Chapter 3
Antifungal Potential of Trichoderma sp. Against Three Species of Fusarium Genus:
Responsible for the Root Rot of the Saffron Corms (Crocus sativus L.)

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ABSTRACT

This study examines the in vitro antagonistic effect of three native Trichoderma sp. isolates originating from saffron corms, against three Fusarium species plants (F. pseudograminearum, F. moniliforme and F. oxysporum) known to cause rotting in the bulbs and roots of saffron. To introduce Trichoderma into a preventive control program, the Trichoderma isolates were tested by in direct confrontation and volatile substances production. They demonstrated colonization percentages ranging from 50% to 79.6%, significantly inhibiting the mycelial growth and spore germination of pathogenic species, with inhibition rates ranging from 53% to 79% and 51% to 79%, respectively. However, indirect confrontation through the production of diffusible substances showed low inhibition of mycelial growth and spore germination for all pathogenic isolates studied, not exceeding 28.47% and 20.5%, respectively. This study discusses

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the potential of using Trichoderma as biocontrol agents against a wide range of bioaggressors.

I. INTRODUCTION

Several fungal species carried by corms induce disease in various components of saffron plants (El Aymani et al., 2019; Ourras et al, 2023). Representatives of the genera Fus*arium, Rhizoctonia, Penicillium, Aspergillus, Sclerotium, Phoma, Stromatinia, Cochliobolus and* Rhizopus are associated with saffron diseases (Ahrazem et al., 2010, Rubio-Moraga et al., 2013; El Aymani et al., 2019, Ourras et al., 2023). The most serious diseases reported include *Fusarium oxysporum*-induced rots (Cappelli, 1994; Bentata et al., 2017; Najari et al., 2018), as well as those caused by *Sclerotium rolfsii* (Kalha et al., 2007) and *Rhizoctonia violacea* (Bentata et al., 2017). These saffron diseases cause severe losses across most saffron fields (Palmero et al., 2014). Infected plants exhibit variable symptoms during the flowering period, including yellowing, leaf wilting, and root and corm rot. Typically, pathogens are harbored within corms and contaminated soils (Brayford, 1996). Field plant infections are typically observed shortly after the planting of contaminated corms (Cappelli and Di Minco, 1999).

Chemical control methods against *Fusarium* spp. are not fully effective as the pathogen can penetrate plant tissues (Qostal et al., 2019a). Additionally, crop rotation proves ineffective against these soil fungi due to their ability to survive in crop debris and infect a wide range of host plants (Baha Eddine et al., 2019). Consequently, there is growing interest in alternative control measures, prompting research and development efforts towards sustainable and effective products for managing plant pathogens in Moroccan agriculture (Qostal et al., 2019b). In this context, harnessing fungi belonging to the genus Trichoderma presents an intriguing approach for safeguarding corms and saffron plants against various abiotic and biotic stresses in Morocco.

Various organisms serve as effective biological control agents against soil pathogens. Bacterial and fungal genera commonly utilized and marketed for this purpose comprise Gliocladium, Bacillus, Coniothyrium, Paecilomyces, Phlebiopsis, Pseudomonas, Rhizobium, Serratia, Streptomyces, and Trichoderma (Mazzola and Freilich, 2017; Elbouazaoui et al., 2022; Ait Rahou et al., 2022; Sellami et al., 2023).

Trichoderma are filamentous fungi (Papavizas, 1985) renowned for their antagonistic abilities against numerous phytopathogens (Artigues & Davet, 1984; Camporota, 1985; Mouria et al., 2008; Ouazzani Chahdi et al., 2014; Qostal et al., 2020; Kribel et al., 2020; Mouden et al., 2023; Adnani et al., 2024; Errifi et al., 2024). These fungi are effective soil colonizers (Davet & Camporota, 1986), inhabiting the rhizosphere (Hem & Pang, 2017) and plant roots (Mouria et al., 2008; Qostal et al., 2020; Kribel et al., 2020). They are recognized as biological control agents against a wide range of pathogens, both soilborne and foliar (Tijerino et al., 2011; Leylaie & Zafari, 2018; Camporota, 1985; Ouazzani-Touhami et al., 1994; Pertot et al., 2015; Qostal et al., 2020; Bastakoti et al., 2017). Several studies have been conducted to evaluate the antagonistic abilities of Trichoderma against various phytopathogens, both in vitro and in vivo. These pathogens include *Fusarium* spp. (Mayo et al., 2015; Moumene et al., 2016; Abbas et al., 2017; Luis Vargas-Inciarte et al., 2019; Adnani et al., 2024), *Botrytis* spp. (De Meyer et al., 1998; Hmouni et al., 1999, 2006; Tronsmo, 1977; Sadek et al., 2020), *Verticillium* spp. (Mouria et al., 2008; Hanson, 2000), *Pythium* spp. (Dumitras & Fratilescu-Sesan, 1980), Colletotrichum spp. (El Kaissoumi et al., 2024), *Sclerotinia rolfsii* (Elad et al., 1980), *Phytophthora infestans* (Moumene et al., 2015), and *Rhizoctonia solani* and *Macrophomina phaseolina* (El-Sebaay & El-Sayed, 2019; Wang & Zhuang, 2019; Ali, 2021; El-Benawy et al., 2020; Errifi et al., 2024).