Estrella 2015).

However, *Trichoderma* spp., for example, has been very successfully used as a beneficial microorganism (G. E. Harman et al. 2008b; Monte 2001; Mbarki et al. 2017). This is due to the fact that *Trichoderma* spp. Inhibit a