Novel strain of soil microbe *Peribacillus frigoritolerans* shows plant growth-promoting potential in barley (*Hordeum vulgare*)

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Introduction

Plant growth-promoting microbes (PGPM) as biofertilizers

- PGPM can **improve plant growth** and resilience to stress[1]
- For example, PGPM can increase the bioavailability of nutrients in the soil[2]
- PGPM may be an **alternative to chemical fertilizers** which have unwanted effects on the environment[3]
- Applying PGPM can help respond to the large demand for **more productive agriculture**

Barley and PGPM

- Barley is an economically important Canadian crop[4], but a limited number of PGPM strains have been applied to barley

Can any of these novel bacterial strains increase barley growth and yields?

Methods

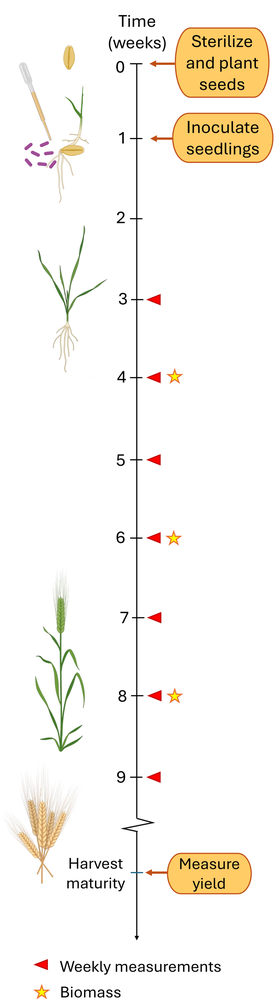

Figure 1. Experimental timeline. Weekly measurements of stem length, chlorophyll concentration, stem width, and leaf width were taken from week 3 to 9. Biomass was measured on weeks 4, 6, and 8.

Microbe inoculant treatments

- *Bacillus pumilus* (Bp)
- *Metabacillus indicus* (Mi)
- *Paenibacillus* sp. (Pn)
- *Peribacillus frigoritolerans* (Pf)
- *Arthrobacter* sp. (Ar)

Control treatments (no inoculants)

- Half strength Hoagland's fertilizer (½C)
- Full strength Hoagland's fertilizer (1C)

Inoculation

Seedlings were inoculated after 1 week with 1 mL of inoculum each at about 10^8 CFU/mL.

Biochemical assays

- Nitrite production
- Nitrate production
- Ammonia production

Results

Barley inoculated with *P. frigoritolerans* developed faster

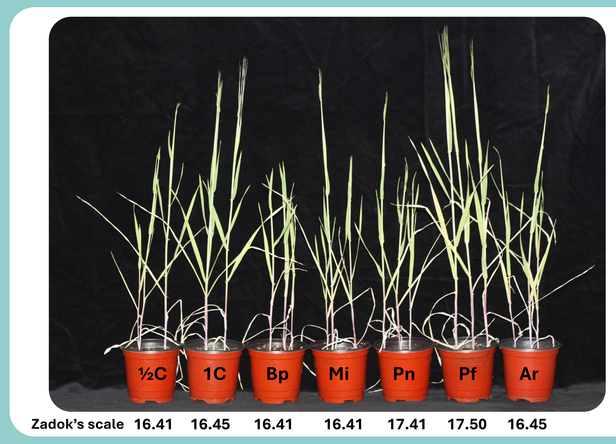

Figure 2. Barley plants 7 weeks after sowing with Zadok's scale for cereal crop development[5] shown below each plant.

Barley inoculated with *P. frigoritolerans* had greater masses

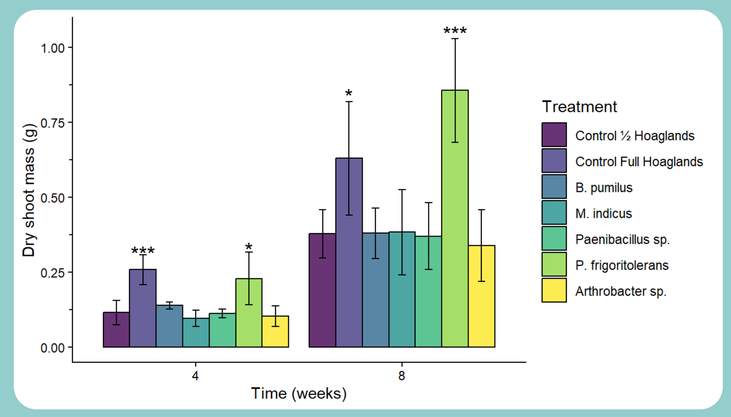

Figure 3. Barley fresh shoot masses. N = 6. Asterisks (*) indicate significant differences based on a one-way student's t-test compared to the control ½ Hoagland's treatment group. Significance codes: * p < 0.05, ** p < 0.01, *** p < 0.001

Barley inoculated with *P. frigoritolerans* had higher chlorophyll concentrations

