Synergisms in Rock-P acquisition by combined application of Ammonium fertilizers and *Bacillus amyloliquefaciens* FZB42 in Maize as affected by Soil pH

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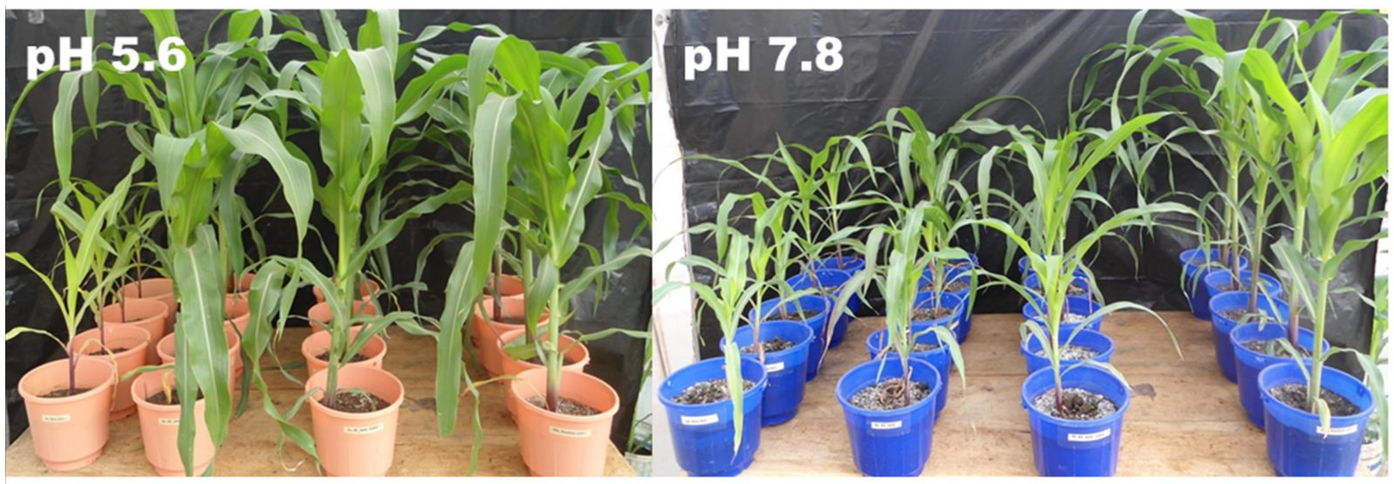
INTRODUCTION

The use of P-solubilizing microorganisms as plant inoculants to improve Phosphate (P) acquisition of crops is frequently biased by limited reproducibility and the conditions required for successful applications in agricultural practice are still poorly understood. Recent studies suggest beneficial effects by combined application with stabilized ammonium fertilizers but were so far restricted only to field soils with neutral pH. Therefore, this study investigated the expression of ammonium-assisted Rock-P acquisition by microbial inoculants on two soils with contrasting pH (5.5 and 7.8) using *Bacillus amyloliquefaciens* FZB42 and maize as a model system.

Experimental

Two low-P West African (Ghana) soils with contrasting pH were used for the pot experiment:
Atebubu: pH $_{CaCl2}$ = 5.6, P_{Bray1} = 7.2 mg kg^{-1} soil; Dormaa Ahenkro: pH_{CaCl2} = 7.8, P_{Olsen} = 2.2 mg kg^{-1} soil.
Maize seedlings (cv. Wandataa-NBS/16/wan/wm) were inoculated in 3 weekly intervals with B*acillus amyloliquefaciens* FZB42 (Abitep, Berlin, Germany, BE3; 10^9 spores kg^{-1} soil). NPK Fertilization (mg/kg soil): N 200 (DMPP- stabilized NH_4 Novatec Solub, Compo Expert; Münster, Germany or $Ca(NO_3)_2$ Calcinit, Yara, Oslo, Norway); P 100 (Rock-P Granuphos,Landor Birsfelden, Switzerland or STP Super-Phosphate Triferto, Gent, Beldium; K 100 (K_2SO_4). Plants were grown completely randomized in greenhouse culture over 5 weeks in 3 kg pots with 5 replicates.

