STRATEGIES TO ALLEVIATE IRON TOXICITY OF WETLAND RICE ON NUTRITIONALLY POOR AND/OR ACID SULFATE SOILS

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ABSTRACT

Iron toxicity (bronzing) is ascribed to the excessive uptake of reduced iron by wetland rice (Oryza sativa L) and has been observed in most rice-growing countries. A physico-chemical survey of iron toxic soils in different geographical regions (India, Indonesia, Philippines, People's Republic of China, Sierra Leone, Sri Lanka, Senegal etc) reveal that most of these soils are deficient in P and K and low in available Ca and Zn. The majority of the affected soils are classified as highly weathered Ulti- and Oxisols or nutritionally poor Histosols. Further, title lands with potential acid sulphate formation often show iron toxicity. In order to evaluate the hypothesis of iron toxicity as a multiple nutritional soil stress, a field trial (with IR 8) on an acid sulfate soil was carried out in South Senegal in cooperation with the Institut Senegalais des Recherches Agricoles (ISRA) in Djibelor. In regular intervals the effect of fertilization (N, N+P, N+K, N+Ca) on the uptake of nutrients (leaf analyses), the symptoms of Fe-toxicity and on the pH, Eh and Fe(II)-concentration in soil solution (rhizosphere) was recorded throughout the vegetation period. In the untreated soil, two peaks of intensive Fe-formation and uptake occurred, one during the first week after transplanting (= primary iron toxicity) and the second between heading and flowering (= secondary iron toxicity). Fertilization (in particular with P and K) decreased the uptake of Fe which seems to be determined neither by pH or Eh nor by the Fe(II)-concentration in soil solution. The P and K-level of the plants significantly affects the Fe-concentration of the leaves. Primary iron toxicity is explained by sensitivity of the freshly transplanted rice seedlings to the high amounts of Fe(II) produced by bacterial reduction just after flooding, while secondary iron toxicity should be ascribed to an ineffective Fe-excluding root mechanism caused by an increased root membrane permeability (deficiency in K, P and/or Zn) and enhanced microbial iron reduction. The latter is explained by intensive exudation particularly during the physiologically active phases of heading and flowering. Practical strategies to alleviate the excessive Fe-uptake on the basis of the mechanisms given above are discussed.