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Effect of Chromium Toxicity on the Growth and Mineral Composition of Brown Mustard (*Brassica juncea* L.)

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Abstract
The present study was conducted to access the effect of chromium toxicity on the growth and mineral composition of brown mustard (*Brassica juncea* L.). The experiment was carried out in pots. Different concentration of chromium was applied to plant before germination. The results showed that increasing concentration of chromium caused reduction in growth of brown mustard. Mineral composition was also reduced.

Keywords: Chromium toxicity, Growth, Mineral composition, Brown mustard

Introduction
Chromium is a heavy metal with risk to human health. Its presence in agricultural soils can be attributed to the use of industrial effluents for irrigation (Baxter *et al*., 1983). Increase of world population has resulted in the pollution of the environment. The main factor responsible for pollution and other type of environmental degradation in any community are combined effects of pollution increased, effluents and technology (Medows *et al*., 1992).
Chromium is highly toxic non-essential element for microorganism and plants (Cervantes et al., 2001). The source of chromium in environment are both natural and anthropogenic, natural source include burning of oil and coal, petroleum from Ferro chromate refractory material, chromium steels, pigments oxidants, catalyst and fertilizers This element is also used in metal plating tanneries and oil well drilling (Abbassi et al., 1998). Sewage and fertilizers are also the sources of chromium (Pil ay et al., 2003). Chromium has its effect on certain enzymes such as catalase, peroxidase, a cytochrome oxidase, which have iron as constituent. Agarwala et al. (1962) has reported stimulation of catalase activity at excess supply of chromium. Significant toxicity of chromium was found with regard to photosynthetic pigments, photosynthesis and activity of nitrate reductase enzymes activity and protein levels of some members of algal group. (Rai et al., 1992). The direct interaction of metal with cellular components can initiate variety of metabolic responses finaly leading to a reduction in the growth of the plant (Assche and Clijsters, 1990). Chromium toxicity produces chlorosis and necrosis in plants (Cervantes et al., 2001). Several polluting metal and compounds are discharged into the water streams by tanneries. With these aspects in view, the present investigation was made to study the effect of different concentrations of chromium on the growth and mineral composition of brown mustard.

Material and methods
Brown mustard seeds were sown in the earthen pots filled with loamy soil. In each pot 8 seeds were sown and after germination five plants were retained in each pot by thinning process. Sub soil water was pumped out and applied to the plants as and when required. The experimental design was arranged in this way that every treatment was comprise three replications was (Steel *et al*,. 1996). All crop protection measures were adopted to ensure a good crop health. Five chromium levels including control, 25, 50, 75, 100 ppm were applied to fifteen days old mustard after seedlings.

After sampling the root and shoot length was measured in cm with the help of scale while the dry weight of root and shoot was measured with the help of electrical balance. Elemental analysis was carried out according to the method (AOAC, 1998). The oven dried fruit samples were grinded into fine powder and then digested by a wet digestion method. 0.5 g of samples were taken into the digestion flask, after it than add10ml HNO_3 in each sample and kept it for overnight. Then the process of digestion was carried out on a hot plate by adding 5ml Perchloric acid in the sample. The process was repeated until the sample solution becomes transparent. Then added distilled water to make the solution up to 100 ml was added to make 50 ml final solution and placed for analysis. Then standard solutions were formulated and with the help of those standards the digested samples were ready for elemental analysis.

For elemental analysis, the filtered solution samples were loaded to the atomic absorption spectrophotometer. Standard curve for each metal prepared by running samples. The elemental contents of the samples were estimated by standard curve prepared for each metal.

Statistical analysis was carry out using Microsoft Excel 2007 (Steel *et al*., 1997).

Results & Discussion

Results shown in table 1 that chromium has negative on the growth of brown mustard. The plant remain unaffected at control (0ppm) when no chromium treatment were applied in the soil and plant was most affected at 100ppm, when the chromium concentration was maximum in soil. So the effect of chromium increased with increasing chromium concentration in the soil. More accumulation of chromium was in shoots as compared to roots in brown mustard while the outcomes of the study also showed that the maximum concentration of minerals was also noted in the control. So mineral composition was also reduced in the plant by increasing amount of chromium in the soil shown in table 2.

