College of Agriculture & Environmental Sciences

Sustainable Agroecological Solutions Using Salt-Tolerant Plants and Brine Irrigation in Arid Regions

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INTRODUCTION

The escalating severity of prolonged droughts driven by climate change has dramatically accelerated desertification processes, especially in arid regions. As a result, freshwater resources are depleting at an alarming rate, surpassing critical thresholds and creating serious challenges for food security—both for human consumption and agricultural irrigation. In response, water desalination has emerged as a viable and increasingly favored solution in areas where freshwater is scarce. However, the environmental risks associated with brine discharge—such as increased soil salinization and long-term damage to soil ecosystems—pose significant challenges to its sustainability.

MATERIALS AND METHODS

To address these issues, we developed a pioneering long-term experimental trial to explore the potential of agroecological engineering strategies for enhancing soil health.

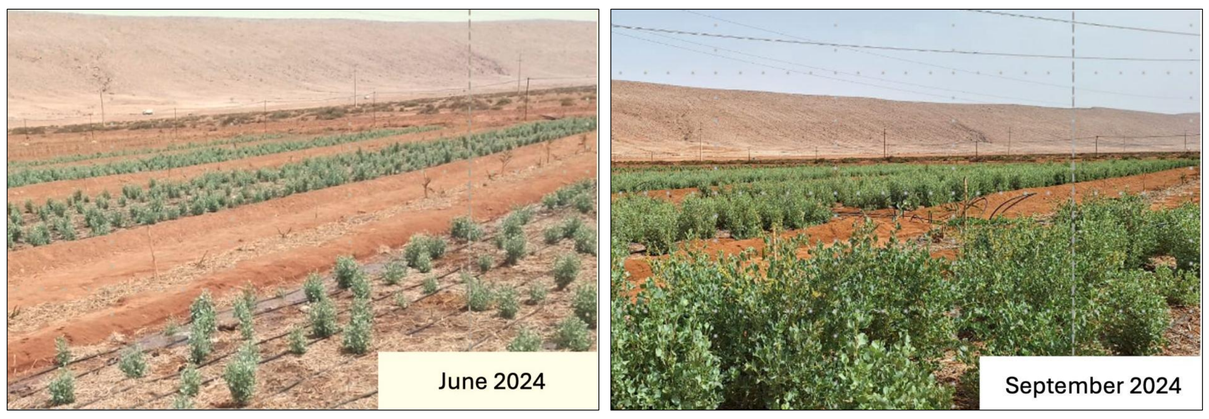

Fig. 1. Long-term experimental trial of Rass Oumlil (Morocco). A highly arid region situated between Guelmim and Tan-Tan, where annual rainfall averages less than 60 mm.

Our approach leverages salt-tolerant plants, including *Atriplex halimus* and *Opuntia ficus-indica*, to repurpose brine as an alternative water resource while simultaneously producing food for both humans and livestock in arid environments.
The salt-tolerant plants were irrigated from a desalination unit, primarily with brine—at times reaching conductivity levels above 30 mS/cm—interspersed with occasional freshwater applications.

Fig. 2. Solar-powered Mascara Osmosun desalination unit, producing 6 m³/h

RESULTS

Water parameters

Rass Oumlil groundwater was extracted and treated in the desalination unit. Results showed a concentration of a wide range of trace elements excepted Mg, Si and Zn. The concentration of As and P was observed in higher concentration in freshwater than in brine. As expected the concentration of Na is higher in brine, than in Groundwater and freshwater.