RESULTS



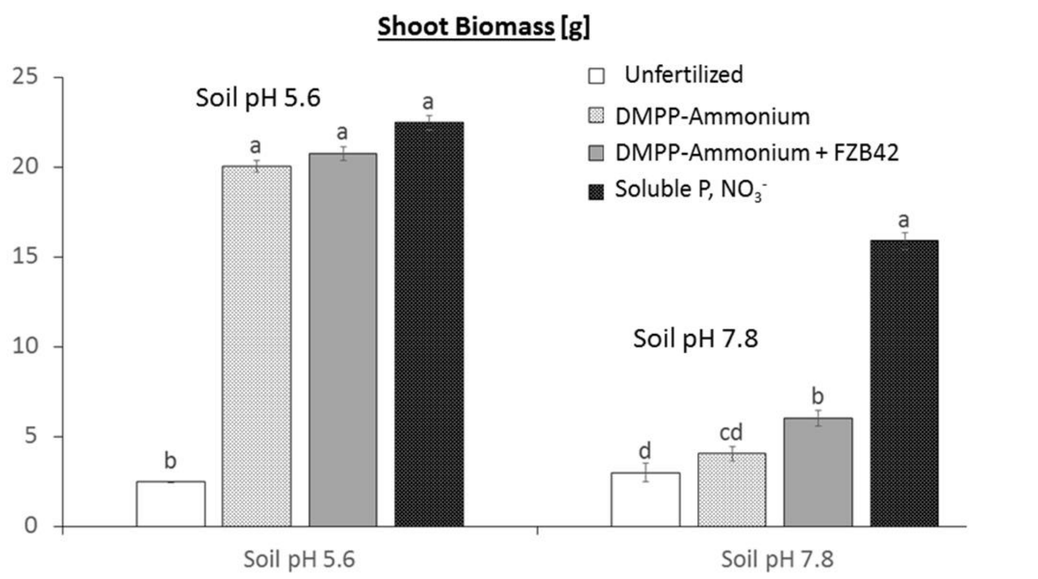
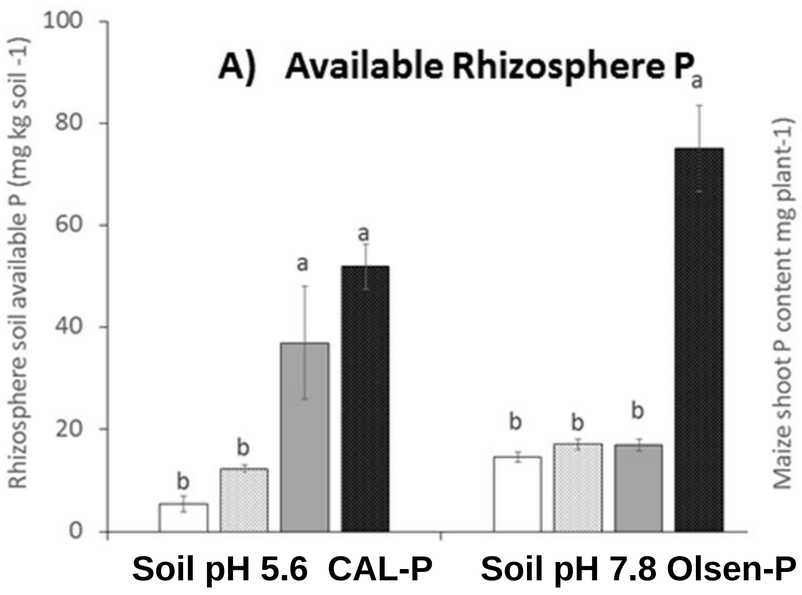
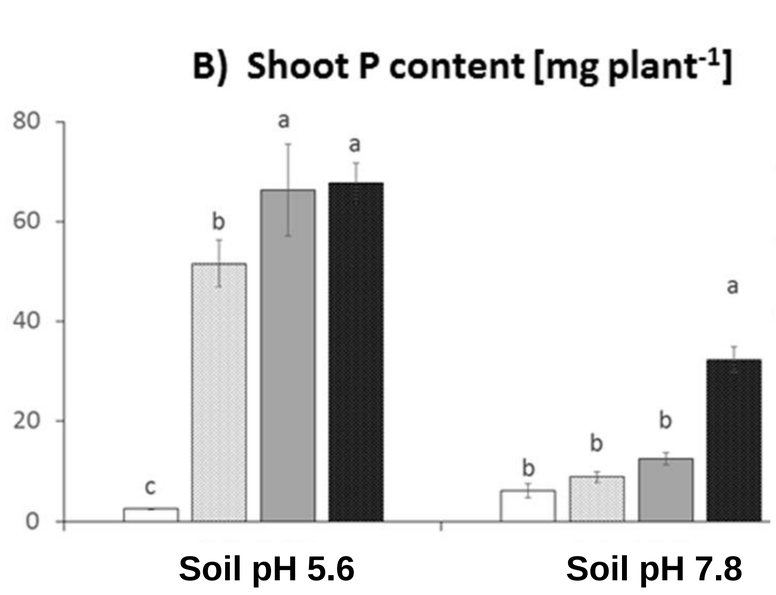


