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Interactive effects of EDTA and Oxalic acid on chromium uptake, translocation and photosynthetic attributes in Indian mustard (*Brassica juncea* L. var. Varuna)

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Running title: *Chelates assisted phytoextraction of chromium in Brassica juncea L.*

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29 **Abstract**

30 Present experiment was conducted to investigate the accumulation and toxicity of
31 Chromium (Cr) in Indian mustard (*Brassica juncea* L.) under ethylene diamine tetra acetic
32 acid (EDTA) and oxalic acid (OA) as chelating agents. Plants were exposed to Cr(VI) and
33 chelating agents in four experimental setups as Cr(VI), Cr(VI)+EDTA (1:1), Cr(VI)+OA
34 (1:1) and Cr(VI)+EDTA+OA (1:1:1) where each set-up comprised of 0, 6.25, 12.5 and 25.0
35 mg of Cr(VI) and/or chelating agents in 250 g of soil. Results conferred that EDTA
36 augmented bio-concentration factor in all the three doses of Cr(VI), OA considerably
37 increased translocation factor in all the treatments including control and the combined
38 application of both chelates escalated both aforesaid factors. Moreover, these chelating agents
39 helps in ameliorating Cr(VI) toxicity asserted by low degree of lipid peroxidation,
40 insubstantial damage in root and shoot length, fresh and dry biomass, chlorophyll and leaf gas
41 exchange parameters. Besides, plant showed a robust detoxification mechanism primarily by
42 significant ($p < 0.05$) production of reduced glutathione and phytochelatins among other
43 enzymatic (SOD, CAT, APX, GPX, GR) and non-enzymatic (Cys, NP-SH) antioxidants
44 under these chelating agents. Conclusively, present findings suggest that Indian mustard
45 could be used as a potential phytoremediator of Cr(VI) under the combined application of
46 EDTA and OA.

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48 **Keywords:** *Brassica juncea* L., Chromium, Chelates, Glutathione, Phytochelatins,

49 Photosynthesis, Phytoremediation.

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