Inoculation of root microorganisms for sustainable wheat-rice and wheat-black gram rotations in India

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The scarcity of non-renewable resources such as soils and fertilizers and the consequences of climate change can dramatically influence the food security of future generations. Mutualistic root microorganisms such as plant growth-promoting rhizobacteria (PGPR) and arbuscular mycorrhizal fungi (AMF) can improve plant fitness. We tested the growth response of wheat (Triticum aestivum [L.]), rice (Oriza sativa [L.]) and black gram (Vigna mungo [L.], Hepper) to an inoculation of AMF and PGPR alone or in combination over two years at seven locations in a region extending from the Himalayan foothills to the Indo-Gangetic plain. The AMF applied consisted of a consortium of different strains, the PGPR of two fluorescent Pseudomonas strains (Pseudomonas jessenii, R62: Pseudomonas synxantha, R81), derived from wheat rhizosphere from one test region. We found that dual inoculation of wheat with PGPR and AMF increased grain yield by 41% as compared to un-inoculated controls. Yield responses to the inoculants were highest at locations with previously low yields. AMF or PGPR alone augmented wheat grain yield by 29% and 31%, respectively. The bio-inoculants were effective both at Zero and at farmers practice fertilization level (70 kg N ha(-1), 11 kg P ha(-1) in mineral form to wheat crop). Also raw protein (nitrogen x 5.7) and mineral nutrient concentration of wheat grains (phosphorus, potassium, copper, iron, zinc, manganese) were higher after inoculation (+6% to +53%). Phosphorus use efficiency of wheat grains [kg P grain kg(-1) P fertilizer] was increased by 95%. AMF and PGPR application also improved soil quality as indicated by increased soil enzyme activities of alkaline and acid phosphatase, urease and dehydrogenase. Effects on rice and black gram yields were far less pronounced over two cropping seasons, suggesting that AMF and PGPR isolated from the target crop were more efficient. We conclude that mutualistic root microorganisms have a high potential for contributing to food security and for improving nutrition status in southern countries, while safeguarding natural resources such as P stocks.
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