Isolation and Characterization of Plant-Growth Promoting Bacteria from Olive Tree Cultivated Under Desert Farming in Saudi Arabia

Kholoud Sefreji, Ramona Marasco, Faisal Al-Khwaiter, Anas Rawas, Sara Al-Romaih, Daniele Daffonchio

Biological and Environmental Sciences and Engineering Division, King Abdullah University of Science and Technology, Thuwal, Saudi Arabia

Background

While under mild abiotic stress conditions plants rely on the ability to adjust their physiology to secure survival, under abrupt circumstances they are no longer able to efficiently face the stress with drastic consequences for their survival [1]. Under these challenging conditions, the **adaptive response** of the **plant** can be **supported** and **enhanced by beneficial plant growth promoting (PGP) microorganisms** that are actively recruited by the plant itself from the surrounding soil [2,3]. Such plant-microorganisms cooperation is even more important under climate change, when agricultural land experiences reduced rainfall and increasing drought and temperatures [4].

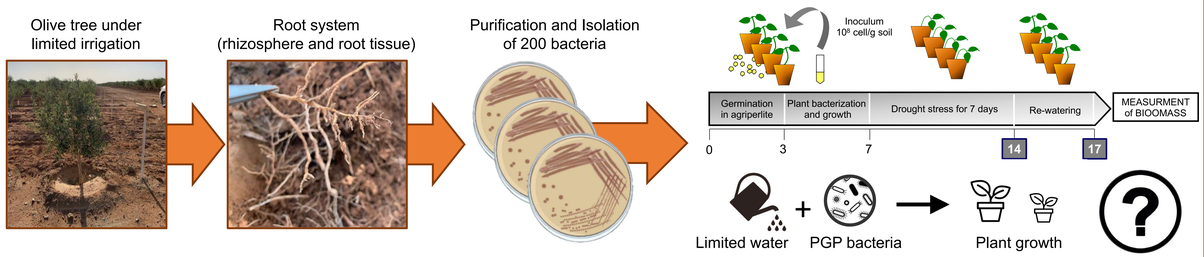
Hypothesis and Aim

Aridity forces the **plants** to modify their edaphic niche (rhizosphere and root surrounding soil) to **attract beneficial microbes** more adapted to stressful environmental conditions and able to support the holobiont homeostasis, in a **'win-win' interaction mechanism**. Thus, **plants** growing in the dry soils of **Saudi Arabia** represent a valuable **source** for **new PGP microorganisms**.

Isolation of **cultivable bacteria** associated with the **root system** of **olive trees** (*Olea europea* L.) cultivated in **desert agroecosystems** of **Al Jouf** (Saudi Arabia) to select PGP bacteria (i) naturally adapted to harsh and stressful conditions typical of arid lands, (ii) capable to colonize plant root system, and (iii) able to protect plant under drought stress.

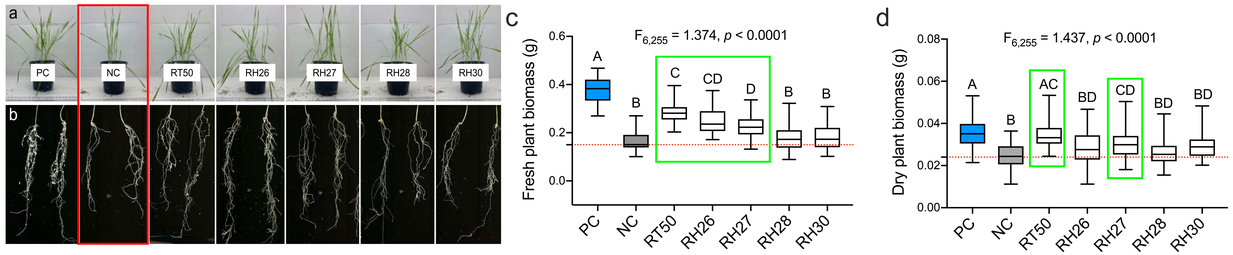
Material and Methodology

- **Isolation, purification, and identification of bacteria.** Root tissue and rhizosphere of xerophytic olive tree [5] have been used as starting material to cultivate bacteria.
- ***In vitro* and *in vivo* analyses.** Evaluation of (i) **abiotic stress tolerance** and (ii) **PGP potential** under controlled conditions.



Data analysis and Results

Among the bacteria isolated, five were identified as *Bacillus pumilius* (RT50), *Pseudarthrobacter oxydans* (RH26), *Kocuria sediminis* (RH27), *Arthrobacter subterraneus* (RH28) and *Pseudomonas reineke* (RH30).



- From the *in vitro* analyses, the bacteria showed **multiple PGP traits differentially distributed** across them.
- The selected **PGP bacterial strains promote plant biomass** and **favored** the **development** of **the root system under drought** (7 days without irrigation; panels a and b).
- Plants treated with RT50 showed an **increment** of the **fresh and dry biomass** of **68.4% and 94.8%**, respectively, compared to the negative control (NC) with values **similar to those of irrigated plants** (PC) as showed in panels c and d.

Conclusion

The bacteria isolated in this study had multiple beneficial PGP traits that are carried and expressed during the interaction of these microbes with the host plant. Indeed, these beneficial bacteria can contribute to plant fitness and adaptation to water limitations, typically occurring in arid lands of Saudi Arabia. This study proposes a **methodological approach** for the **isolation** and **characterization** of **beneficial PGP bacteria** able to sustain plant growth during drought. At the same time, the results obtained in this work confirm that plants growing in arid ecosystems are important sources of microbes that can be used as **nature-based solutions** to **support desert farming** in Saudi Arabia and arid countries in a sustainable way.

Application

The characterized isolates lead to the selection and proposal of **efficient inocula for plant cultivation** under water deficit conditions in Saudi Arabia. **Planting trees** with the **minimum use of freshwater** is a strategic option in line with **Saudi Green Initiative** and **Saudi Vision 2030**.

SAUDI GREEN INITIATIVE

References

[1] Berdugo *et al.*, 2020 *Science* 367:787-790; [2] Trivedi *et al.*, 2020 *Nat. Rev. Microbiol.* 18:607-621; [3] Soussi *et al.*, 2016 *Plant Soil* 405:357-370; [4] Hu *et al.*, 2021 *Nat. Commun.* 12:5350; [5] Brito *et al.*, 2019 *Plants* 8:232.