CADMIUM ACCUMULATION IN THREE RICE (*Oryza sativa*) VARIETIES GROWN IN METAL SPIKED ALFISOL

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Introduction

Food chain contamination by heavy metals is a growing concern throughout the world. Among many heavy metals in the soil environment, cadmium (Cd) is of considerable importance because of its high bioavailability and accumulation in cereals. High water solubility of Cd makes it more available in the flooded soils and subsequent contamination of rice (Simmons *et al.*, 2008). However, affinity of the rice plant to Cd and partitioning of Cd to grain are known to be varied with the plant genotype (Liu *et al.*, 2003; Li *et al.*, 2005). This study was undertaken to assess the Cd accumulation in three commonly grown rice varieties by exposing them to elevated Cd levels.

Materials and Methods

Soils used for this experiment were collected from a paddy field from Maha-Illuppallama. The soils are classified as Tropaqualfs. About 4.5 kg of sieved and air dried soils were transferred into 81 plastic pots. A solution of $CdSO_4$ was added initially to contaminate the soil and mixed well. Soils in 27 pots were contaminated at a rate of 15 mg Cd kg^{-1} soil and 27 with 45 mg Cd kg^{-1} soil. The rest non-contaminated 27 pots served as the control. The soils were left submerged for three days and chemical fertilizers, urea, triple super phosphate and muriate of potash were applied at recommended agronomic rates (37:62.5:37 kg ha^{-1}, respectively).

Two week old seedlings of Bg 300, *Sudu heenati* and *Kalu heenati* were planted in contaminated and non-contaminated pots. One replicate represented three pots. Two pots were planted with two seedlings and one was uprooted. One pot was planted with four seedlings and two were uprooted after a week. Treatments were replicated three times. Soil and plant samples were taken at 3, 6, and 11 weeks after planting and at harvest. First two samplings were done from the pot planted with two seedlings.

Soils were extracted for total Cd by digesting the soil with HNO_3 acid whereas plant shoots and grains by dry ashing and dissolving in aqua-regia mixture (HCl: HNO_3, 3:1) (Lindsay *et al.*, 1978) and measured using atomic absorption spectrophotometer. Means of varieties were compared only at a given Cd treatment since the interaction between variety and Cd level was significant.

Results

The total Cd concentration of the experimental soil, which was initially at 0.51 mg kg^{-1} soil, was reduced to 0.3 mg Cd kg^{-1} soil at harvesting. The treatment added with 15 mg Cd kg^{-1} soil resulted in 12.3, 10.9 and 12.8 mg Cd kg^{-1} soil in Bg 300, *Sudu heenati* and *Kalu heenati* varieties at harvest, respectively. In the contaminated treatment with 45 mg Cd kg^{-1}, total Cd in soil declined up to 44, 42 and 41 mg Cd kg^{-1} soil in soil grown with Bg 300, *Sudu heenati* and *Kalu heenati*, respectively. Slight growth retardation was observed in Bg 300 and *Sudu heenati* when they were grown in soil contaminated with 45 mg kg^{-1} soil.

The total Cd content in tissue Cd content increased over the growing season (Fig. 1). Tissue Cd content of the control treatment was below detectable levels for *Sudu heenati* and *Kalu heenati* but Bg 300 accumulated Cd at detectable levels at all samplings. A similar trend was observed for the Cd accumulation in rice grains. Variety Bg 300 accumulated significantly higher Cd concentrations at two levels, 0 and 15 mg Cd kg^{-1} (Table 1). However, as the Cd concentration in soil increased, the two traditional varieties also accumulated Cd in grains at high concentrations. Between the two, *Kalu heenati* accumulated more Cd in shoot than *Sudu heenati* at elevated Cd concentrations (Fig. 1). However, the partition of Cd to grain was comparatively low in traditional varieties (Table 1).

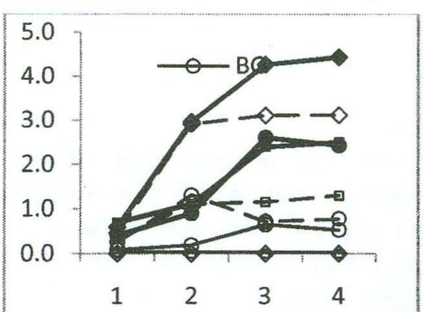

Fig. 1. Total Cd concentrations in shoots of three varieties

(Solid lines with open symbols represent control treatment, broken lines with open symbols represent 15 mg Cd kg^{-1} soil treatment and solid lines with solid symbols represent 45 mg Cd kg^{-1} soil treatment)

Table 1: Concentration of Cd in rice grain

Rice		**mg Cd kg^{-1} soil**	
Variety	**Control**	**15**	**45**
Bg 300	0.02	2.20^{a}	2.99
Sudu heenati	nd	1.54^{b}	3.35
Kalu heenati	nd	0.93^{c}	2.75

nd: below detectable level

Discussion

Results indicated that the experimental soil has very low concentrations of total Cd and therefore risk of contaminating rice with Cd also is low. Among the three varieties, the risk of accumulating Cd appeared to be higher for Bg 300 at concentrations of 0-15 mg kg^{-1} soil. Although *Kalu heenati* showed a higher Cd accumulation in tissues, partitioning of Cd to grain appeared to be low. The observed differences in Cd accumulation in plant shoot and grain may be attributed to genetic factors that govern the nutrient uptake and xylem-mediated root-to-shoot translocation (Li *et al.*, 2005). The ability of the plant to mediate xylem loading with Cd and the inherently high transpiration rate enhanced Cd accumulation (Uraguchi *et al.*, 2009). Results of this study also provide evidence that *Kalu heenati* has a high potential to remediate wetland soils contaminated with Cd.

Conclusion

The risk of contamination of rice grain by Cd is very low in the soils used in this experiment. *Sudu heenati* and *Kalu heenati* accumulate more Cd in tissue than Bg 300 but the latter translocated more Cd to grains at total Cd concentrations of 15 mg kg^{-1} soil. At total 45 mg Cd kg^{-1} soil, grains of all three varieties accumulated Cd in very high concentrations.

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