Table 1: Effect of different concentrations of chromium on the growth of brown mustard

Parameters	Concentrations				
	Control	**25 ppm**	**50 ppm**	**75 ppm**	**100 ppm**
shoot Length(cm)	11.74±0.26	10.37±0.29	9.75±0.07	8.26±0.31	7.210±0.33
Root length (cm)	8.76±0.031	8.21±0.07	6.84±0.04	5.62±0.09	3.89±0.08
Root dry weight (g)	1.23±0.03	1.12±0.04	0.98±0.03	0.67±0.05	0.19±0.02
Shoot dry weight (g)	3.81±0.07	3.27±0.06	2.11±0.02	1.33±0.01	0.94±0.01

Many scientists have revealed that symptoms like retarded growth, deficiency of chyllorophil,marginal death of tissues, leaf epinasty, red brownish discoloration due to metal toxic effect of chromium metal (Lepp, 1981; Woolhouse, 1983). Reduction in growth of plants due to toxic effect of chromium in nutrient solution was reported by Moral *et al*., (1995). Decreased growth in terms of root and shoot lengths and weight at increasing concentration of chromium in soil might be due to adverse effect of this metal on overall metabolism of plant. Barton *et al* (2000) observed that chromium addition inhibits the shoot growth in plants (Lucerne cultures). Sharma and Sharma (1993) also reported that chromium cause reduction in plant height significantly.

The increase in the concentration of chromium in the soil from 25-100 ppm attributed to the changes of the shoot concentrations of nutrient elements shown in table 2. Increasing chromium concentrations from 25- 100 ppm in the soil decreased the N, P, K, Ca and Fe contents in mustard. This inhibition of uptake may be due to increased competition. At high Cr concentrations reduced uptake of these elements may be due to breakdown of membrane function. The concentrations of N, K, P and Ca in treatment were below the concentrations considered enough for plant growth. This was despite the concentration these elements in soil solution being within the range considered enough for the growth of plants in solution culture. The effect of Cr toxicity resembles Al toxicity, in that Al is a strong inhibitor of Ca and Mg uptake (Chatterjee and Chatterjee 2000). A slight depletion in K concentration was observed. This may be attributed to K efflux as part of a mechanism of Cr tolerance.

Table 2: Effect of different chromium concentrations on mineral contents of brassica

Treatments	Concentration						
	N	**P**	**K**	**Na**	**Ca**	**Fe**	**Zn**
0	1.53±0.23**	1.73±0.01**	2.14±0.3**	1.96±0.06*	2.91±0.01***	4.26±0.8*	2.88±0.01***
10	1.09±0.32**	1.34±.02***	1.76±0.3**	1.86±0.01***	2.87±0.02**	3.66±0.5**	1.54±0.03***
20	0.67±0.34***	0.84±0.05**	1.33±0.4*	1.01±0.04**	2.21±0.03***	2.99±0.1***	1.38±0.2**
30	0.66±0.04***	0.53±0.02*	0.74±0.1***	0.11±0.03*	1.54±0.03**	1.95±0.3**	1.30±0.2*
40	0.13±0.02***	0.34±0.01*	0.38±0.01**	0.03±0.01**	1.32±0.01***	1.24±0.1**	0.56±0.07***

Statistical significant: *= P≤ 0.1 **= P≤0.05 ***= P≤0.01

Furthermore, excess amount of chromium might have negatively affected the translocation of iron in the leaf of brassica plants. Earlier also several workers have reported inhibition of chlorophyll biosynthesis by metal in higher plants (Baszinsky *et al*., 1980, Prasad and Prasad, 1987) and in algae (Defil ippis and Pal aghy, 1976 and Hamp and Ziegler, 1981). Some heavy metals including chromium in excess amount may result into chlorosis, caused by change in concentration of essential mineral nutrients. It may also cause reduced photosynthesis resulting from stomatal closure and also reduced intercellular spaces and alteration within chloroplast (Vazquez *et al*., 1987). Excess amount of cobalt, chromium and copper had an adverse effect on biomass, concentration of iron, chlorophyl "a" and "b", protein and catalase activity in plants (Chatterjee and Chatterjee, 2000).

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