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Developing a Standardised Procedure to Screen Lowland Rice (*Oryza sativa*) Seedlings for Tolerance to Iron Toxicity

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Abstract

Despite a rapid expansion of cultivated lowlands, rice production in West Africa lags behind consumption. Among numerous yield-limiting factors, iron toxicity is one of the dominant production constraints on the Ulti-, and Alfisols in the humid zone of the region, accounting for yearly yield losses of about 50,000 tons of paddy. The use of tolerant rice cultivars is seen to be the most effective means to address Fe toxicity. However, current varietal development in Asia and West Africa provided few transferable results (i.e. Fe-tolerant cultivars or breeding lines). Thus, supposedly tolerant cultivars from Asia succumbed to Fe-stress in West Africa and vice versa. Controlled and standardized experimental conditions producing repeatable results are required for varietal screening procedures particularly at seedling stage. A series of phytotron experiments were conducted to establish and test such a standard screening tool. Concentrations of 0–3000 ppm Fe ($\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$) were applied to two and four week-old seedlings of known Fe-tolerant (Suakoko-8) and Fe-sensitive (IR317) check cultivars. Rice seedlings were planted in 1% slant agar, prepared from Yoshida culture solution with different strengths. The 330 ml plastic pots were filled with solution medium and covered with paraffin oil to maintain anaerobic conditions. Different levels of vapour pressure deficit (air humidity of 60–65%) were used in the phytotron. An additional set of Fe-tolerant and sensitive rice varieties from Ghana was used to validate the set-up. Expression of leaf bronzing symptoms was scored between one and four days after Fe addition and dry biomass and Fe content in shoot were determined. In both two and four week-old rice seedlings, a leaf-scoring three days after applying 2000 ppm Fe II provided the best visual differentiation of the test cultivars. Increasing the vapour pressure deficit from 60 to 65% air humidity in the phytotron tended to increase leaf iron uptake in the sensitive cultivar. Plotting the iron content in the leaf tissue against the leaf bronzing score allowed for a differentiation of cultivars into sensitive, tolerant inclusions and tolerant excluders. It may be concluded that the proposed culture set-up allows within three days of Fe II addition to two and four week-old rice seedlings to reliably differentiate tolerant from susceptible cultivars. A validation using a wider range of cultivars and breeding lines and further studies on the effect of the vapour pressure deficit are required.

Keywords: Fe-toxicity, rice breeding, Ghana