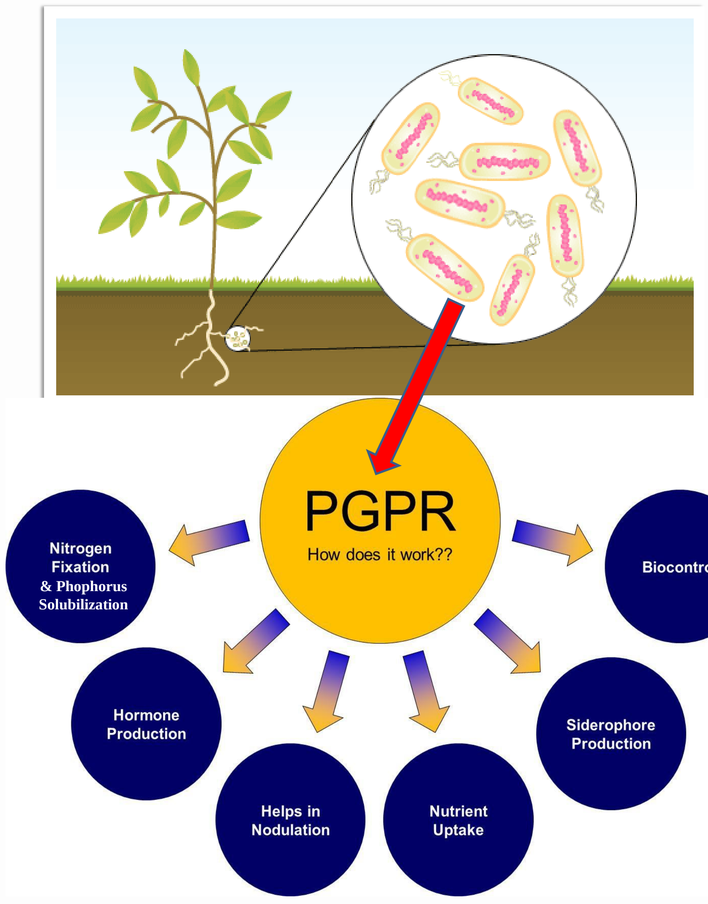
Impacts of Plant Growth-Promoting Rhizobacteria on Wheat Growth under Greenhouse and Field Conditions

Minh Luan Nguyen[1], Bernard Bodson[2], Gilles Colinet[3], Haïssam Jijakli[4], Marc Ongena[5], Micheline Vandenbol[6], Patrick du Jardin[1], Stijn Spaepen[7], & Pierre Delaplace[1]

University of Liège, Gembloux Agro-Bio Tech: [1]Plant Biology, [2]Crop Science and Experimental Farm, [3]Soil Science, [4]Phytopathology, [5]Bio-Industries, [6]Animal and Microbial Biology,
[7]Plant Microbe Interactions, Max Planck Institute for Plant Breeding Research

Introduction

Plant Growth-Promoting Rhizobacteria (PGPR)[1, 2, 3] are well-known for stimulating root growth, enhancing mineral availability, and nutrient use efficiency in crops, and therefore become promising tool for sustainable agriculture. In addition, PGPR are one of the main classes of plant biostimulants[4].

