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Effects of PGPR and *Rhizobium phaseoli* on nitrogen fixation of Mungbean (*Vigna radiata*) under dryland conditions

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1. Introduction

Mungbean is a grain legume well adapted to the dryland conditions of the tropics and subtropics that can fix around 9-112 kg N ha^{-1}, representing an N_2-fixation between 15-63% of its total N uptake [(1)]. However, due to the lack of summer rains, mungbean is exposed to severe water deficits that result in lower N_2-fixation activity and plant growth, affecting the yield up to 70% [(2)]. Facing this problem, the use of combined inoculation with plant growth promoting rhizobacteria (PGPR) might have the potential to diminish the adverse effects caused by water deficits and salinity stresses [(3)].

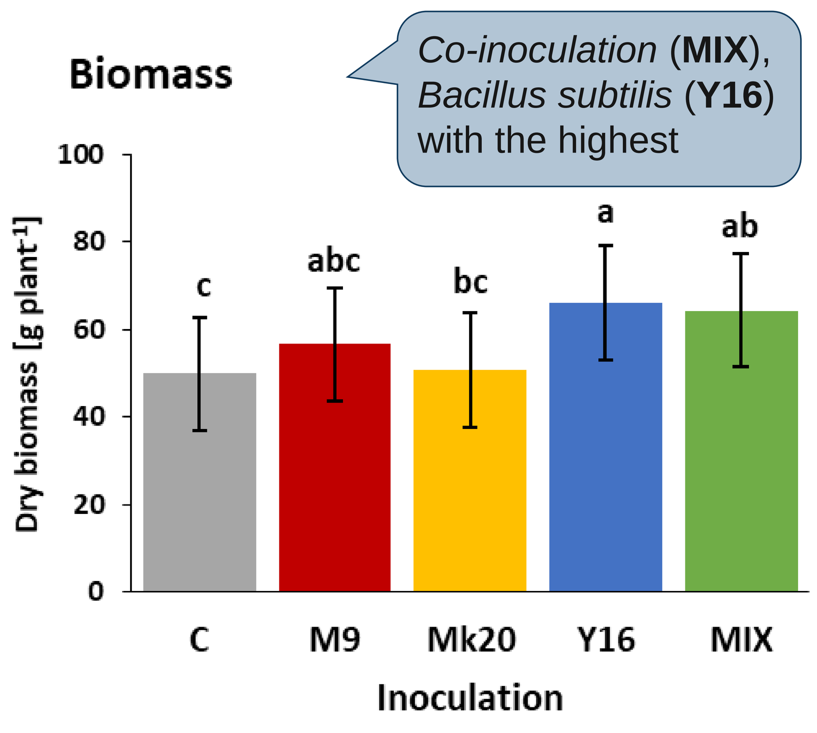
Objective

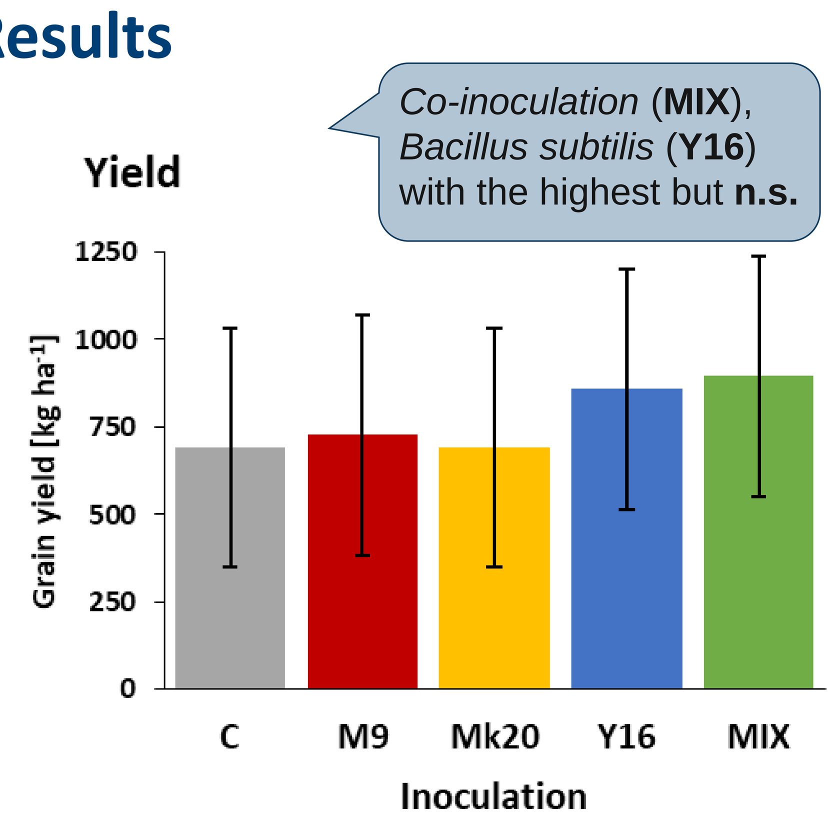
- Identify the impact of single and combined inoculations of PGPR with *Rhizobium phaseoli* on the N_2-fixation, nitrogen content, biomass accumulation and growth development of mungbean in Pakistan.

