# *Pseudomonas chlororaphis* as a potential Plant Growth Promoting Rhizobacteria for enhancing barley performance under drought stress

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## Background

Barley (*Hordeum vulgare L.)* is the fourth cultivated cereal crop in the world, and its important is due to its economic and nutritional value. The increase of drought events represent a major issue for agronomical and global food security for barley (Ferioun et al., 2023).

Plant growth promoting rhizobacteria (PGPR) could very well achieve the goal of sustainability in agriculture without affecting the yield. Due to their diverse nature and activity on the plants, PGPR can play direct or indirect role (**Fig. 1**) in improving the growth of plants, the yield, and crop tolerance to abiotic stress events.

The **aim** of the present study was to evaluate the interaction between strategies (Ali et al., 2022) using inoculation of six barleys with *Pseudomonas chlororaphis* spp. *aureofaciens* under drought stress in controlled condition .

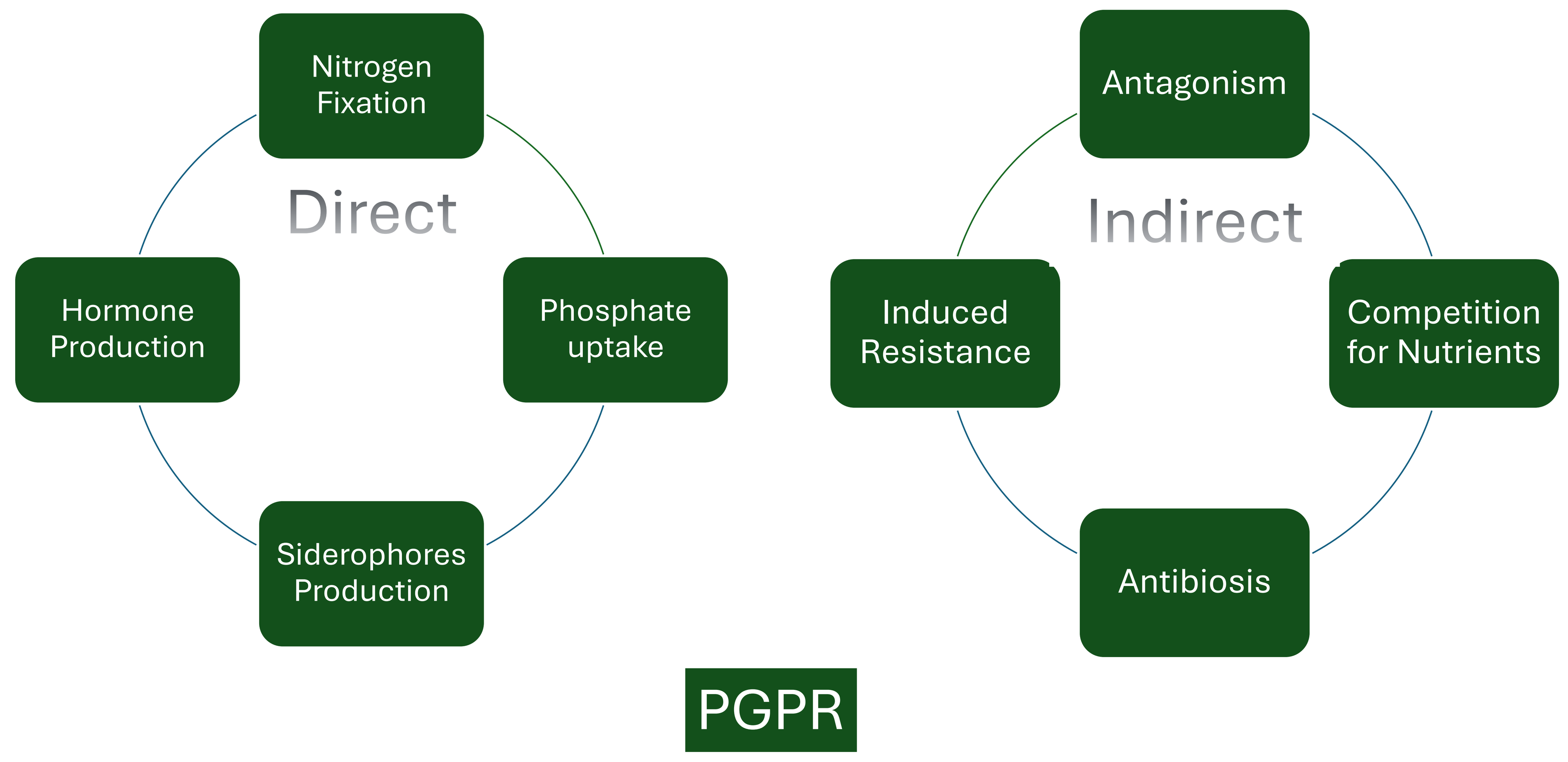


**Figure 1**
Direct and indirect benefits of PGPR inoculation.

## Materials and Methods

The selected cultivars are facultative (Lunet and Pamina), spring (Tremois and Morex), and winter (Nure and Ponente) growth habit genotypes. A randomized complete design (**Fig. 5**) was applied, with two treatments (inoculated and non-inoculated; **Fig. 6**), and two irrigation regimes (soil moisture at 20% and 40% as stress and control conditions, respectively). Twelve biological replicates per genotype were considered. Seeds of barley were inoculated at sowing in pots (12 cm x 14 cm) with *P. chlororaphis* spp. *aureofaciens* ($1 \times 10^9$ CFU/mL), and plants were kept at control conditions (16 h / 8 h day/ night; 24 °C day and 19 °C night). Drought stress was applied fourteen days after sowing. The growth of seedlings was monitored, and morphological and physiological traits were recorded. Two weeks after the application of drought the plants were harvest for biomass evaluation (**Fig. 2**).

