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Solution culture - A reliable fast screening technique towards screening rice genotypes for zinc efficiency

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ABSTRACT

In rice ecosystem, correction of zinc deficiency via fertilization does not always remain a successful strategy due to economic and environmental factors. A more efficient and sustainable solution to zinc deficiency limitation is the development of rice genotypes with superior zinc efficiency that can grow under low soil zinc conditions. A reliable, inexpensive and fast screening technique to differentiate rice genotypes with respect to zinc efficiency is presently unavailable. This missing link has necessitated the current research on development of fast screening technique to screen rice genotypes for their relative tolerance to zinc stress. Solution culture experiment was conducted with 56 rice genotypes employing plastic pans, bottom severed with nylon mesh, countersunk into plastic trays containing modified Hoagland's solution as the nutrient medium. Five levels of zinc (0.0, 0.025, 0.05, 0.1 and 0.2 mg L^{-1} of Zn as $ZnSO_4$) were added to the trays. A completely randomized block design was adopted with each treatment replicated thrice. The genotypes were scored for expression of zinc deficiency symptoms employing standard evaluation system of rice. The per cent depression in shoot length, root length, shoot dry weight, root dry weight of the seedlings were computed at all the inadequate / excess levels of zinc at 30 days after sowing (DAS). The content of phosphorus, iron and zinc in the shoot and root of the seedlings were determined and their corresponding uptake was calculated. The above parameters were subjected to systat multivariate analysis and the genotypes were classified as efficient (a), moderately efficient (b) and inefficient (c) to zinc stress.

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The resilience of rice production is very often subjected to acid test due to the prevalence of two major limiting nutrients viz., nitrogen and zinc in the rice ecosystem. Zinc (Zn) deficiency is a dreadful challenge constraining two million hectares of rice production in Asia. Though fertilizer recommendations exist, correction of zinc deficiency via fertilization does not always remain a successful strategy due to agronomic and economic factors as reduced availability of zinc due to top soil drying, subsoil constraints, disease interactions and high cost of fertilizer in developing countries. As a consequence of coping with low Zn availability, certain genotypes exhibit significant variation in their tolerance to zinc stress, termed as zinc efficiency (ZE) (Graham and Rengel, 1993). Hence, a more efficient and sustainable solution to zinc deficiency limitation is the development and use of zinc efficient rice genotypes with root system capable of greater mobilization that can more efficiently function under low soil zinc conditions. "Rhizosphere" is a challenging environment for the acquisition of nutrients and trace elements by plant roots (Hinsinger *et al*., 2005). A more efficient and sustainable solution to zinc deficiency limitation is the development of Zn efficient rice genotypes with the root system capable of greater mobilization that can more efficiently function under low soil Zn conditions. A reliable, inexpensive and fast screening technique to differentiate rice genotypes with respect to their Zn efficiency would be an essential component of any breeding effort and such a technique is presently unavailable (Graham and Rengel, 1993). Hence the present investigation was framed to develop an inexpensive, reliable and fast screening technique to screen rice genotypes for their tolerance to zinc stress.

MATERIALS AND METHODS

In the present study, conducted during 2003 - 04, the system described by Sullivan and Ross (1979) was suitably altered. Plastic plates with depressions were taken, the ends smoothened and the bottom was covered with a nylon mesh of pore size approximately 5 mm. The plate was countersunk into a tray containing modified Hoagland's solution (Hoagland and Arnon, 1950). Each setup had 30 holes of 2.5 cm diameter and 3cm depth.

Five day old seedlings germinated by paper towel method was inserted through the nylon mesh and