THE ROLE OF MICROBIAL INOCULANTS ON PLANT GROWTH PROMOTION

Sofia I.A. Pereira, Albina Franco, Ana P.G.C. Marques, Helena Moreira, Nadine R. Sousa, Miguel Ramos and Paula M.L. Castro

CBQF/Escola Superior de Biotecnologia, Universidade Católica Portuguesa, R. Dr. António Bernardino de Almeida, 4200-072 Porto, Portugal
plcastro@porto.ucp.pt

CATÓLICA PORTO
BIOTECNOLOGIA

Aims and Scope

Plant growth promoting rhizobacteria (PGPR) is a group of rhizosphere-colonizing bacteria producing substances which increase the growth of plants and/or protect them against pathogens. These bacteria are significant to agricultural purposes, but they also play an important role in soil restoration by enhancing growth and successful establishment of plants in stressed soils. They also have the potential to be mycorrhizal helper bacteria (MHB), enhancing their importance on forest management.

At ESB we have been conducting work on the isolation and application of bacterial strains for promoting plant growth in disturbed soils; we have been also conducting research on co-inoculation of bacteria and mycorrhizal fungi (MF) for improving reforestation of forest soil, as biotechnological tools.

Results and Discussion – Case studies

Plant growth promoting traits

- ✓ ca. 40 isolates retrieved from metal contaminated soils with PGP traits
- ✓ In general isolates produced NH_3, siderophores and HCN
- ✓ Only 7 isolates had positive results for phosphate solubilization
- ✓ IAA and ACC-deaminase activity were detected in all tested rhizobacteria, however at different rates

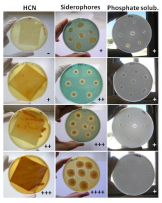


Fig. 1 Cyanide (HCN) production; Siderophore production detected as halos surrounding colonies of isolates on CAS medium; Phosphate solubilizing bacteria; (-) negative; (+) positive; (++) good; (+++) very good; (++++) extremely good production.

Effect of PGPR on *Trifolium repens* growth

➢ Biomass

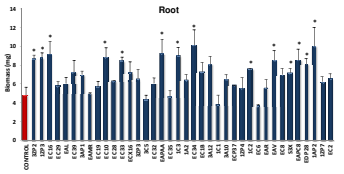


Fig.2 Influence of PGPR on root biomass (mg) of *Trifolium repens* plants. Results are expressed as means ± SE (n=3-5). * means are significantly different (P< 0.05) from control

- ✓ The root dry biomass was influenced by rhizobacteria
- ✓ EC34 and 1AP2 belonging to *Rhodococcus erythropolis* and *Achromobacter* sp. increased root biomass production by 112% and 110%
- ✓ Other isolates belonging to *Microbacterium* (3ZP2), *Cupriavidus* (1C2), *Pseudomonas* (EAV) and *Arthrobacter* (EC10, EAPAA) genera have also promoted root biomass

➢ Elongation

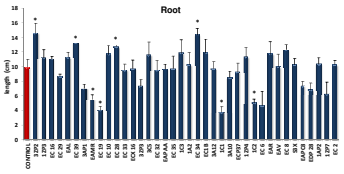


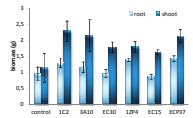
Fig. 3 Influence of PGPR on root elongation (cm) of *Trifolium repens* plants. Results are expressed as means ± SE (n=3-5). * means are significantly different (P< 0.05) from control

- ✓ Several isolates belonging to *Microbacterium* (3ZP2), *Bacillus* (EC39), *Rhodococcus* (EC34) and *Arthrobacter* (EC28) significantly (P<0.05) promoted root elongation

- ✓ Plant growth promotion was related to bacterial traits: IAA, HCN and siderophore production
- ✓ IAA levels were positively correlated to root biomass and root elongation