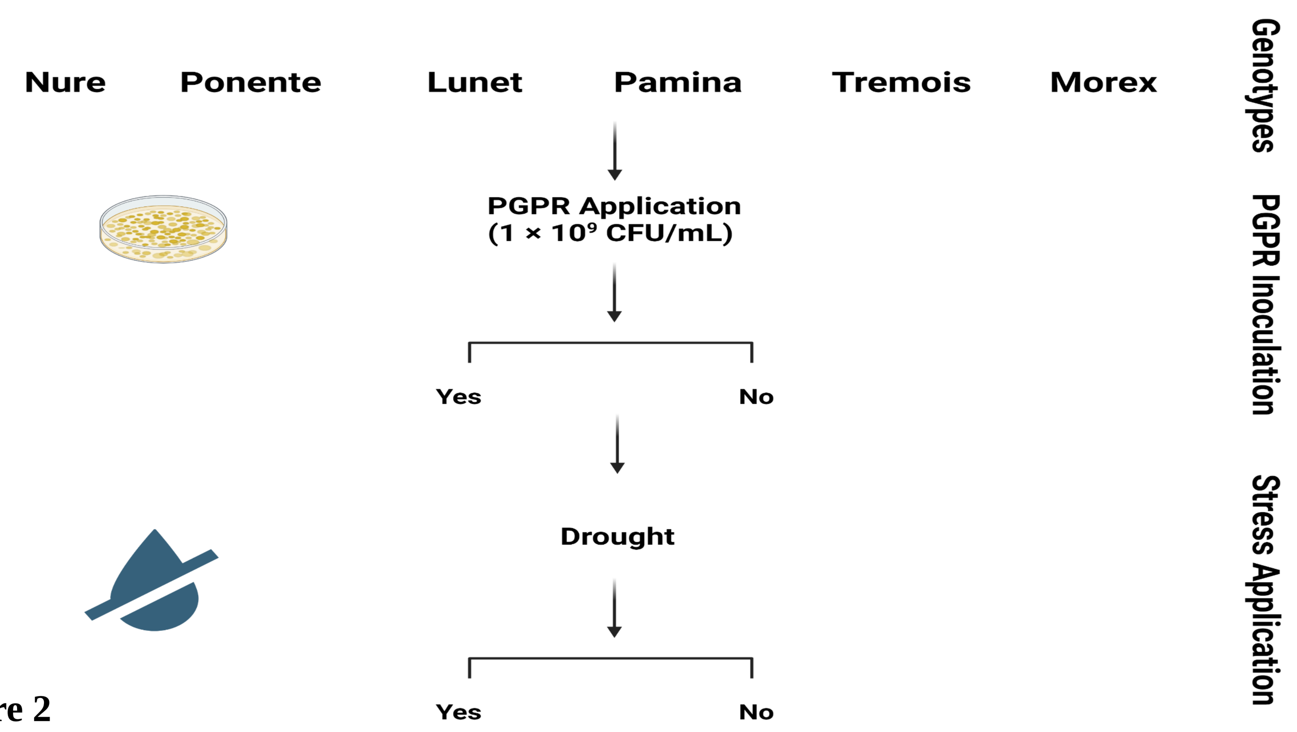


**Figure 2**
Experimental design.

## Results

Various morphological and physiological parameters were significantly improved by bacterial application under drought vs. no stress: height (+3.6%), leaf chlorophyll (+17.5%), root fresh weight (+63.8%) and dry weight (61%), plant fresh weight (+37%) and dry weight (+28.8%, **Fig. 3**).

Significant interactions among factor (Genotype, Stress and Treatment) influenced some traits (i.e., plant height, dry weight of root and shoot, Water Use Efficiency). Considering the dry weight of plants the best results were achieved by inoculated plants without drought stress followed by plants without inoculation and without drought stress, inoculated plants under drought stress and plant without inoculation and under drought stress (**Fig. 2**). Genotypes Nure and Morex showed the highest values of WUE when inoculated with *P. chlororaphis* spp. *aureofaciens* (**Fig. 4**).

