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Adaptation Mechanisms in Rice Cultivars of Different Origin to Iron Toxic Conditions

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Abstract

Iron toxicity is a complex nutritional disorder that differentially affects lowland rice cultivars. The occurrence of excessive amounts of reduced Fe^{2+} in the soil solution, its uptake by the rice roots, and its acropetal transport by xylem stream can lead to elevated Fe^{2+} concentrations in leaf cells that catalyse the formation of radical oxygen species, entailing structural damage, the visual symptom of leaf bronzing, and yield losses of up to 30 %. Diverse morphological and physiological adaptation mechanisms have been described, ranging from exclusion of toxic Fe^{2+} (*e.g.* oxidation power of roots), Fe partitioning (*e.g.* immobilisation in stem tissues or the apoplasm) to tissue tolerance (*e.g.* scavenging of radicals by enzymes). The effectiveness of these adaptation mechanisms to cope with Fe stress differs between cultivars of different origin, and varies with plant age, environmental conditions (*e.g.* vapour pressure deficit - VPD), the nutritional status of the crop, the intensity and duration of the Fe stress, and the timing of its appearance. We hypothesise that an effective breeding or selection of cultivars for Fe toxicity tolerance requires the matching of the cultivar- and plant age-dependant coping-mechanisms with the prevailing environmental and Fe stress conditions.

Twenty rice genotypes (different species and cultivars of different origin) are being comparatively evaluated in hydroponic culture at the seedling, vegetative and early reproductive growth stages. Symptom occurrence, biomass accumulation, Fe translocation patterns, and the Fe content in various tissues are monitored. Cultivars are being classified based on their ability to cope with elevated Fe^{2+} (sensitive vs. tolerant) and their tolerance mechanisms (excluders vs. includers). Contrasting genotypes will be used to assess the effectiveness of various adaptation mechanisms to diverse stress situations (Fe intensities of 0, 1000, 2000 ppm Fe^{2+} , stress durations of 0 to 10 days, conditions of high and low VPD). First results of required cultivar characteristics for defined Fe stress conditions will be presented.

Keywords: Hydroponics, iron toxicity, *Oryza sativa*, oxidation power, tissue tolerance, rice