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Research Paper

CADMIUM INDUCED CHANGES IN THE GROWTH AND OXIDATIVE METABOLISM OF GREEN GRAM- *Vigna radiata* LINN.

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Abstract

The effect of cadmium chloride on green gram (*Vigna radiata* Linn.) was studied using the parameters like carbohydrates, protein, chlorophyll and oxidative enzymes like superoxide dismutase, catalase and peroxidase of leaves inorder to know the possible involvement of cadmium metal in the generation of oxidative stress. Results obtained in this work showed that the application of cadmium decreased the growth of the plant interms of shoot and root growth. It also suggests that the growth of green gram with cadmium chloride can induce a concentration-dependent oxidative stress situation, characterized by the inhibition of the antioxidant systems, in leaves.

Key words: *Vigna radiata Linn., Cadmium phytotoxicity, Oxidative enzymes*.

INTRODUCTION

Phytotoxicity is a term used to describe the degree of toxic effect by a compound on the growth of plants. It is caused by a wide variety of compounds, including heavy metals, salinity, pesticides, phytotoxins or allelopathy. The sensitivity of plants to heavy metals depends on an interrelated network of physiological and molecular mechanisms such as uptake and accumulation of metals from cytoplasm to extra cellular exudates and cell wall constituents; efflux of heavy metals from cytoplasm to extra nuclear compartments including vacuoles; complexation of heavy metal ions inside the cell by various substances, for example, organic acids, phytochelatins, amino acids and metallothioneins; accumulation of osmolytes and induction of antioxidative enzymes; activation or modification of plant metabolism to allow adequate functioning of metabolic pathways and rapid repair of damaged cell structures (Cho *et al*., 2003).

Cadmium (Cd), being a highly toxic metal pollutant of soils, which inhibits the root and shoot growth (yield), affects nutrient uptake. The application of sewage sludge, waste and cadmium containing fertilizers causes the increase of cadmium content in soils. As green gram is a stress sensitive legume, the present investigation was undertaken to analyze whether cadmium produces oxidative stress during early stages of seedling development.

MATERIALS AND METHODS

Sample collection and Preparation

The healthy seeds of Green gram (*Vigna radiata* Linn.) were collected from Tamil Nadu Agricultural University (TNAU), Coimbatore. The seeds (3 sets of 1 gram each) were soaked in 10, 50 µM solution of Cadmium chloride over night. Then the seeds were sown in the earthern

pots and allowed to grow naturally for a week. Every alternate day they were watered with distilled water in the green house. At the 7th day seedlings were removed, leaves were washed and homogenized in 50 mM tris-HCl buffer (pH 7.5). Homogenates were centrifuged at 3000rpm for 20 minutes and the supernatant were used for the content of carbohydrate, protein, chlorophyll and superoxide dismutase, catalase and peroxidase using the methods of Sadasivam and Manickam, 2008.

RESULTS AND DISCUSSION

Table I- Effect of cadmium chloride on carbohydrate and protein content on the leaves of *Vigna radiata*

S.No	Treatments	Carbohydrate (mg/g)	Protein (mg/g)
1	Control	**29.8±0.26**	**110.0±1.48**
2	10µM	23.3±0.24	87.8±1.29
3	50µM	17.6±0.19	72.8±0.99

The results revealed a drastic decrease in the levels of carbohydrate and protein in cadmium treated plants in both the concentrations compared to control plants, coincides with the massive decrease in barley plant (Gubrelay *et al*., 2013) and Singh and Sinha (2005) who found decrease in soluble protein content in plant when grown on various amendments of tannery waste containing heavy metals.

Table II- Effect of cadmium chloride on chlorophyll content on the leaves of *Vigna radiata*

S.No	Treatments	Chlorophyll a (mg\g)	Chlorophyll b (mg/g)
1	Control	**1.011±0.24**	**0.26±0.04**
2	10µM	0.77±0.10	0.23±0.02
3	50µM	0.66±0.09	0.21±0.02

The level of chlorophyll a, b was found to be 1.011±0.24, 0.26±0.04 in control plants which has been reduced in 10 and 50 µM cadmium treated plants. The decline in chlorophyll content in plants exposed to Cd2+ stress is believed to be due to (a) Inhibition of important enzymes, such as protochlorophyllide reductase (Van Assche and Clijsters, 1990) and δ-aminolevulinic acid dehydratase (ALA- dehydratase) associated with chlorophyll biosynthesis (Padmaja *et al*., 1990); (b) Impairment in the supply of Mg2+, Fe2+, Zn2+, and Mg2+ (Kupper *et al*., 1996). The decrease in chlorophyll content was also reported in sunflower and in almond (Elloumi *et al*., 2007).

Table III- Effect of cadmium chloride on Superoxide dismutase, Catalase, Peroxidase activity on the leaves of *Vigna radiata*

S.No	Treatments	Superoxide dismutase (SOD)	Catalase (CAT)	Peroxidase
1	Control	**18.83±0.24**	**283.33±1.99**	**24.69±0.31**
2	10µM	13.83±0.17	204.12±1,68	14.69±0.22
3	50µM	10.71±0.11	168.53±1.29	9.10±0.13

UNITS

SOD - Amount that causes 50% reduction in the extent of NBT oxidation.

CAT - Amount of enzyme required decreasing the optical density by 0.05 units.

PEROXIDASE - 1 Micro Molar pyrogallol oxidized per min.

The level of SOD was found to be 18.83±0.24 in control plants, which has been reduced in 10 and 50 µM cadmium treated plants. SOD is a key enzyme in the plant antioxidant defences

and is encharged of the dismutation of $O_{2^{\cdot}}^{-}$ radicals to H_2O_2 and O_2 (Alscher *et al*., 2002). Reduction of SOD activity induced by Cd was reported in wheat (Milone *et al*., 2003) and bean plant (Cardinales *et al*., 1984). The level of Catalase was found to be 283.33±1.99 in control plants, which has been reduced in 10 and 50 µM cadmium treated plants. The decrease of Catalase activity in the presence of Cd ions was also described in pea plant (Dixit *et al*., 2001). The level of Peroxidase was found to be 24.69±0.31 in control plants, which has been reduced 10 and 50 µM cadmium treated plants. Peroxidase was down regulated probably by enzyme inhibition by the Cd metal, reported in wheat roots (Converso *et al*., 2000).

Hence the present investigation also supports the fact that $CdCl_2$ can induce a concentration-dependent oxidative stress situation in leaves, characterized by the inhibition of the antioxidant systems.

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