Screening Rice Cultivars for their Zinc Sequestration Potential

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INTRODUCTION

Micronutrient malnutrition affects more than half of the world population particularly in developing countries. Bio-fortification, the delivery of micronutrients via micronutrient dense crops, offers a cost effective and sustainable approach to overcome this deficiency. Among the micronutrients, zinc (Zn) deficiency is widespread throughout the world particularly in lowland rice fields causing decreased crop yields and poor quality (low Zn) grains. Again, zinc content in rice cultivars differs widely owing to their genetic variability (Palmgren *et al*., 2008). Possibly, the cultivars also differ in their response to zinc application in Zn-deficient soil. Therefore, screening of elite cultivars containing higher content of this nutritionally important element and assessing their response to Zn fertilization has become a high priority research for overcoming Zn related nutritional disorders in human, plant and animal.

METHODS

We evaluated 26 rice cultivars - 7 local, 13 high yielding (HYV), 3 hybrid and 3 aromatic as to their native Zn contents as well as response to Zn applied through soil (20 kg Zn ha^{-1}) as well as spray (0.5% $ZnSO_4.7H_2O$ solution). They were raised with standard management practices for consecutive two years in strip plot design. Grains and straw were dry-ashed and the Zn concentration was measured by using an atomic absorption spectrophotometer. Zinc efficient cultivars were screened out and compared. Zinc efficiency is calculated as yield without applied zinc divided by yield upon zinc application and zinc harvest index is calculated by grain zinc uptake divided by biomass zinc uptake.

Cultivars Used

Local: Samba, Bhudev, Samba masuri Sub1, Gayasura, Lalat, FR-43B and Kalma-222
Aromatic: Gobindabhog, Badshabhog and PNR-546
High yielding varieties: CN-492 (Sabita), IR-36, IET-4094, Triguna, Swarna-1, Satabdi, IR-64, Samba masuri, MTU-7029, GS-2, GS-1, Rasi-1444 and PNR-519
Hybrid: KRH-2, PHB-71 (Pioneer) and Pro-agro (6444)

RESULTS AND DISCUSSION

On average, the concentration of zinc in rice grains was higher in aromatic> local> HYV> hybrid; while the concentration of zinc in straw was higher in local> aromatic> HYV> hybrid (Table 1). There was a higher response of local cultivars followed by hybrid> aromatic and HYV to applied zinc at different levels of its application. This is true for both grains and straw. The zinc harvest index of the cultivars was, in general, higher with HYVs followed by hybrids, aromatic and local indicating that grains of the former cultivars could accumulate a higher amount of zinc than those of the latter types (Fig. 1). Of the twenty six cultivars, zinc efficiency varied from 0.68 to 0.92 with a mean value of 0.81 for soil zinc application and 0.65 to 0.89 with a mean value of 0.78 for foliar applied zinc. The efficiency was higher for aromatic cultivars followed by high yielding varieties, hybrid and local cultivars. Aromatic cultivars possibly have adaptive mechanisms to tolerate Zn deficiency stress and

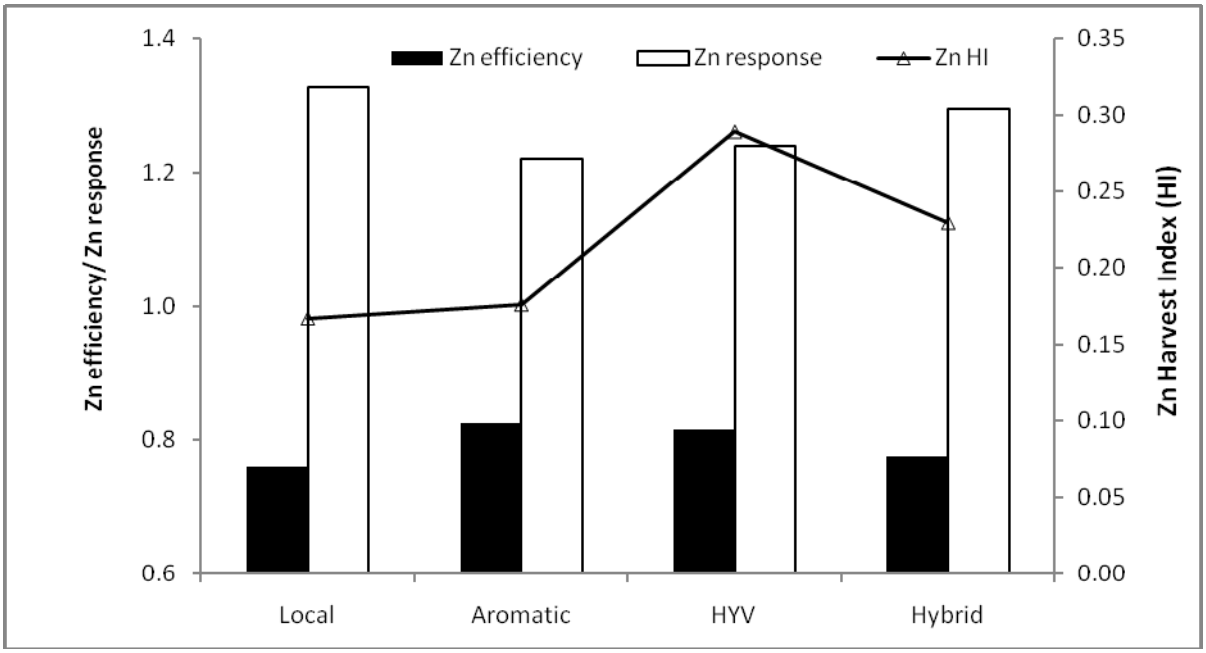

Fig. 1. Efficiency, response and harvest index of zinc for different groups of rice cultivars.

are highly efficient due to their reported greater fine root length and release of zinc chelating phytosiderophores and more efficient utilization of Zn within cells, tissues and organs (Rengel *et al.*, 1998). Lower zinc-HI of local varieties than that of HYVs indicated that the formers are not efficient in transporting Zn from shoot to grains.

Table 1. Zinc content (µg g^{-1}) in grains and straw of different groups of rice cultivars.

	Grain			Straw		
	Range	**Mean**	**SD**	**Range**	**Mean**	**SD**
Local	23.3-30.1	26.5	2.6	25.3-49.6	34.6	9.5
Aromatic	24.7-31.6	27.7	3.6	26.4-46.6	33.6	11.3
HYV	20.4-30.6	23.8	2.8	23.3-38.1	32.8	4.7
Hybrid	21.8-24.1	22.7	1.2	26.0-34.1	30.7	4.2

CONCLUSIONS

Aromatic cultivars of rice contain higher amount of grain zinc, while local cultivars responded more to zinc application in zinc deficient soils. Zinc harvest index and zinc efficiency were highest in HYV and aromatic cultivars respectively.

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