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Rice wild relatives under different iron stress regimes – growth parameters, yield and grain quality factors



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Abstract

Iron toxicity is a major challenge for one of the most important crops of our time, as the mineral is getting reduced under the anoxic conditions prevalent in flooded rice fields. The resulting Fe²⁺ cations are easily taken up and lead to oxidative stress within the plant and subsequently cause yield losses. On the other hand, iron as well as other minerals such as zinc are scarce in rice grains and therefore insufficiently available for people whose nutrition is based on rice. Also the antinutrient phytate plays a role in this context, as it is present in the rice grain in large amounts. The following study seeks to address these different but related topics by searching among the wild relatives of rice, which harbor a wide range of still unknown genes, for useful traits.

*Fifty-eight wild rice accessions of 20 species and 17 cultivated varieties were grown in 6 soil plots of 2 x 6 m under greenhouse conditions. Two polders each were used for the three treatments chronic iron stress, acute iron stress or control and four semi-randomized replicates were planted in each polder. Heading times of the plants were noted and after harvest plant height, tiller number, dry weight of straw biomass and grain yield were determined. For grains of wild relatives and selected *O. sativa* varieties iron, zinc and phytate concentration were determined in brown rice.*

*Growth parameters were increased under acute stress compared to control, while plants under chronic stress only showed an increase in height. Iron stress affected the onset of reproductive stage in some genotypes. Grain yield was elevated under acute stress but reduced under chronic stress compared to control. Yield losses were mainly caused by increased spikelet sterility and decreased thousand kernel weights, which were compensated in acute treatment by an elevated panicle number. One *Oryza rufipogon* and one *O. alta* accession showed signs of iron tolerance along with some varieties for which iron tolerance was already known, such as *O. glaberrima* CG 14 and *O. sativa* Dom Sofid. Grain analysis revealed average Fe values between 19.1 and 51.9 mg/kg per genotype but with a high variation among samples. Zn values on average ranged from 21.3 to 34.1 mg/kg and phytate concentrations from 6.8 to 12.8 g/kg. One *O. sativa* var. *spontanea* showed significantly less phytate compared to nearly all other varieties and one *O. barthii*, one *O. alta* and *O. sativa* Dom Sofid could be of use for Zn biofortification through breeding. Grain Zn concentration was significantly elevated under chronic treatment and phytate concentration was higher in acute treatment compared to control while no effect was measured for Fe. This pioneering work provided some interesting hints and new insights for further research regarding the use of wild relatives for rice breeding.*

Keywords: Rice wild relatives, iron toxicity, grain mineral concentration, iron, zinc, phytate