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## Frontier Article

# Growth, tolerance efficiency and phytoremediation potential of *Ricinus communis* (L.) and *Brassica juncea* (L.) in salinity and drought affected cadmium contaminated soil

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## ABSTRACT

We have previously reported that *Ricinus communis* (castor) is more tolerant to soil cadmium (Cd) and more efficient for Cd phytoremediation than *Brassica juncea* (Indian mustard) (Baudhh and Singh, 2012). In the present study, *R. communis* was found more tolerant to salinity and drought in presence of Cd and removed more Cd in a given time than Indian mustard. *R. communis* produced 23 and twelve folds higher biomass in terms of fresh weight and dry weight, respectively than that in *B. juncea* during three months when grown in Cd contaminated soil in presence of 100 mM NaCl salinity and ten day water withdrawal based drought at 90 day after sowing (DAS). Castor plants showed stronger self-protection ability in form of proline bioaccumulation ( $r^2=0.949$ ) than Indian mustard ( $r^2=0.932$ ), whereas a lower  $r^2$  for malondialdehyde (MDA) and total soluble protein in *R. communis* ( $r^2=0.914$  and  $r^2=0.915$ , respectively) than that of *B. juncea* ( $r^2=0.947$  and  $r^2=0.927$ , respectively) indicated a greater damage to cell membrane in Indian mustard during the multiple stress conditions. Though, the amount of Cd accumulated in the roots and shoots of Indian mustard was higher as per unit biomass than that in castor, total removal of the metal from soil was much higher in castor on per plant basis in the same period in presence of the stresses. *R. communis* accumulated about seventeen and 1.5 fold higher Cd in their roots and shoots, respectively than that of *B. juncea* in 90 DAS under the multiple stresses. Salinity alone enhanced Cd uptake, whereas drought stress reduced its uptake in both the plants.

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## 1. Introduction

Amongst the various strategies adopted for removal of toxic heavy metals from the contaminated sites, phytoremediation has emerged as an economical, eco-friendly and aesthetically acceptable technology in the recent years (Cecchi and Zanchi, 2005; Liu et al., 2010; Sylwia et al., 2010; Huang et al., 2011; Santana et al., 2012; Witters et al., 2012; Stingu et al., 2012). *Brassica juncea* is one of the most studied plant found tolerant to most of the toxic heavy metals and suggested to be a potential phytoremediator (Singh et al., 2007; Nouairi and Ammar, 2009; Baudhh and Singh, 2009, 2011, 2012; Sharma et al., 2010). Most of the contaminated lands bearing industrial wastes and waste water are waste lands possessing multiple stresses like salinity, drought and excessive heavy metals simultaneously. *B. juncea* have been found to be sensitive to most of the stresses and its green leaves are used as vegetable and fodder in many part of the Indian subcontinent, therefore other alternatives are required to

be investigated for removal of the metals from the contaminated agricultural ecosystems. We have recently reported *Ricinus communis* (Baudhh and Singh, 2012) and *Jatropha curcas* (Ghavri et al., 2010; Ghavri and Singh, 2010, 2012; Pandey et al., 2012) as better alternative to *B. juncea*. A considerable portion of the agricultural ecosystem supporting cultivation of *B. juncea* in Indian subcontinent is affected by drought and salinity; therefore it will be very significant to investigate comparative tolerance and phytoremediation efficiency of *B. juncea* and *R. communis* from the metal contaminated soil under these stresses. The present study is planned with this perspective to study the tolerance capability and cadmium removal by these two plants in similar agro-climatic conditions from the Cd contaminated soil under the influence of the multiple stresses.

## 2. Materials and methods

### 2.1. Plant materials and experimental design

The seeds of Indian mustard (*B. juncea* L.) cv Pusa Jai Kisan were obtained from the National Seed Disposal Centre of Indian Agricultural Research Institute (IARI), New Delhi and that of Castor (*R. communis* L.) cv Kalpi were procured from the

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