



Zabol University
Faculty of Agriculture
Ph.D. Thesis

**The aspects of biochemical and molecular interactions with
Fusarium species cause wilt of banana and the effect of some
medicinal plants essential oil on defence responses of plant**

Supervisor

Dr. Mahdi Pirnia
Dr. Abdolhossein Taheri

Advisor

Dr. Nima Khalidi
Dr. Shir Ahmad Sarani
Dr. Mojtabi Keykhasaber

Student

Yasamin Irandegani

Spring 2023

Abstract

In this study, in the first stage, the *Fusarium* species responsible for *Fusarium oxysporum* f. sp. *cubense* (FOC) and investigated the pathogenicity of *Fusarium* isolates obtained from banana samples in Sistan and Baluchistan province and was identified based on morphological characteristics and nucleotide sequencing of ITS-rDNA, TEF and RPB2 regions. Pathogenicity was confirmed on banana seedlings of Cavendish variety. Extracting essential oils from some native medicinal plants of the region (neem leaves, eucalyptus, Desert Teak, Milkweed, Myrtle as well as savory and Peppermint leaves and stems and luffa seeds), identifying the compounds that make up effective essential oils and investigating their effects on growth and pathogenicity indicators. *Fusarium* was isolated from banana samples. The inhibition percentage of savory essential oil was higher than other plants examined in this experiment, and 23 main compounds were identified using gas chromatography-mass spectrometry. The main components of the essential oil included alpha-pinene (0.26%) and myrcene (0.7%), which had antifungal effects against FOC. The minimum fungicidal concentration (IC₅₀) and the minimum growth inhibitory concentration (MIC) of the essential oil were 95 and 174.75 parts per million (ppm), respectively, and it was determined that the essential oil and its effective compounds in lower amounts have better effects in They inhibit mycelium growth, spore production and germination compared to fungicides. In the second part of this research, the role of reactive oxygen species, changes in antioxidant enzymes, total protein content and expression levels of defense enzymes genes in Cavendish variety banana seedlings were investigated. The seedlings were treated with pathogenic fungi, savory essential oil and the effective compound of alpha-pinene. Faster production of H₂O₂ and O₂⁻ was observed in the seedlings infected with the pathogen compared to the effective compound and essential oil treatments. The highest total protein content was in essential oil and alpha-pinene treatments. Examining the activity of SOD, POX and CAT enzymes showed that the activity of these enzymes was higher during the interaction of banana seedlings with the combination of alpha pinene and essential oil. The analysis of the expression of *SOD*, *POX* and *CAT* genes using the RT-PCR method showed a direct relationship between the activity of the enzymes and the expression of the corresponding genes. In general, higher levels of enzyme activity and expression of enzyme antioxidant genes were observed in most of the examined times in the treatments of essential oil and active ingredient, as well as during the interaction of banana with *F. oxysporum*. According to the results of this research, the use of essential oils of medicinal plants can be used as an efficient, healthy and safe management solution for the environment in controlling *Fusarium* disease of banana plants in the greenhouse.

Keywords: identification, essential oil, enzymes, gene expression