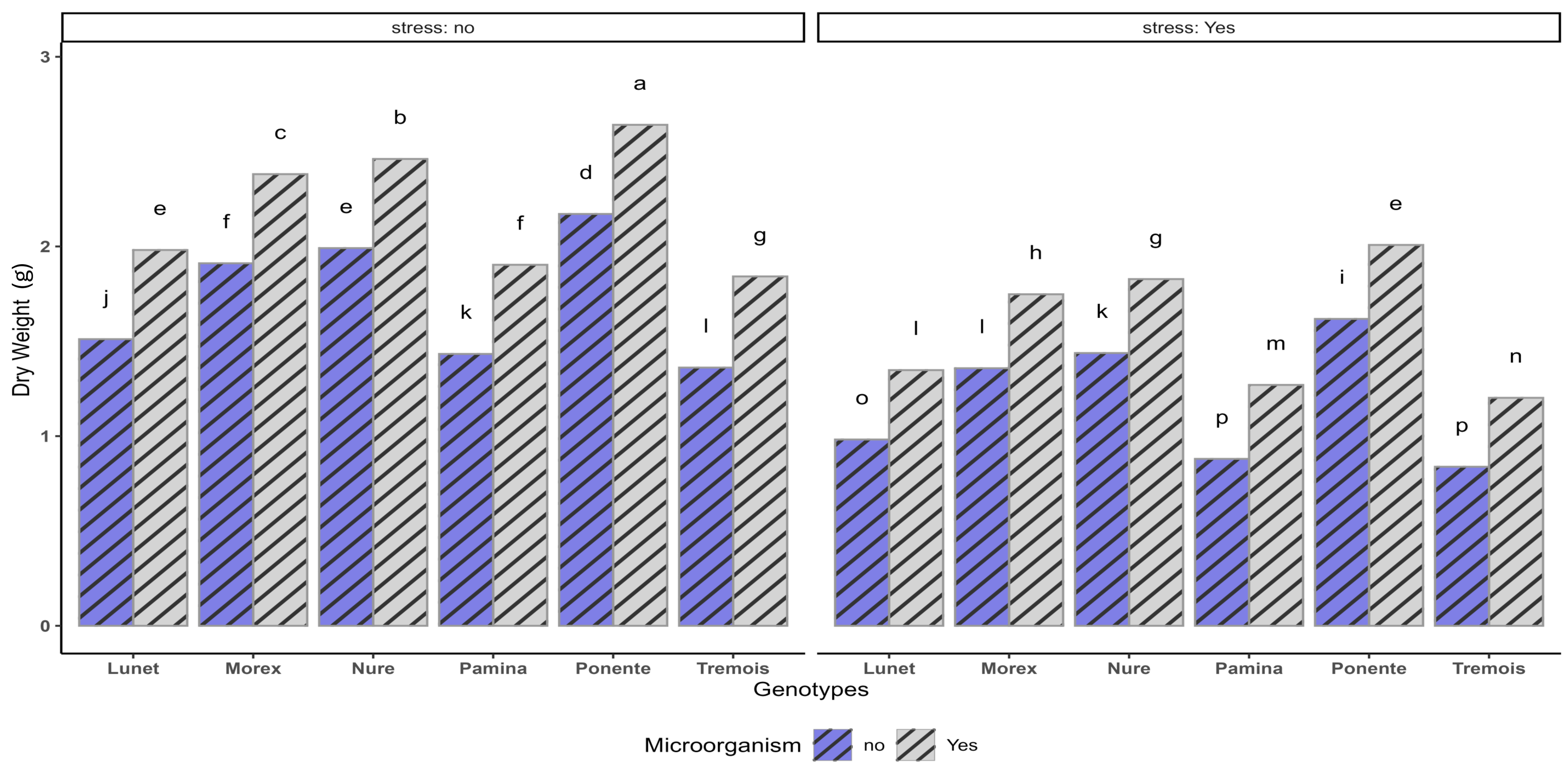


**Figure 3**
Effect on dry weight with the microorganism application on genotypes in stress vs. no stress conditions. Data are expressed as mean±SD and were subjected to three-way ANOVA followed by Duncan's multiple range test. Different letters indicate significant difference at $P < 0.05$.