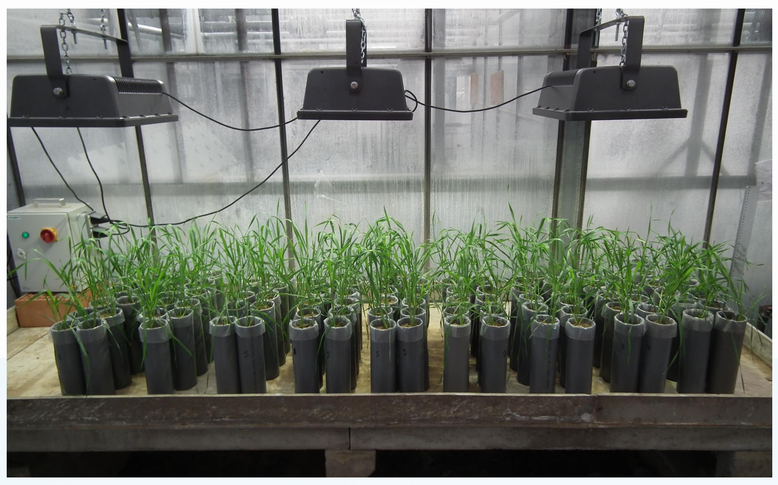


Objective

1. The aim of this study is to screen PGPR strains to enhance wheat growth and yield in combination with an optimised nitrogen (N) fertilizer dose, and thus finally reduce the use of N fertilizer without decreasing the yield compared to the full recommended N dose. The application method (e.g. seed coating, spraying) and the application growth stage will be optimized.
2. Development of relevant research protocols:
   - ➢ To assess the impacts of PGPR on plant growth and yield in greenhouse and field conditions.
   - ➢ To assess the impacts of PGPR on the microbial communities in the wheat rhizosphere.
   - ➢ To figure out the best agronomical practices to stimulate the beneficial microbial communities.

Materials & methods

- ➢ **PGPR strains** include in-house strains (*Bacillus pumilus* C26, *B. subtilis* AP-305-GB03, *Enterobacter cloacae* AP-12-JM22) and 5 commercial PGPR-containing products [(1) TwinN (diazotrophic bacteria); (2) NitroGuard (TwinN + 2 *Bacillus* sp. trains); (3) FZB24 fl (*B. subtilis*); (4) Rhizocell GC (*Bacillus* sp. IT45); and (5) RhizoVital 42 (*B. amyloliquefaciens*)]
- ➢ **PGPR screening under greenhouse condition**: Seeds of a spring wheat, *Triticum aestivum* (variety Tibalt), were planted in 30-cm depth PVC tubes filled with field soil (maintained at 16% humidity, no fertilizer) and inoculated with 10^8 cells/plant under LED lighting (flux: 150 W/m2). After 4 weeks, plant biomass were measured.
- ➢ **PGPR screening under field condition in combination with different N fertilizer doses**: Seeds of a winter wheat, *T. aestivum* (cv Forum) were sowed on 2nd Dec. 2013 in a criss-cross design. Two fixed factors were used: the PGPR strain (5 PGPR-containing products above and control) and N fertilizer (0, 50, 75 and 100%). The shoot weight, spike number and grain yield were measured at Zadoks' stage 39, 69 & 100, respectively.



