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Root Iron Plaque Formation as Resistance Mechanism to Iron Toxicity in Lowland Rice

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Abstract

Iron toxicity is one of the most important abiotic stresses limiting rice production in lowland systems. Fe toxicity during the seedling stage widely affects the yield of lowland rice in the Tropics. The most efficient way to address Fe toxicity is via resistant genotypes. To date screening tools for Fe-toxicity tolerance in rice are based on leaf symptoms and yield, but not on actual resistance mechanisms such as exclusion or tolerance. Thus, cultivars that reportedly showed Fe(II) tolerance frequently succumb to iron toxicity. Recently we developed a mechanistic early screening method that allows the investigation of actual tolerance mechanisms. However, the rice roots are not accessible in this screening method and it is not possible to identify the Fe exclusion potential or retention power of rice roots. The aim of this research was to adapt this screening tool in a controlled growing environment that allows accessing the rice roots.

Rice seedlings were hydroponically grown in PVC boxes for 4 weeks and then subjected to three Fe treatments (0, 1000 and 1500 mg L^{-1} Fe(II) applied as $FeSO_4$). Nitrogen gas was infiltrated to the cultural solution through porous stones to provide anoxic conditions. After 3 days stress exposure the rice seedlings were scored for iron toxicity symptoms and, root Fe plaque, iron uptake and partitioning within plant tissues were determined. The amount of Fe formed as plaque at the root surface was approximately three times higher in all tested genotypes than the tissue-Fe concentrations of the rice cultivars. Genotypes differed significantly in the amount of Fe precipitated on the roots under low external Fe concentration and in the ratio between Fe taken up into the root and Fe formed as root plaque. The results indicate that the oxidation power of rice root plays an important role in genotypic resistance to Fe-toxicity as an avoidance mechanism and thus needs to be assessed in screening systems that evaluate rice resistance to Fe toxicity. Further studies to elucidate the mechanisms of root Fe plaque formation are ongoing.

Keywords: Iron uptake, leaf symptoms, *Oryza sativa*, oxidation power

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