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Coordinated effects of lead toxicity and nutrient deprivation on growth, oxidative status and elemental composition of primed and non-primed rice seedlings

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A factorial growth chamber experiment was carried out to unravel the coordinated effects of Pb stress (1 mM $PbCl_2$) and different nutrient management regimes (sufficient nutrient supply, Nitrogen (N) deprivation, Phosphorus (P) deprivation and Potassium (K) deprivation) on morphological growth, Reactive Oxygen Species (ROS), antioxidants and nutrient status in primed and non-primed rice seedlings. Seeding was primed with distilled water (hydropriming; HP), 60 µM selenium (chemical priming; Se) or 100 mg L^{-1} salicylic acid (hormonal priming; SA). Results indicated that Pb toxicity did not affect the root growth, but severely reduced the shoot growth (length and biomass) of rice in N- or P-deprived seedlings. Rice seedlings grown with sufficient supply of nutrients (all nut) or K-deprivation showed no growth reduction under Pb toxicity. Exposure of Pb stress triggered the production of ROS (H_2O_2, O2•−, OH−) and lipid peroxidation rate under all the nutrient management regimes particularly under N- or P-deprivation. Moreover, the shoot accumulations of macronutrients (particularly P) were also restricted under Pb toxicity. Seed priming treatments (particularly Se and SA) were found to be significant in alleviating the undesirable effects of Pb stress on rice growth. The primed rice seedlings showed minimal oxidative damage caused by excessive generation of ROS under Pb stress and/or nutrient deprivation. Seed priming strengthened the anti-oxidative defense system of rice seedlings by regulating the activities/levels of superoxide dismutase, catalase, peroxidase and glutathione in rice leaves. Moreover, better accumulation of essential nutrients in primed rice seedlings prevented the excess uptake and translocation of Pb, as evident by the lowered shoot accumulation of Pb. In short, these results suggested the protective role of seed priming against the adversities caused by Pb toxicity and nutrient deprivation in rice seedlings.

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