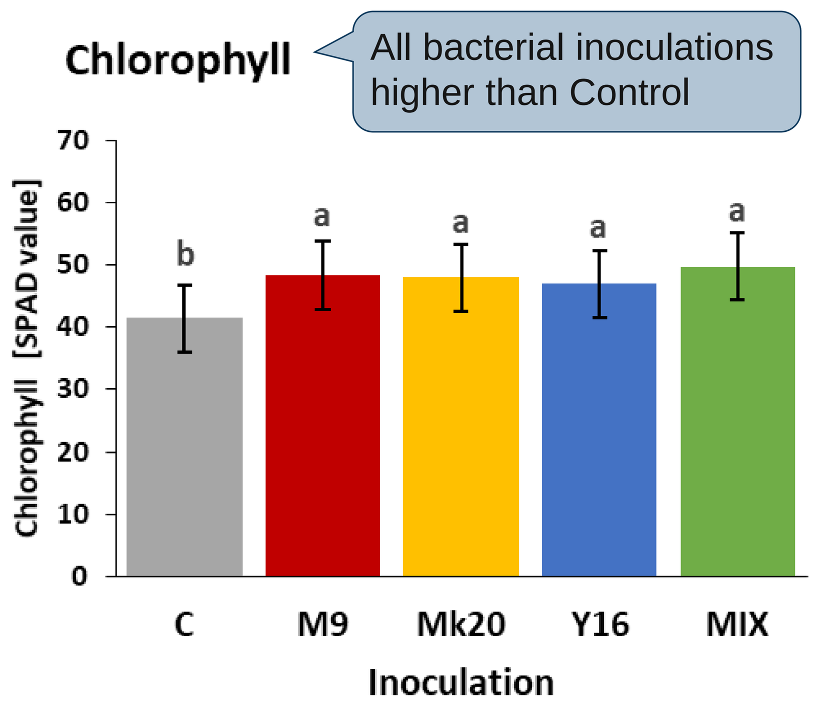
Research Question

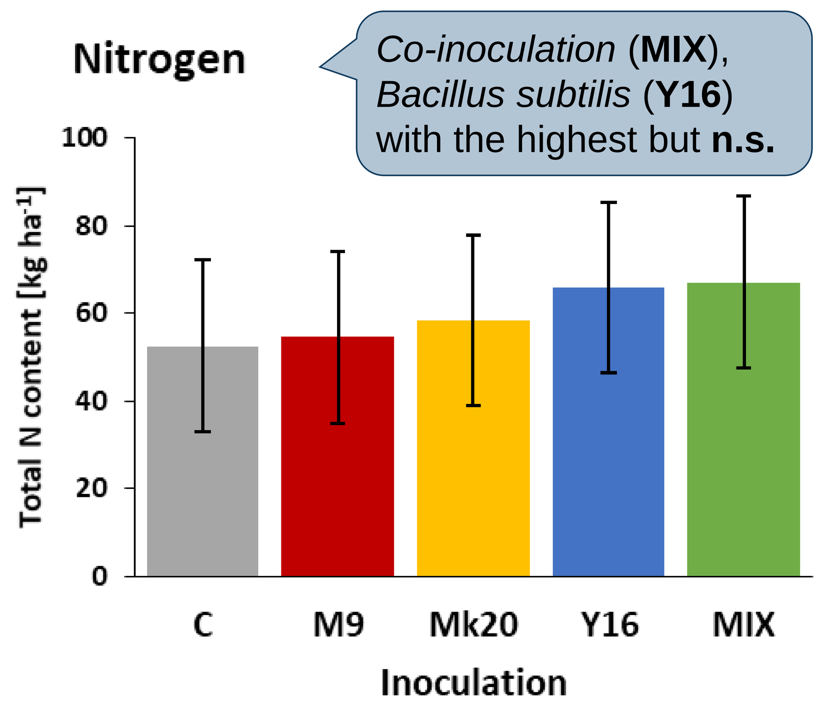
- Is the combined use more effective than the separate single inoculation?

