

Variation in Rice Grain Zinc and their Response to Zinc Fertilizer

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INTRODUCTION

Zinc (Zn) deficiency is a serious problem in crop production and nutritional quality for humans worldwide. In addition, low seed Zn concentration may also affect germination, seedling growth and establishment and subsequent crop growth and yield (Cakmak, 2008; Rengel and Graham, 1995). With rice grown by farmers in the Vientiane Plain of Lao PDR and popular and improved Thai varieties grown together at Chiang Mai, Thailand, it is shown that Zn content of rice that people consume can indeed be quite low. Potential for boosting Zn intake of rice eaters is shown by the existence of genotypes with exceptionally high grain Zn in a local landrace rice and effectiveness of foliar Zn application in raising Zn concentration of white rice, the form most commonly consumed, as well as whole grain rice.

METHODS

In the first study, 30 samples of nine varieties of whole grain rice were collected from farmers' fields in the Vientiane Plain of Lao PDR. The samples were analyzed for Zn concentrations as whole grain and brown rice (husk was manually removed). The second and third studies were conducted at Chiang Mai University (Sansai soil series: a sandy loam with pH 6.2: OM 0.91%: total N 0.06%: Bray II P 177 mg kg⁻¹: extractable K 33.6 mg kg⁻¹). In the second study, Zn concentrations of eleven varieties of Thai paddy rice were assessed (five popular and modern varieties, and six purelines of a local landrace, Bue Bang) that were produced under the same wetland condition in the same season at Chiang Mai University, and IR68144 as a high Zn check. In the third experiment, five rice varieties with varying grain Zn were grown under wetland condition in the field in 4 replicated blocks. Two Zn treatments were imposed: foliar Zn (Zn+: 0.5% ZnSO₄·7H₂O sprayed until all leaves were wet, at panicle initiation and one week after flowering, total 3 kg Zn ha⁻¹) and nil (Zn-: DI water spray). Mature grains were analyzed for Zn as whole grain, brown and white rice by inductively coupled plasma optical emission spectrometry (ICP-OES).

RESULTS AND DISCUSSION

Farmers' rice samples from Lao PDR contained on average 21.5±2.2 mg Zn kg⁻¹ in whole grain, and 18.4±2.0 mg Zn kg⁻¹ in brown rice. Popular and modern Thai rice varieties grown at Chiang Mai in Thailand had similar range of grain Zn, which were significantly lower than the high Zn check IR68144 (Fig. 1). At these levels of grain Zn found in rice commonly consumed, the average per capita rice consumption of 0.47 kg day⁻¹ in Lao PDR and 0.28 kg day⁻¹ in Thailand (Maclean et al., 2002) would furnish only a fraction of the recommended dietary intake of 15 mg Zn day⁻¹. However, as it has been previously pointed out there is genetic potential for higher grain Zn, which can be achieved through plant breeding (Welch and Graham, 2004). Just as it has been reported for grain iron (Pintasen *et al.*, 2007), exceptionally high levels of grain Zn in some lines of a genetically diverse local landrace from the uplands of Thailand (Fig. 1).

Foliar Zn significantly increased grain Zn in rice varieties with low and high grain Zn, with a doubling of Zn in whole grain and an increase of 20-30% in white rice which is the form commonly consumed (Fig. 2).

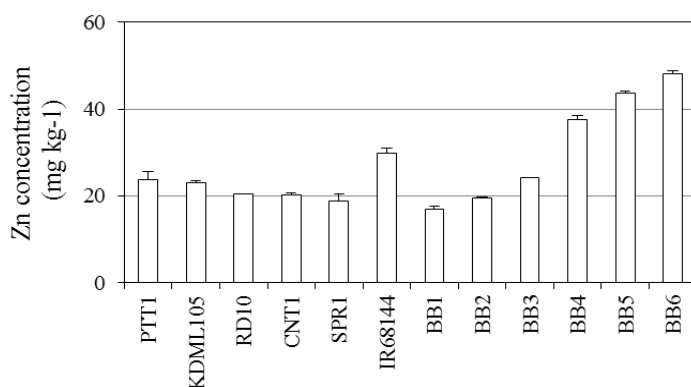


Fig. 1. Zinc concentration (with error bars) in whole grain of some Thai rice varieties compared with IR68144 and 6 lines of a local landrace *Bue Bang* (BB).

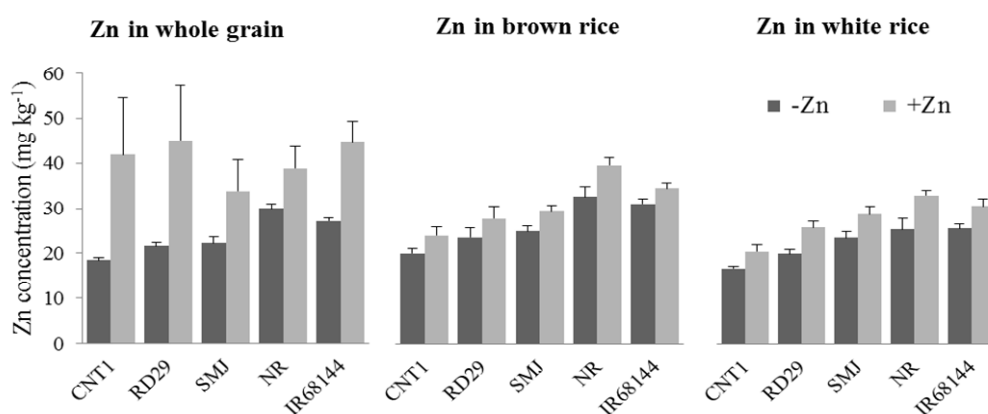


Fig. 2. Zinc concentration (with error bars, n = 4) in whole grain, brown rice and white rice of five rice varieties without and with foliar Zn application.

CONCLUSIONS

Although rice consumed by people in Laos and Thailand is low in Zn, genotypes with exceptionally high Zn were found in a local landrace. For rice genotypes with low and high grain Zn, foliar Zn effectively increased whole grain Zn for better crop growth and yield, and in white rice for better nutrition of rice eaters.

ACKNOWLEDGEMENTS

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