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Unraveling the bioremediation potential of Arbuscular Mycorrhizal Fungi through bio-inoculation approach

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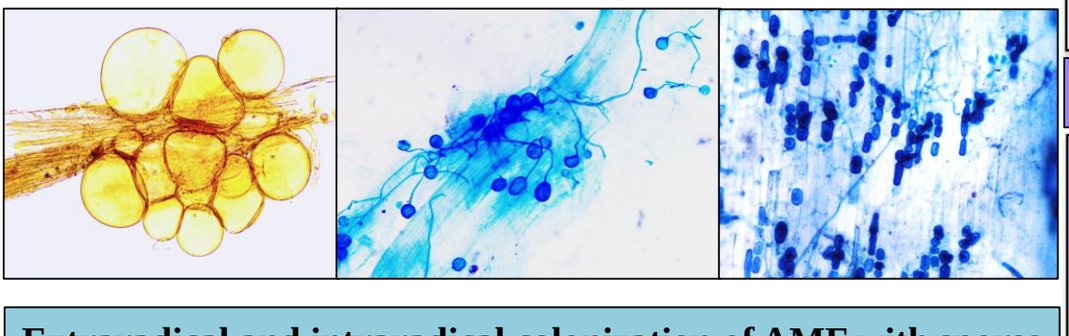
INTRODUCTION & AIM

Heavy metal contamination, particularly cadmium (Cd), poses a significant environmental challenge, affecting soil health and plant productivity. Conventional remediation methods are often costly and environmentally invasive, highlighting the need for sustainable alternatives. Arbuscular Mycorrhizal Fungi (AMF) have emerged as a natural and eco-friendly solution, forming symbiotic associations with plant roots to enhance nutrient uptake, improve stress tolerance, and influence soil microbial activity. *Albizia lebbeck* (L.) Benth., a fast-growing leguminous tree, has demonstrated potential for phytostabilization—immobilizing heavy metals in soil to reduce their bioavailability. This study explores the bioremediation potential of AMF through bio-inoculation in Cd-contaminated soils. By assessing plant growth, Cd uptake, and soil enzymatic activities under varying Cd concentrations, the role of AMF in mitigating Cd stress has been analyzed and deliberated.

METHODS

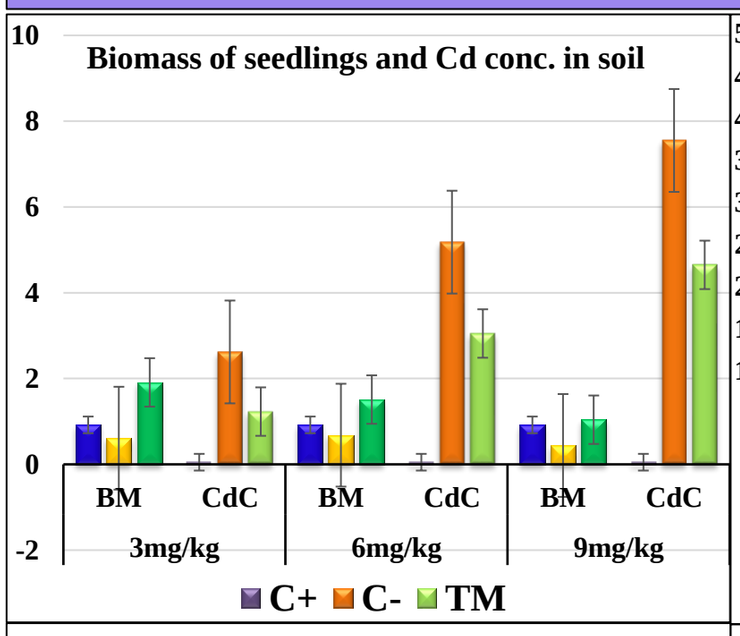
Effect of AMF inoculation on seedling's growth and development in the presence of Cd (3, 6, and 9 mg/kg) by establishing a pot experiment (CRD). The treatments are as follows: C+ = No bio-inoculation;
C- = Cd + no bio-inoculation;
TM = Cd + AMF
The following parameters were recorded 60 days after inoculation (DAI):