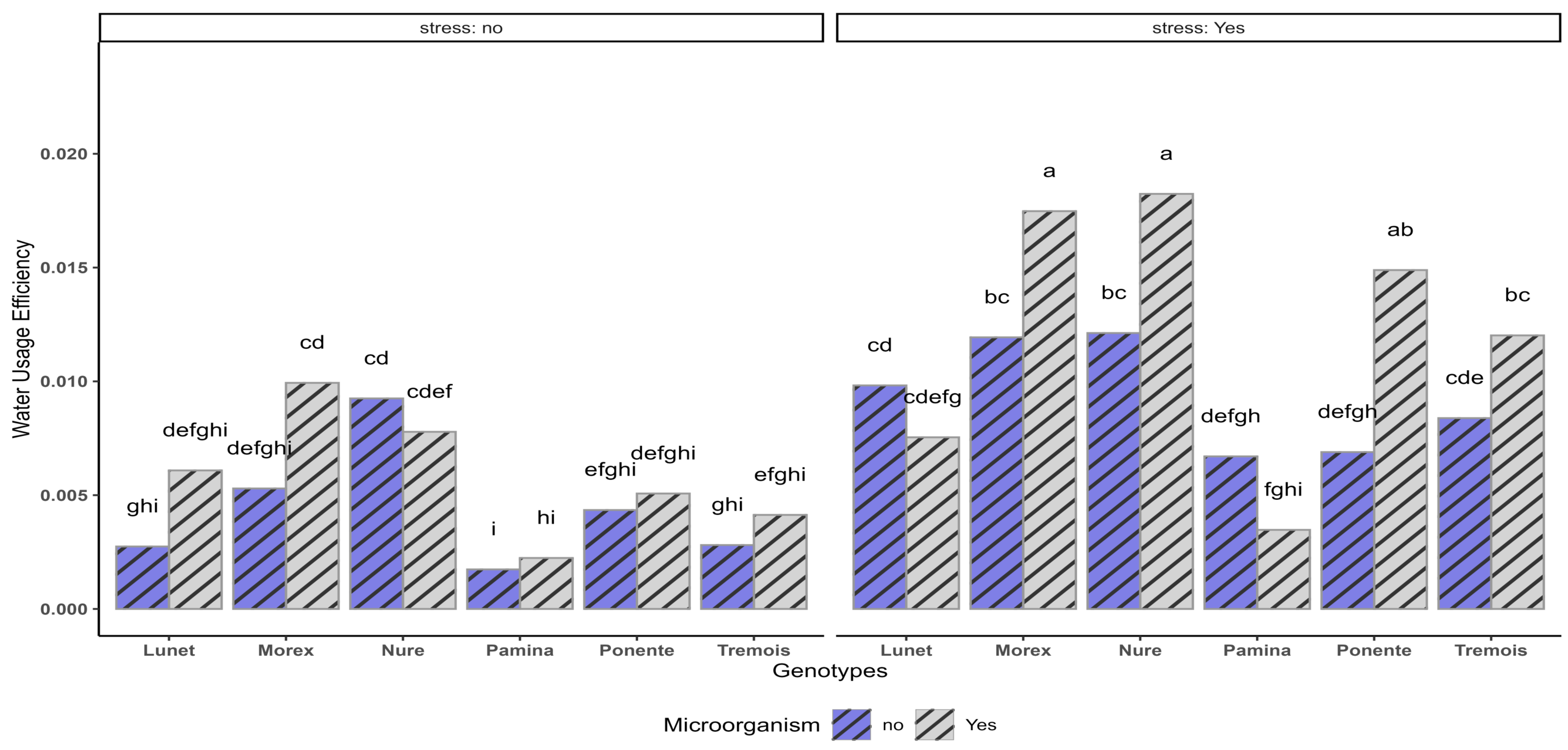


**Figure 4**
Effect of microorganism application on WUE between genotypes under drought vs. no stress conditions. Data are expressed as mean±SD and were subjected to three-way ANOVA followed by Duncan's multiple range test. Different letters indicate significant difference at $P < 0.05$.

**Figure 5**
A picture of experimental setup in growing chamber.

## Conclusion

Our results show that *Pseudomonas chlororaphis* subspecies *aureofaciens* has the potential to ameliorate drought tolerance in