Effects of Mycorrhiza and Plant Growth Promoting Rhizobacteria Inoculants on Rice Crops in Northern India

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Mutualistic root microorganisms such as arbuscular mycorrhizal fungi (AMF) and plant growth promoting rhizo-bacteria (PGPR) can ameliorate plant nutrition through an extended extra-radical hyphal network and by nutrient mobilisation. Running under the Indo-Swiss Collaboration in Biotechnology (ISCB), our project focuses on the integration of AMF and PGPR as bio-fertilisers in wheat-rice and wheat-black gram systems.

The inoculants were isolated and selected from wheat roots. AMF inoculation was performed with a natural consortium (Mnat) multiplied via host plants and comprising several AMF strains. In addition, two AMF single strains multiplied via a root organ culture were applied (an AMF strain isolated from Mnat and a commercial strain). The PGPR inoculum (Ps) consisted of two *fluorescent Pseudomonas* strains.

Effects of inoculants, presented here on rice crops (*Oryza sativa* [L.]), were assessed between 2006 and 2009 in a trial at Bhawanipur, Uttar Pradesh. The plots were managed at fertiliser level Zero (3 t ha^{-1} farmyard manure) and Farmer's Practice (FYM + mineral fertilisers), in the presence or absence of a *Sesbania* green manure intercrop before rice. Calculated across both fertiliser levels and over four years, rice grain yield was most increased by application of the dual inoculum "Mnat+Ps". Compared to the un-inoculated treatment, the yield was 22 % higher without and 30 % higher with *Sesbania*. This corresponds to an increase from 2.64 t ha^{-1} to 3.21 t ha^{-1} grain dry matter yield without *Sesbania*, and from 2.99 t ha^{-1} to 3.88 t ha^{-1} grain DM yield with *Sesbania* (means of four rice crops, $p \leq 0.001$). AMF single strains were less effective than Mnat. Phosphorus, zinc and iron concentration in rice grain was significantly increased in all inoculation treatments. The inoculants were effective both at Zero and Farmer's Practice fertiliser level.

Our results show that the bio-fertilisers tested have the ability to optimise rice crops in a wheat-rice rotation in India. Applying the same inoculants, Mäder *et al.* (Soil Biology & Biochemistry 43, 2011) obtained a wheat grain yield enhancement of 41 % compared to un-inoculated plots, suggesting that isolates from the rhizosphere of the target crop can even be more efficient.

Keywords: Inoculation, micro-elements, microorganisms, mineral nutrient concentration, mycorrhiza, PGPR, *Pseudomonas*, rice, *Sesbania*, yield

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