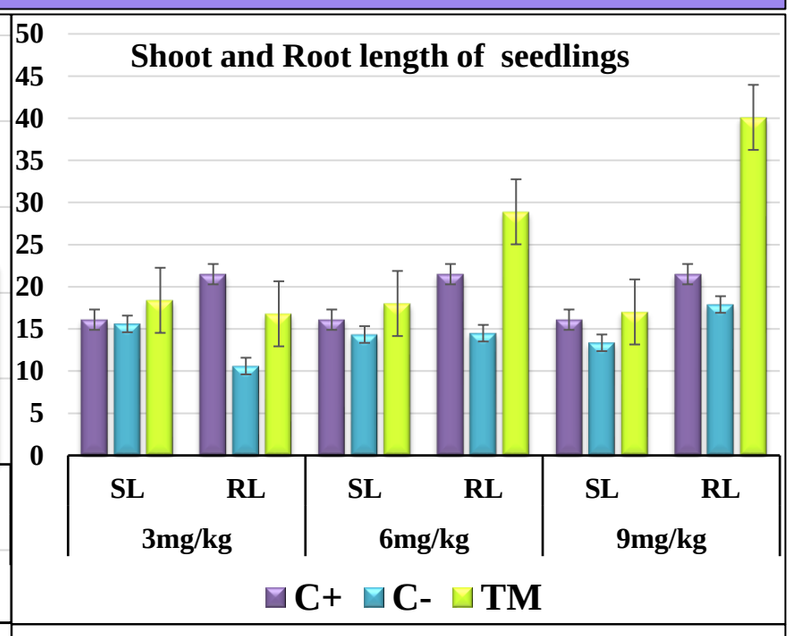
1. Cd (CdC) presence in the soil (Acid digestion method & ICP-MS).
2. Biomass (BM) of inoculated seedlings.
3. Shoot length (SL) and root length (RL) of inoculated seedlings.
4. Spore count (SC) and colonization in root (RC).
5. Enzymatic activities in soil
   - Dehydrogenase assay (DA) (Casida et al. 1964).
   - Acidic and Alkaline Phosphatase (AcP and AlP) assay (Tabatabai and Bremner 1969).
   - Catalase assay (CA) (Zhou & Zhang 1980).
6. Translocation factor (TF) = $\frac{\text{Cd conc. in shoot (mg/kg)}}{\text{Cd conc. in root (mg/kg)}}$
7. Bioaccumulation factor (BF) = $\frac{\text{Cd conc. in the whole plant (mg/kg)}}{\text{Cd conc.in soil (mg/kg)}}$

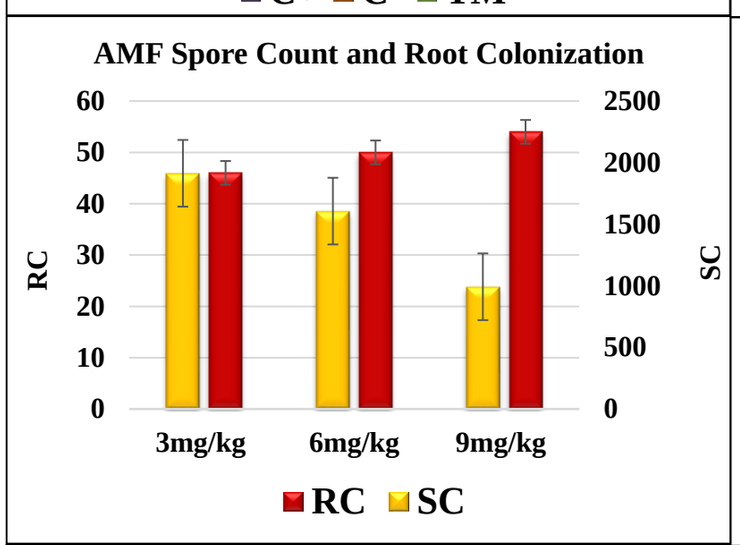


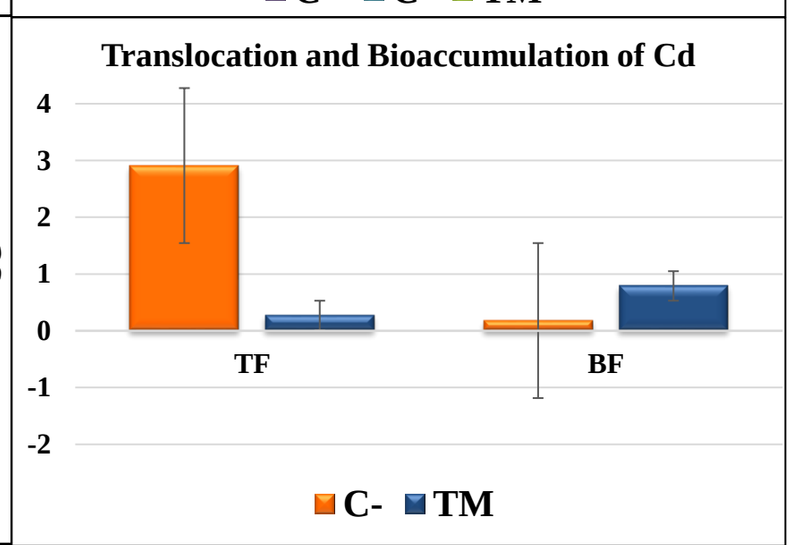
Extraradical and intraradical colonization of AMF with spores