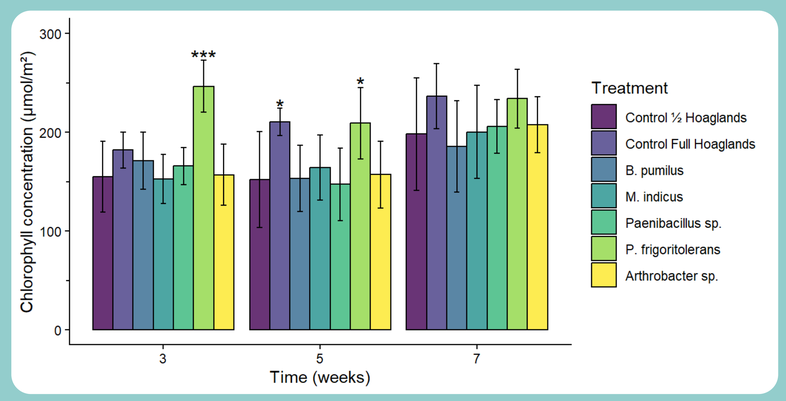

Figure 4. Barley leaf chlorophyll concentrations. N = 6. Asterisks (*) indicate significant differences based on a one-way student's t-test compared to the control ½ Hoagland's treatment group. Significance codes: * p < 0.05, ** p < 0.01, *** p < 0.001

P. frigoritolerans and *Arthrobacter* sp. can produce nitrite

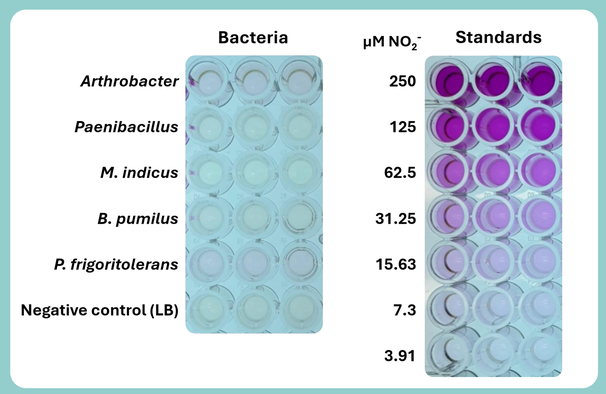

Figure 5. Biochemical test for nitrite production on bacteria in LB. Both *Athrobacter* sp. and *P. frigoritolerans* appeared to produce nitrite at a concentration of about 5 µM.

Barley inoculated with *P. frigoritolerans* had greater grain yields

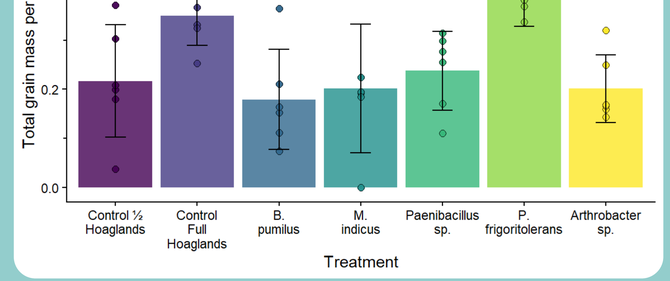

Figure 6. (**A**) Barley total grain masses per plant. N = 6. Asterisks (*) indicate significant differences based on a one-way student's t-test compared to the control ½ Hoagland's treatment group. Significance codes: * p < 0.05, ** p < 0.01, *** p < 0.001. (**B**) Barley spikes at harvest maturity (87 days).

Conclusion

Inoculating barley with *P. frigoritolerans* may increase their growth rate based on several morphological measurements, possibly due in part to its production of nitrite.

Next Steps

Future experiments will investigate the effects of *P. frigoritolerans* and other **bacteria applied in consortia** to barley with and without **abiotic stress** such as waterlogging.

This research can help **increase the efficiency of Canadian agriculture** and further our understanding of plant-microbe interactions.

1. Khaskheli, M. A. et al. (2025). Chapter 20—Potential of soil associated plant growth-promoting microbes in improving the abiotic-stress resilience of agricultural crops. In *Role of Antioxidants in Abiotic Stress Management* (pp. 333–362). Academic Press.
2. Hasan, A. et al. (2024). Role of Plant Growth Promoting Rhizobacteria (PGPR) as a Plant Growth Enhancer for Sustainable Agriculture: A Review. *Bacteria*, *3*(2), 59–75.
3. Ward, M. H. (2009). Too Much of a Good Thing? Nitrate from Nitrogen Fertilizers and Cancer. *Reviews on Env Health*, *24*(4), 357–363.
4. Izydorczyk, M. S. & McMillan, T. (2024). *Quality of western Canadian barley in 2024: Summary, conditions, and production.*
5. Brook, H., & Cutts, M. (2020). *Crop protection 2020.* Alberta Agriculture and Forestry.