Figure 1: Habitus, shoot biomass and root length of maize at 5 weeks after sowing: Higher shoot biomass production on the acidic soil as compared to the alkaline soil, with ammonium effects comparable to soluble P fertilization. Plant growth promotion by FZB42 (biomass, trend for increased root length) on the alkaline soil only.





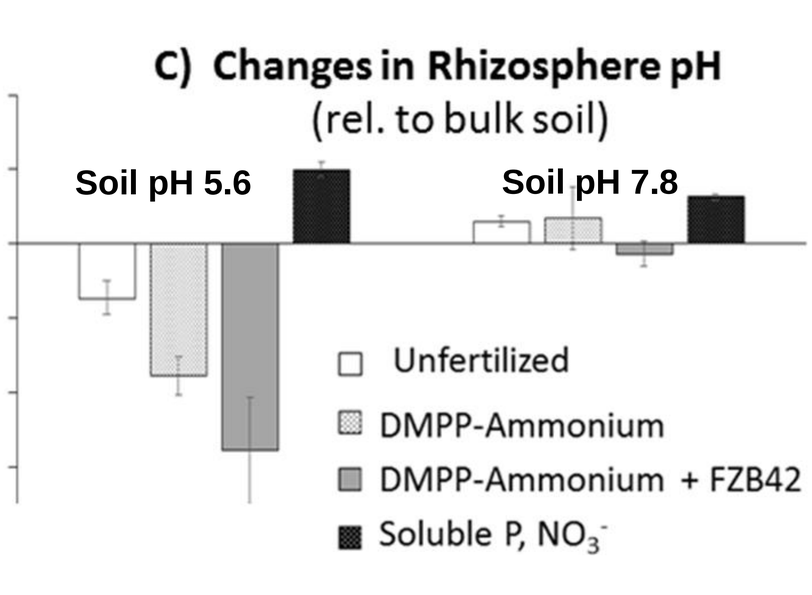


Figure 2: Despite absence of growth effects on the acidic soil, FZB42 increased P availability in the rhizosphere (**A**), P-nutritional status (**B**) associated with the strongest expression of rhizosphere acidification (**C**) → FZB42 shows P-solubilizing properties but NH_4-induced Rock-P solubilization was already sufficient. No comparable effects on the alkaline soil. Here plant growth promotion by FZB42 may be related to hormonal effects and/or root growth promotion.

CONCLUSIONS

- **FZB42 shows Rock-P-solubilizing activity via rhizosphere acidification in a synergistic interaction with NH_4^+ fertilization on a moderately acidic but not on alkaline soil (**high pH buffering capacity ?**)**
- **FZB42-induced P solubilization and improved plant P acquisition does not necessarily translate into plant growth responses in cases of sufficient P supply of non-inoculated controls**
- **Synergistic plant growth promotion by ammonium fertilization and FZB42 on the alkaline soil seems related to other mechanisms (e.g. improved spatial P acquisition by root growth promotion, hormonal effects?)**

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