Zea mays with PGPR innocula - growth in soil

➢ Biomass



➢ Elongation

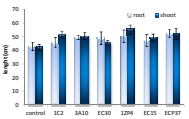


Fig. 4 Biomass (g) and elongation (cm) of *Zea Mays* roots and shoots inoculated with PGPR belonging to *Ralstonia, Sphingobacterium, Bacillus, Achromobacter* and *Cupriavidus* genera and non-inoculated plants (control)

- ✓ All the isolates promoted elongation when compared to control plants; the isolates that better performed were 1ZP4 (*Sphingobacterium*), ECP37 (*Chryseobacterium humi*) and 1C2 (*Cupriavidus*)
- ✓ The isolates 1C2 and ECP37 promoted root and shoot biomass production.

➢ N and P levels in root and shoot

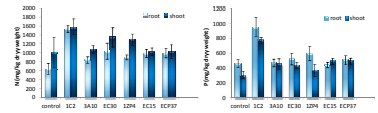


Fig. 5 N and P levels in *Zea mays* roots and shoots, inoculated with PGPR belonging *to Ralstonia, Sphingobacterium, Bacillus, Achromobacter,* and *Cupriavidus* genera and non-inoculated plants (control).

- ✓ 1C2 was the strain that most promoted root and shoot P and N levels

PGPR and MF as promoters of *Betula pubescens*

➢ Forest soil

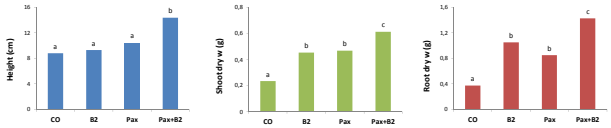


Fig. 5 Shoot height, shoot and root dry weight of *Betula pubescens* seedlings inoculated with the rhizobacteria *Mesorhizobium* sp. (B2), mycorrhyral fungi *Paxillus involutus* (PAX) and non-inoculated control (CO), growing in forest soil. Columns marked with different letters differed significantly (P <0.05)

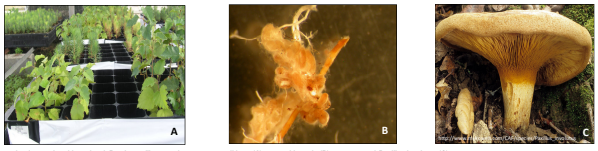


Fig. 7 Example of control and inoculated *Betula* seedlings, under nursery conditions (A); mycorrhizae tip (B); sporocarp of *Paxillus involutus* (C).

- ✓ In forest soil, the combination of a PGPR (*Mesorhizobium*) and a MF (*Paxillus involutus*) significantly increased seedling growth in all parameters studied
- ✓ Further studies are needed to understand how bacteria-fungi could help plant performance and nutrition of outplanted seedlings, under stress conditions

Conclusions

✓ The co-inoculation of plants with PGPR and micorrhyzal fungi can represent a successful strategy as a replacement for the use of fertilizers and pesticides

On going work ….

At the moment we are searching for endophytes within the same sites with similar abilities to be applied in association with PGPR and MF, aiming to improve plant growth under environmental stress conditions

Acknowledgements

Sofia Pereira, Albina Franco, Ana Marques, Helena Moreira thank to Fundação para a Ciência e Tecnologia the grants SFRH/BPD/65134/2009, SFRH/BD/47722/2008, SFRH/BPD/34585/2007, SFRH/BD64584/2009. This work was supported by the FCT Projects PTDC-AGR-CFL-111583-2009 and PEst-OE/EQB/LA0016/2011 and Fundo Social Europeu (III Quadro Comunitário de Apoio). The authors also thank to COST FA1103: Endophytes in Biotechnology and Agriculture ..

FCT Fundação para a Ciência e a Tecnologia
MINISTÉRIO DA CIÊNCIA, TECNOLOGIA E ENSINO SUPERIOR Portugal
POPH
QREN
UNIÃO EUROPEIA Fundo Social Europeu