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Phytotoxicity of chromium in paddy (*Oryza sativa* L.) plants

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Abstract: *Effect of different doses of chromium on growth and some physiological parameters were investigated. Increasing doses of chromium caused reduction in growth and concentration of chlorophyll, sugar and protein in paddy leaves. At increasing doses of chromium, catalase and peroxidase activity was found to be reduced.*

Key words: *Catalase, Chlorophyll, Paddy (Oryza sativa L.) Peroxidase, Protein, Sugar.*

Introduction

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 (Pillay *et al*., 2003). Chromium has its effect on certain enzymes such as catalase, peroxidase, and cytochrome oxidase, which have iron as constituent. Agarwala *et al*. (1962) in barley, has reported stimulation of catalase activity at excess supply of chromium. Marked toxicity of chromium was found with respect to photosynthetic pigment, photosynthesis, nitrate reductase activity and protein content of some alga (Rai *et al*., 1992). The direct interaction of metal with cellular components can initiate variety of metabolic responses finally leading to a shift in the development 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 doses of chromium on the growth and metabolism of paddy.

Materials and Methods

Paddy seeds were soaked in the controlled nutrient solution with varying concentration of chromium in petridishes with the filter paper moistened with the solution on which seeds were soaked. Thirty-five seeds were germinated in each petridish.

The nutrient solution had the following composition: as M eq./1- $Ca(NO_3)_2$-8; KNO_3-4; $MgSO_4$-4, NaH_2PO_4-4; as ppm – Fe-5.6; Mn-0.55; Cu-0.046; Zn-0.065; B-0.37; Mo-0.05; Co and Ni-0.006 each.

Potassium dichromate was used to produce Cr (VI) concentration of 1.0, 2.0 and 4.0 mM. Growth in terms of root and shoot lengths were measured at regular intervals. Chlorophyll, sugar and protein concentration were estimated respectively by the method of Petering *et al*. (1940), Dubais *et al*. (1956) and Lowry *et al*. (1951). Catalase and peroxidase activities were assayed respectively by the method of Euler and Josephson (1927) and by the modified method of Luck (1963).

Results and Discussion

Increasing doses of chromium caused significant reduction in both root and shoot lengths. Activities of enzymes catalase and peroxidase were found to be significantly decreased at 1.0, 2.0 and 4.0 mM of chromium as compared to control. Chlorophyll and sugar concentration were also found to be reduced at increasing doses of same elements. However, protein concentration was found to be increased at 1.0 and 2.0 mM of chromium but it was decreased at highest dose of chromium i.e. 4.0 mM. Minimum activities of these enzymes were obtained at 4.0 mM dose of chromium; several workers have reported symptoms like reduced growth, chlorosis, necrosis, leaf epinasty, red brownish discolouration due to metal phytotoxicity (Lepp, 1981; Woolhouse, 1983). Reduced growth of tomato plants due to presence of chromium in nutrient solution was reported by Moral *et al*. (1995). Reduced growth in terms of root and shoot lengths at increasing doses of chromium might be due to adverse effect of this metal on auxin synthesis in paddy plants more so during early stages of their growth.

Excess doses of chromium may cause adverse effect on the iron metabolism of paddy plants, which might have resulted into reduced concentration of total sugar, chlorophyll and activities of enzymes catalase and peroxidase. Bisht *et al*. (1976) reported heavy metal induced iron deficiency.

Further, excess amount of chromium might have negatively affected the translocation of iron in the leaf of paddy 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 (Defillippis and Pallaghy, 1976 and Hamp and Ziegler, 1981). Increased protein concentration at initial doses of this heavy metal might be due to disturbance in balance of functional part of protein due to excess amount of chromium. Some heavy metals including chromium in excess amount may result into chlorosis,

Table – 1: Effect of different doses of chromium on growth, activity of catalase and peroxidase enzymes and concentration of chlorophyll, sugar and protein in paddy (*Oryza sativa* L.) leaves.

Parameters	Treatments Chromium concentration				
	Control	1.00 mM	2.00 mM	4.00 mM	C.D. at 5%
Shoot length (cm)	12.30±0.283	10.350±0.354	9.650±0.070	9.350±0.212	1.24
Root length (cm)	8.645±0.021	6.950±0.070	6.015±0.021	5.130±0.099	0.23
Catalase (μ mole H_2O_2 split/100 mg F.W.)	30.00±0.000	15.00±0.000	12.50±3.536	5.00±0.000	7.69
Peroxidase (Δ O.D / 100 mg F.W.)	0.085±0.002	0.017±0.002	0.028±0.000	0.037±0.002	0.009
Chlorophyll Concentration (mg/g F.W.)	1.650±0.000	1.550±0.000	1.530±0.000	1.505±0.007	0.02
Total sugar (mg/g F.W.)	1.110±0.014	0.575±0.106	0.700±0.000	0.825±0.177	0.39
Total protein (mg/g F.W.)	23.365±0.559	34.060±1.117	27.720±0.000	17.025±0.000	3.12

Value represented in mean ± SD with three replicates.

which is clearly an effect of iron deficiency in plants. This adverse effect may be 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, chlorophyll "a" and "b", protein and catalase activity in cauliflower (Chatterjee and Chatterjee, 2000).

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