University of Zabol
Graduate school
Faculty of Agriculture
Department of Horticultural Sciences

**The Thesis Submitted for the Degree of M. Sc**
**(In the field of medicinal plants)**

# Effect of mycorrhiza symbiosis on lead and cadmium phytoremediation via *Calotropis procera* Aiton.

**Supervisors:**
Dr. Mahmood solouki
Dr. Abdolrahman Rahimian Boogar

**Advisor:**
Dr. Mehdi Aran
Dr. Zeinab Mohkami

**By:**
Marzieh Nouri

January 2023

***Abstract***

Soil pollution with heavy metals is the major environmental problems in agricultural lands. Transfer of these elements by plant products to humans often threatens people's health. application of plants is one of the efficient methods for the remediation of contaminated soil. This research was designed to evaluate phytoremediation ability of *Calotropis procera* plant in the symbiosis condition of mycorrhiza. Experiment was carried out in factorial structure with a randomized complete block design with three replications at the Agricultural Research Institute of Zabol University. Heavy metals as first factor were used at 7 levels include control (no pollution), lead (50, 100, and 150 mg/kg of soil), and Cadmium (levels: 15, 30 and 45 mg/kg soil). Symbiosis with mycorrhizal fungi are the second factors that used in this research with 4 treatments of incubation by three species of fungi *G. intraradices*, *G. fasiculatum*, *G. mossae*, and no inoculation. After, 4 months of transplanting the physiological indices were evaluated. Evaluated indices in this study include; number of leaves, number of side branches, number of stem internodes, plant height, stem diameter, third internode length (LTI), fresh and dry weight of aerial parts, fresh and dry weight of root. And physiological indices include Chlorophyll a and b, carotenoid, total phenol, total flavonoid, protein, nitrogen, antioxidant activity, and catalase, guaiacol peroxidase, and ascorbate as antioxidant enzymes. Moreover, accumulation of sodium, phosphorus, potassium, and lead and cadmium as heavy elements were assessed in shoots and roots. Soil characteristics include; silt percentage, clay, sand, pH and Ec and some elements like nitrogen, phosphorus, potassium, cadmium, and lead. Data analysis was done with the JMP statistical software version 8.1, and mean compared by Duncan's multiple range test. The results were shown both factors of heavy metals and fungi inoculation had a significant effect on the morphological and physiological indices of *Calotropis procera*. In fact, plant inoculation with mycorrhizal fungi causes to increase in the number of leaves, plant height, stem diameter, third internode length, chlorophyll a, carotenoid, total phenol, flavonoid, antioxidant, nitrogen, ascorbate, sodium, phosphorus, potassium, lead, and cadmium in shoots. Whereas inoculation with mycorrhizal fungi reduced the number of lateral branches, the number of stem internodes, fresh weight of shoots, root fresh weight, shoot dry weight, root dry weight, chlorophyll b, protein, catalase, guaiacol peroxidase, lead in the root as well as lead in the soil, cadmium in the root, and cadmium in the soil. This experiment revealed that mycorrhiza fungi *G. intraradices*, *G. fasiculatum* and *G. mossae* could increase the ability of the plant as an absorbent and promote accumulation of cadmium and lead in the aerial parts. It also increased plant tolerance to the stress of the heavy metals including cadmium and lead.

**Keywords**: *Calotropis procera*, Mycorrhiza, Phytoremediation, Heavy Metal