



University of Zabol
Graduate Management
Faculty of Agriculture

Thesis Submitted for the Degree of Ph.D In Plant pathology

**Biological control of Phytophthora root rot of pistachio
through simultaneous application of three species of *Glomus*
and *Trichoderma harzianum***

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Abstract

Phytophthora root and crown rot is one of the most important diseases of pistachio trees that causes great economic damage to pistachio orchards. One of the effective methods in reducing the damage of this disease is using fungal antagonist agents, which decrease the use of fungicides while producing a healthy crop. In the present study, the effect of root impregnation of Momtaz and Badami-Zarand pistachio rootstocks (sensitive and tolerant to the disease, respectively) with mixture of three species of Arbuscular mycorrhizas *Funneliformis mosseae*, *Rhizophagus irregularis*, *Claroideoglossum etunicatum*, *Trichoderma harzianum*, and their combination was evaluated on controlling pistachio gummosis caused by *Phytophthora drechsleri*. Simultaneously with sowing pistachio seeds, one hundred gram of the propagated inoculum of Arbuscular mycorrhizas and 10 g of wheat seeds colonized with *T. harzianum* per seedling were mixed with soil, and after two months, the roots of pistachio seedlings were inoculated with inoculum of *P. drechsleri* grown on vermiculate amended with hempseed extracts. The experiment was performed as factorial in a completely randomized design with five replications. The results indicated that root impregnation of fungal biocontrol agents significantly increased shoot and root dry weight, stem height and diameter, leaf area, mineral content in shoot and chlorophyll concentration, chlorophyll index, soluble sugars, and proline in the roots of both pistachio rootstocks, so the most significant impact was seen in combination of biocontrol agents treatment. Inoculation of the pathogen only reduced the above traits in the Momtaz rootstock significantly. The co-inoculation of biocontrol agents with the pathogen caused increase of vegetative, nutritional, and biochemical traits of both rootstocks compared with pathogen treatment, so that combination of biocontrol agents with the pathogen had the most prominent impact on these traits. In this treatment, the mortality percentage of seedlings with the pathogen was 50% and 17% in Momtaz and Badami-Zarand rootstocks respectively that showed a meaningful decrease compared to the pathogen treatment (92% and 42%, respectively). After pathogen inoculation, the specific activity of antioxidant and hydrolytic enzymes first showed an upward trend in combination of the fungal antagonists and pathogen treatments, whereas after remaining at the peak activity for 2 to 8 days, again showed downward trend. The amount of specific activity, the increasing rate of the activity and the duration of the peak activity was higher in Badami-Zarand than Momtaz rootstock. Furthermore, the decline slope of specific activity of the enzymes was lower in Badami-Zarand compared to Momtaz rootstock. Improving the vegetative, nutritional, and biochemical properties of seedlings, along with increasing the specific activity of antioxidant and hydrolytic enzymes and phenolic compounds, are effective factors in biocontrol of *Phytophthora* root and crown rot of pistachio seedlings.

Keywords: Pistachio rootstocks, Antioxidant enzymes, Hydrolytic enzyme, Arbuscular Mycorrhizal Fungi, Biological control