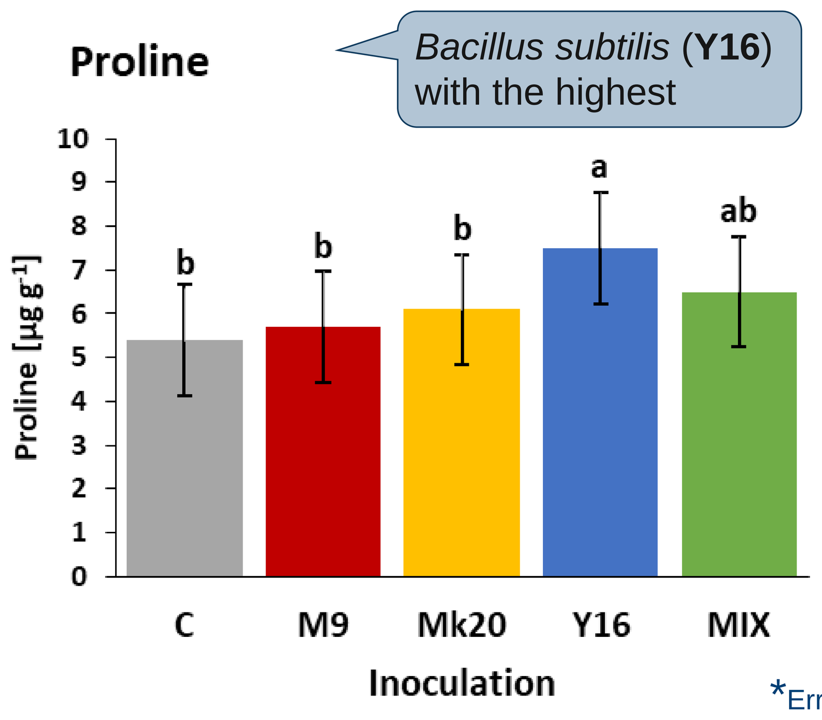
3. Results

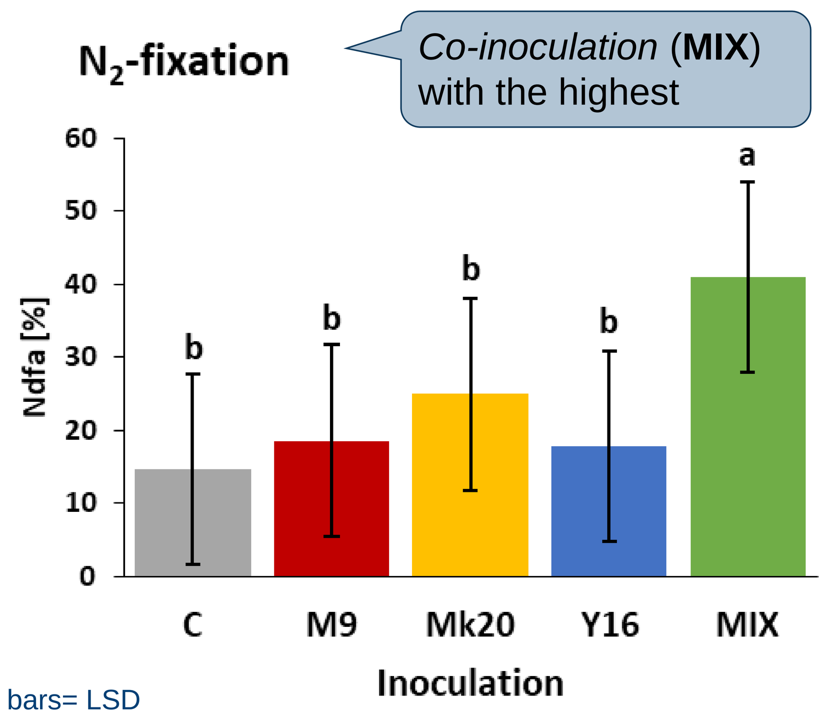












*Error bars= LSD

4. Discussion

- Other experiments in Pakistan supported our results, where the co-inoculation of M9 and Mk20 increased chlorophyll, biomass, and N_2-fixation of mungbeans [(3,5)]. Nevertheless, the separate single inoculations of both bacteria obtained the lowest biomass and N_2-fixation.
- Drought and salinity stress conditions promote proline accumulation in mungbeans [(2,5,6)]. Despite the lack of these stressors, the inoculation with either Y16 or MIX led to the highest proline content, indicating that both treatments also foster mungbean growth under other stresses.
- In contrast with other results, M9 and Mk20 did not reduce proline content [(5,7)].
- Supporting our results, Y16 increased mungbean proline content under non-stress conditions [(6)].

5. Conclusion

- The combined (MIX) inoculation was the most effective. But the single inoculation Y16 obtained similar results.
- Co-inoculation of M9 and Y16 might be the best treatment.
- Y16 increased proline content as well as biomass and yield, suggesting that proline production might be an indicator for adaptation to heat.
- Further research needed to test all combined and single inoculations under normal, salt, drought, and heat-stress conditions.

