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Genotypic variation in *Brassica juncea* (L.) Czern. cultivars in growth, nitrate assimilation, antioxidant responses and phytoremediation potential during cadmium stress

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Abstract: *Four cultivars of Brassica juncea i.e. TM-4, TM-2, RH-30 and T-59 were screened for seed germination and seedling growth up to 15 days in the presence of 0.5-1.5 mM cadmium (Cd). The exposure to Cd reduced seed germination and seedling growth (root and shoot length and dry weight) in all four cultivars; the effect being more severe in TM-2 and RH-30 than in TM-4 and T-59 and at 3 d than at 7 d and 15 d. The cultivars TM-4 and T-59, with higher tolerance to Cd toxicity, were selected for further analysis including the estimation of nitrate reductase (NR) and peroxidase (POD) activities, total organic nitrogen (TON), total soluble proteins, proline levels and Cd accumulation. The NR activity and total soluble proteins decreased upon Cd exposure in a concentration dependent manner, whereas TON increased significantly in 3 d seedlings upon Cd exposure. The activity of POD and proline level increased significantly as compared to the respective controls. The level of Cd accumulation was higher in T-59 than in TM-4. Therefore, T-59 was found to be the most tolerant cultivar to Cd than other three cultivars possibly due to a better capacity to transport Cd in their vacuolar sink. The variety T-59, thus, appears to be suitable for Cd phytoremediation.*

Key words: *Brassica juncea, Cadmium, Growth, Phytoremediation*
PDF of full length paper is available online

Introduction

Cadmium (Cd) is one of the most toxic heavy metals, which is released into the environment by anthropogenic pathways *e.g.* mining and smelting, dispersal of sewage sludge, power stations and Cd-rich phosphate fertilizers (Chaney, 1998). Its long persistence in the environment and accumulation by food-chain organisms make it a potential environmental hazard (Dudka and Miller, 1999; Aina *et al.*, 2007; Siddhu *et al.,* 2008; Hasan *et al.*, 2009). The toxic effects of Cd on biological systems have been reported extensively (di Toppi and Gabbrielli, 1999; Kirkham, 2006). Cadmium is reported to cause chlorosis with stunted growth, ultrastructural and physiological damages (Vecchia *et al.,* 2005; Prasad, 1995; Dinakar *et al.,* 2009; Chaudhary and Sharma, 2009), inhibit the biosynthesis of chlorophyll (Mobin and Khan, 2007), alter water balance (Barcelo and Poshenrieder, 1990), decrease activity of various enzymes (Chaudhary and Singh, 2000; Gouia *et al.*, 2003; Dong *et al.*, 2006; Mishra *et al.*, 2006) and interfere with general and membrane physiology (di Toppi and Gabbrielli 1999; Nouairi *et al.*, 2006; Chaudhary and Singh, 2000; Liu *et al.*, 2003; Lin *et al.*, 2007).

There are many plants, both aquatic and terrestrial, which can accumulate high level of the toxic metals in their tissues. Such plants can be helpful to remove the pollutants from soil and water (Singh *et al.*, 1997, 2001, 2007) to reduce their contamination; the technique is popularly known as phytoremediation. In recent times, Indian mustard *viz.*, *Brassica juncea* (L.) Czern has been one of the most studied terrestrial plants for its potentiality to extract heavy metals from soil, fly-ash and sediments (Zhu *et al.*, 1999; Singh *et al.*, 2001, 2007; Qadir *et al.*, 2004; Gupta and Sinha, 2006). This plant has been demonstrated to be a hyperaccumulator of Cd, is fast growing and possesses higher aerial biomass than many other potential metal accumulators and hence, can be used as a phytoremediator (Singh *et al.*, 2007; Nouairi *et al.*, 2006). To achieve this goal, screening high yielding cultivars of Indian mustard suitable for the various agroclimatic zones and having tolerance to heavy metals including Cd, is needed to develop phytoremediation technology for northern Indian soil contaminated with Cd. The genotypic variation in phytoremediation potential of *B. juncea* cultivars (Qadir *et al.*, 2004; Mobin and Khan, 2007) has been reported. In addition, the use of *Brassica* plants in the phytoremediation of Cd and other metals has also been demonstrated at field level or in simulated pot experiments (Ahmed *et al.,* 2001; Su and Wong, 2004; Ishikawa *et al.,* 2006). Thus, it seems worthwhile to screen appropriate plant cultivars for tolerance and accumulation of Cd, so that the best cultivar be used for phytoremediation of Cd-polluted sites without affecting growth and yield of the crop.

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