PGPR screening under greenhouse condition

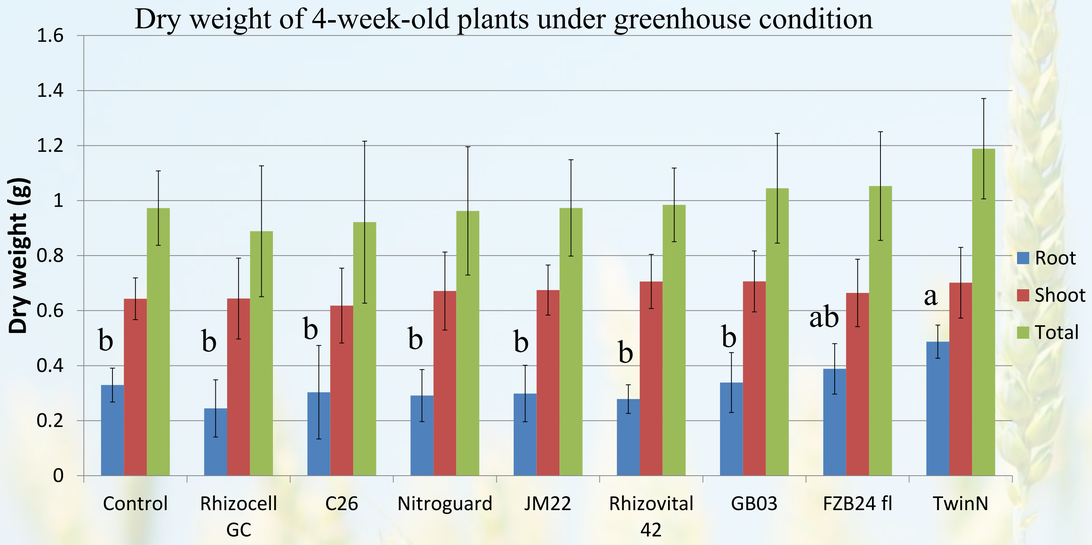
Plants grown in PVC tube

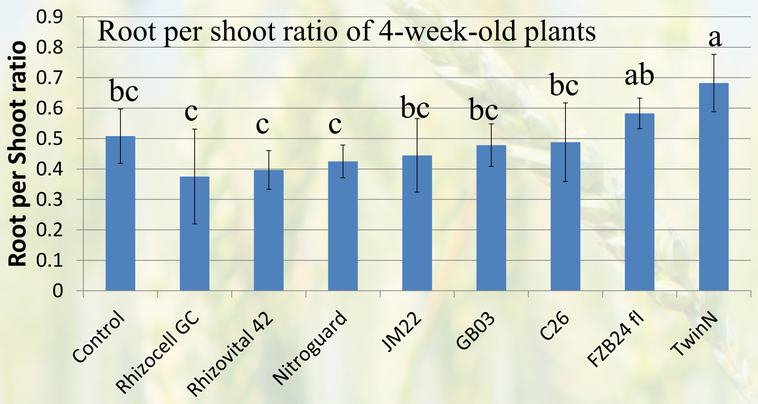
Spraying the PGPR-containing products under field condition

Results and Discussion

Spring wheat

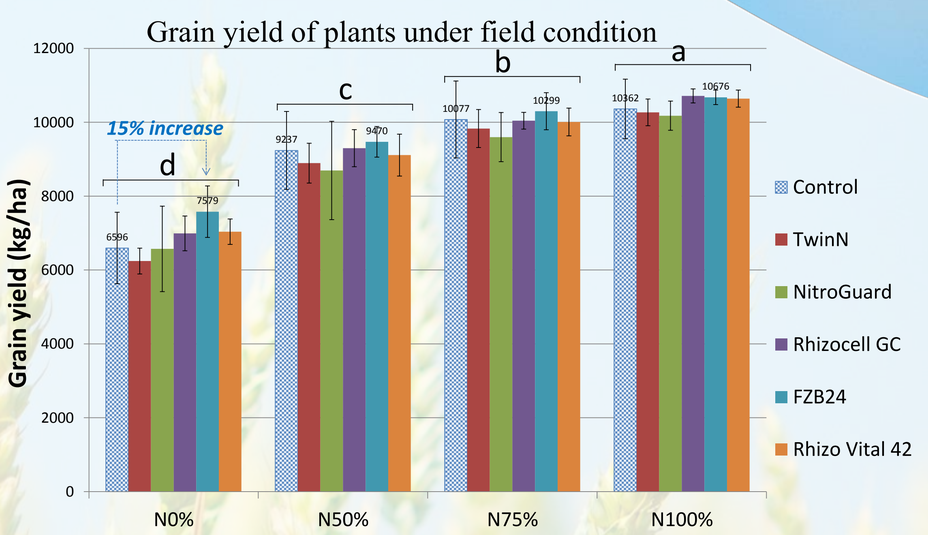
GREENHOUSE TRIALS





Winter wheat

FIELD TRIALS



Results:

- ➢ **Under greenhouse condition: TwinN resulted in the highest root biomass and root per shoot ratio (one-way ANOVA, p=0.000).**
- ➢ **Under field condition: the grain yield was negatively impacted by low N fertilizer applications. Under 0% N dose, the inoculation of the wheat rhizosphere with FZB 24 increased the grain yield by 15% relative to the water control. However, in the field trial, the variability between plot replicates was high and lead to non-significant results.**

Perspectives:

- ➢ **Modified screening strategies for PGPR selection were set up for the 2015 trials to reduce field variability and possibly achieve higher yield increases. The field trial was changed to a new location to reduce the block effects.**
- ➢ **Continue to optimise the growth condition (e.g. fertilizer level, mix soil and sand to reduce the nutrient content) and select the proper plant stage to inoculate PGPR efficiently in the greenhouse and field.**
- ➢ **It is critical to test the colonization capacity of PGPR in the wheat rhizosphere.**
- ➢ **Metagenomic approaches (based on shotgun sequencing of rDNA) should be developed to assess the impacts of PGPR to soil microbial community in greenhouse before testing in the field.**

References

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Contact: ml.nguyen@ulg.ac.be