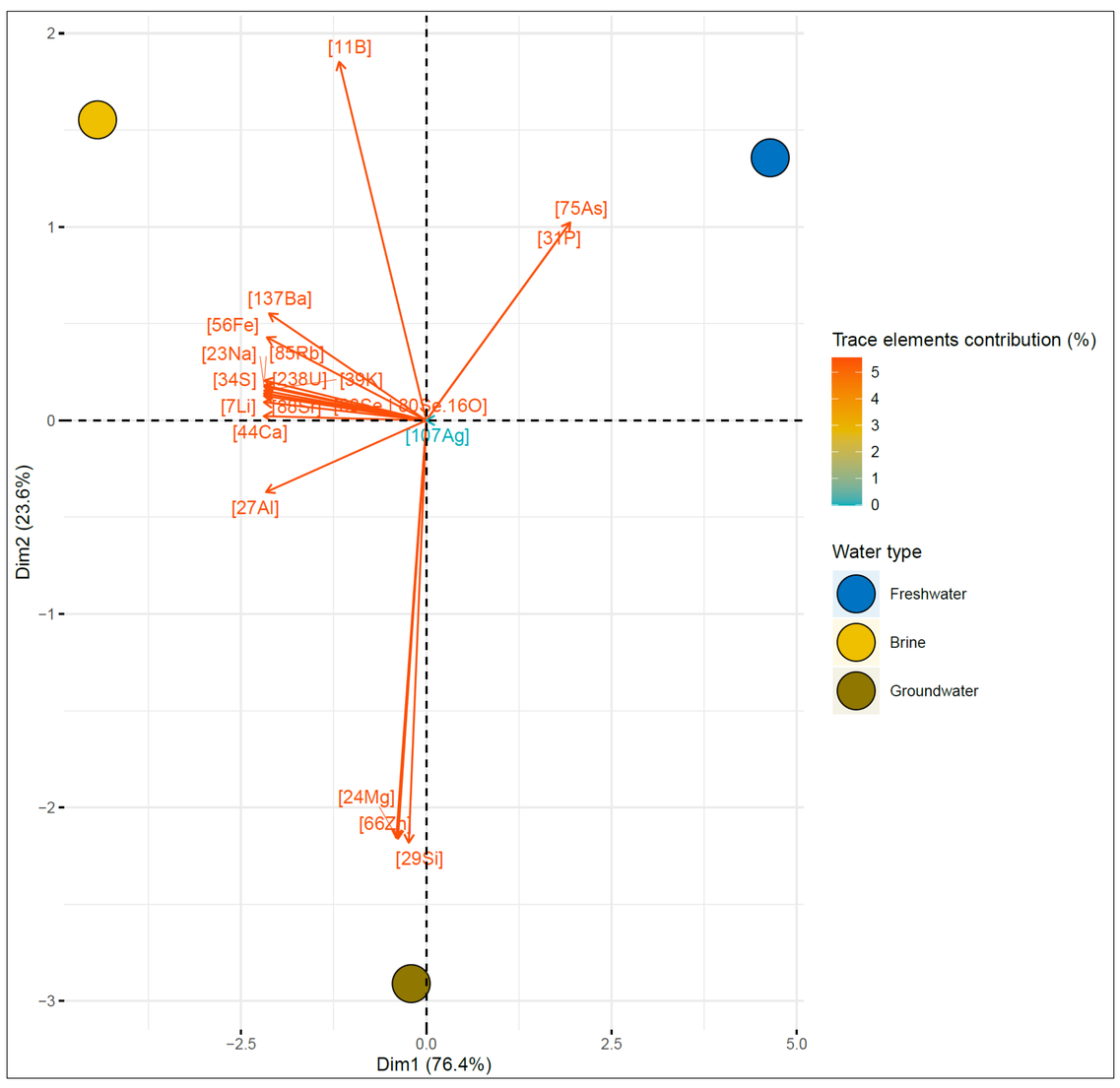

Fig. 3. Water analysis of trace elements in Rass Oumlil groundwater, and freshwater or brine after desalination process

Mycorrhizal parameters

The impact of brine used as water resource for *Atriplex halimus* and *Opuntia ficus-indica* culturing was evaluated on soil mycorrhizal density. The presence *Atriplex halimus* highly improved the spore mycorrhizal abundance in soils compared to *O. ficus-indica.* Interestingly, brine does not have a negative impact on mycorrhizal abundance in soils.