barley. However, considered the interactions between genotype and treatment observed, a wider sample of genotypes should be evaluated.

The effect of treatment with this potential PGPR will also be tested under open field conditions to evaluate the ability of *P. chlororaphis* spp. *aureofaciens* to influence the whole crop performance.

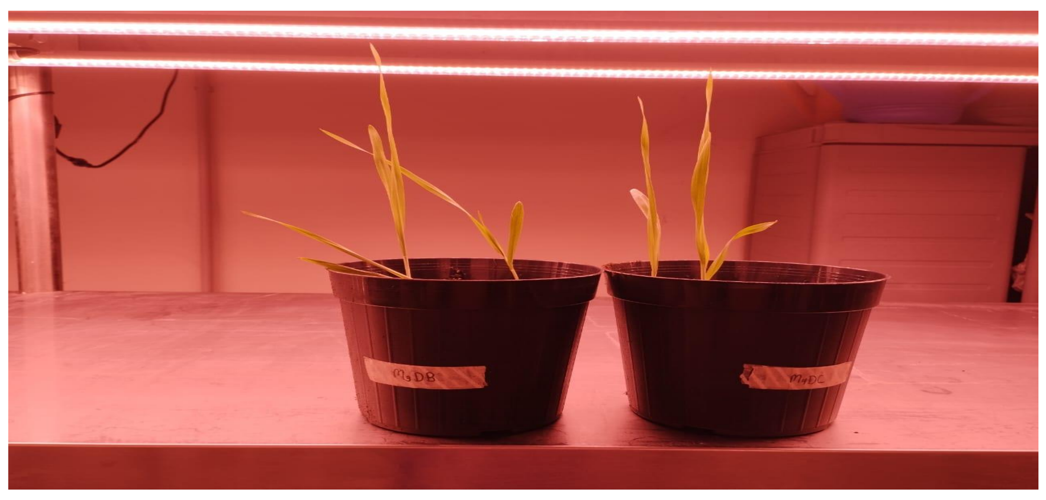

**Figure 6**
Inoculated Morex plants under drought stress and untreated plants under drought stress.

## References

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