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Bacillus-Mediated Cross-Protection against Iron Toxicity and Brown Spot Disease (*Bipolaris oryzae*) in Lowland Rice

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Abstract

The overall fitness of plants under stress conditions has been shown to be influenced by microorganisms. In addition to their own elaborate tolerance mechanisms against biotic and abiotic stresses, plants rely on interactions with their microbiome. Systematic identification of microbial strains providing cross-protection against multiple stressors and the dissection of host-microbe interactions under diverse stress conditions is essential for integrating such microorganisms in sustainable agriculture. Iron toxicity and brown spot disease incited by *B. oryzae* (telemorph: *Cochliobolus miyabeanus*) are important abiotic and biotic stressors which constitute great constraints to lowland rice (*Oryza sativa*) production worldwide. Excess uptake of iron caused by high concentrations of reduced iron (Fe II) in the soil can result in complete yield losses. Yield reduction of up to 90% - as reported in the Bengal famine - can occur in areas affected by brown spot disease.

In the present study, three different *Bacillus* isolates (*B. pumilus* and *B. megaterium*) were tested for their ability to provide cross-protection against iron toxicity and brown spot disease in six different rice cultivars (IR75866-17-B-12-WAB1, Suakoko 8, IR31785-58-1-2-3-3, TOX 4004-8-1-2-3, CG 14, Sahel 108). To this end, plants were inoculated with *Bacillus* cell suspensions and, after one week, exposed to excess iron (1,000 ppm) for 8 days or inoculated with *B. oryzae*. The effects of bacteria treatments on the plant's response to both stresses were evaluated by leaf scoring and determination of dry weight.

Leaf scoring showed that the effects of *Bacillus* strains on brown spot development and iron toxicity tolerance significantly differ between rice cultivars and *Bacillus* isolates. In most cultivars, the effects of bacteria inoculation on brown spot expression differed from those on tolerance to iron toxicity. While application of *B. pumilus* strains suppressed brown spot disease in most cultivars, it increased iron toxicity leaf symptoms in naturally tolerant cultivars. In IR31875 however, *B. pumilus* provided cross-protection against both stressors. Varietal differences in changes in symptom expression following bacteria treatment will be related to the effect the different *Bacillus* isolates can have on general stress responses (e.g. ROS scavenger enzyme activity, lipid peroxidation) and iron homeostasis in selected cultivars.

Keywords: *Bacillus*, *Bipolaris oryzae*, Brown spot disease, *Cochliobolus miyabeanus*, Iron toxicity, *Oryza sativa*

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