2. Methodology

Seed inoculation with broth cultures (M9, Mk20 and Y16).

Sowing by hand with a mean seed density of 7 plants/m^2.

Proline content analysis during flowering period (48 DAS) [(4)].

Chlorophyll concentration analysis during flowering period (49 DAS) with a SPAD-502 meter devise.

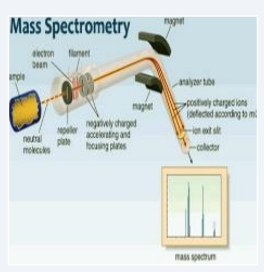
Mungbean root profiles showed at maturity stage tap-roots up to **63 cm deep**.

Biomass analysis at maturity (64 DAS).

Treatments:

- *Rhizobium phaseoli* (M9)
- *Pseudomonas fluorescens* (Mk20)
- *Bacillus subtilis* (Y16)
- *R. phaseoli* + *P. fluorescens* + *B. subtilis* (MIX)

^{15}N natural abundance method



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Mass spectrometry analysis of maize, pot and field samples: Stable isotopes **$^{15}N/^{14}N$**.

Mungbean field plants: **sample** representing the ^{15}N abundance from the soil N and the Ndfa.

Mungbean pot plants: **Background value** representing only the ^{15}N abundance from the atmosphere.

Maize field plants: **Reference plant** representing only the plant available ^{15}N abundance in soil.

BMZ Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung

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