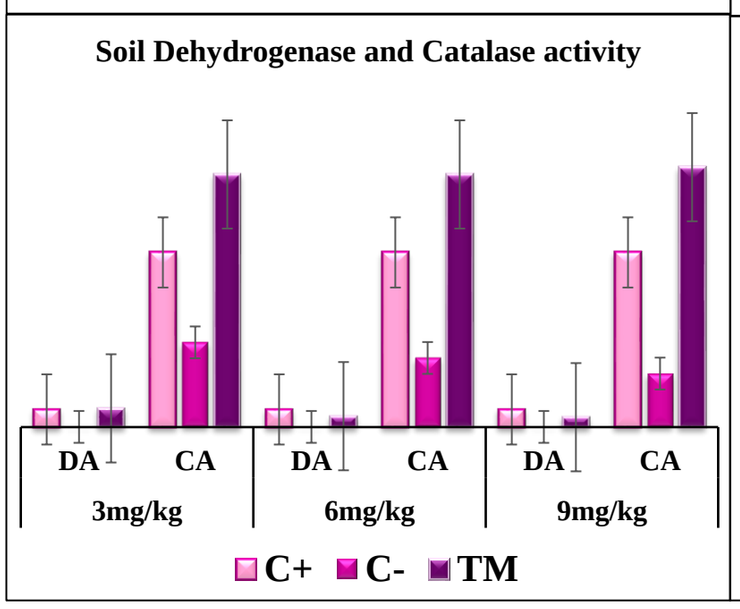
RESULTS

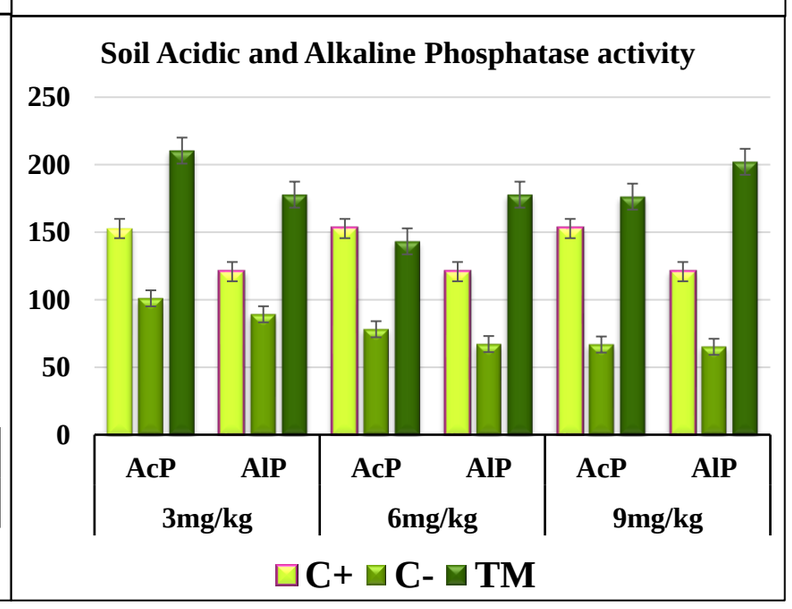












The bar charts highlight significant differences in Cd uptake, plant growth, and enzymatic activity between inoculated and non-inoculated *Albizia lebbeck* seedlings, reinforcing AMF's role in phytostabilization. By colonizing the rhizosphere and plant roots, AMF enhances growth and improves tolerance to Cd stress, demonstrating its effectiveness as a natural bioremediation strategy.

CONCLUSION AND FUTURE ASPECTS

- ❖ The findings of this study suggest that AMF inoculation not only enhances plant growth but also contributes to Cd stabilization, offering a promising approach for restoring Cd-polluted soils.
- ❖ Future field studies should assess its long-term effectiveness and ecological impact under different heavy metal contamination.

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