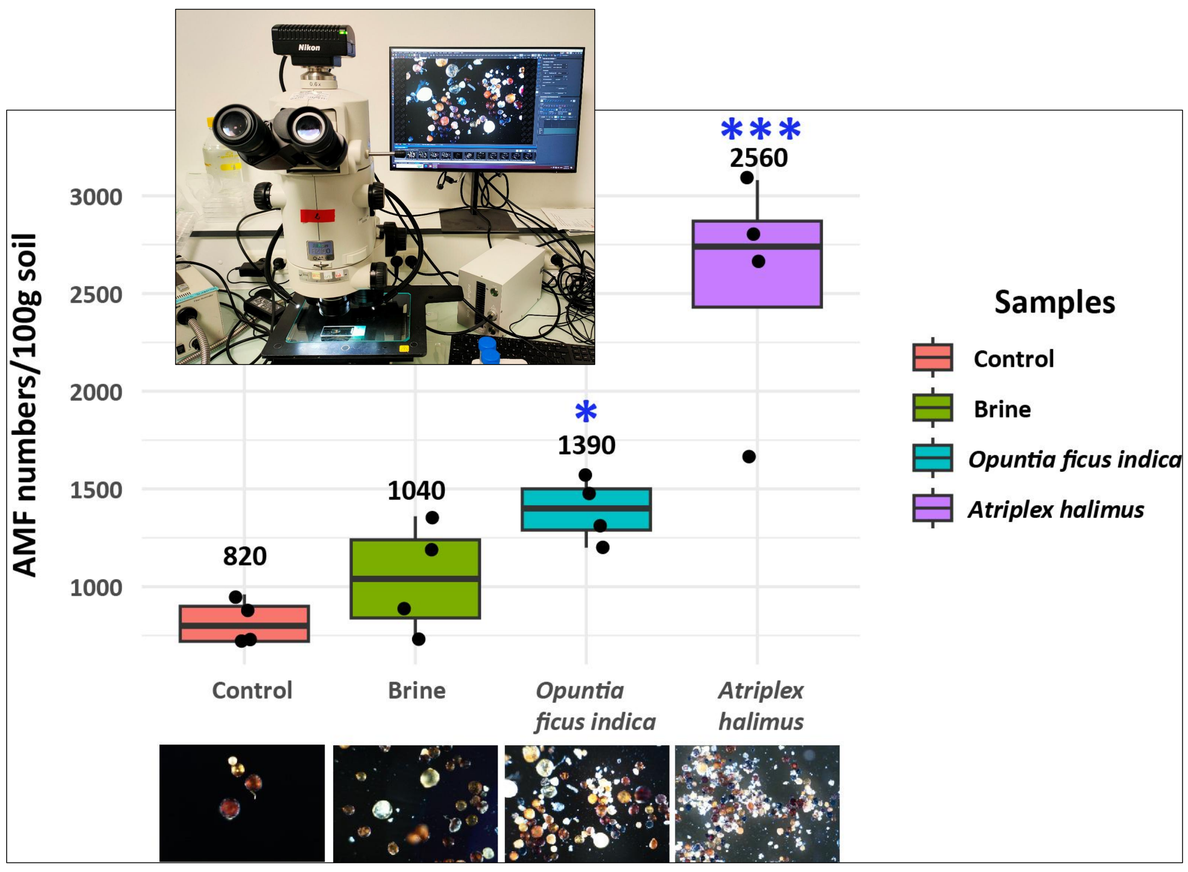

Fig. 4. Estimation of soil mycorrhizal spore abundance in Rass Oumlil experimental trial.

Perspectives

Soil microbiota sequencing (Bacteria + Fungi) is in progress from 60 soil samples (*Atriplex halimus* + brine, Opuntia ficus-indica + brine, brine, bulk soil), as well as the determination of soil parameters. Trace ellements in soils will also be investigated to monitor their dynamic in the trial.

CONCLUSION

The brine-mediated agricultural trial in Rass Oumlil is producing encouraging results with a high biomass of crops, but also an increase of soil mycorrhizal abundance, a key player in soil fertility. The future data on soil microbiota should provide a more robust picture of brine effects on soil functioning. Based on these preliminary results, other crops of interest are going to be evaluated for brine-mediated agriculture and a routine evaluation of soil indicators implemented with a mobile lab.

STAY TUNED !!!

The best is still to come