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Cadmium induced changes in Growth and Biochemical contents of Tomato *(Lycopersicon esculentum L.)*

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ABSTRACT

The effects of different concentrations (10,20,30,40 and 50 ppm) of cadmium chloride on seed germination, root length, shoot length, fresh weight, photosynthetic pigments, protein content and peroxidase activity in tomato (*Lycopersicon esculentum* L.). Higher concentration of Cadmium were reported specially at 40 and 50 µm reduced germination significantly. Leaf chlorosis, wilting and leaf abscission were observed in plants with cadmium. Protein content and sugar content were reduced in higher concentrations of cadmium. However, lower concentrations of $CdCl_2$ resulted in higher peroxidase activity in roots and shoots of tomato.

1. INTRODUCTION

Environmental pollution by metals become extensive as mining and industrial activities increased . Heavy metals have been increasing in soil due to sludge, sewage irrigation, utilization of farmyard manures, fertilizer industry and mine residues. It leads to potential risk for human health when these metals get transferred to crops to the human diet. They play an important role in the environment toxic to species above certain concentrations (Ngayila *et al.,* 2008). At high concentrations, a number of heavy metals have been reported to inhibit the growth and the productivity of crops (Liu *et al*., 2003). Cadmium is an extremely toxic metal commonly found in industrial workplaces is used extensively in electroplating, industrial paints, manufacture of some types of batteries. It is a non-essential heavy metal that does not have any metabolic function in higher plants. Under natural conditions it exists at low concentrations in most soil. It enters the soil with phosphorus fertilizers, sewage sludge and air pollutants. It has a great mobility in the soil when compared with other heavy metals (Varo *et al*., 1980). The increasing amount of cadmium in the environment affects various physiological and biochemical processes in plants (Sanita di Toppi and Gabberielli, 1999). Cadmium is a non-essential and highly toxic heavy metal, whose concentration in air, soil and waters is progressively increasing due to human activities. The most common symptom of Cd phytotoxicity is growth reduction in part due to interference of cadmium with mineral nutrition by hampering the uptake and translocation of essential elements such as Ca and K (Khan *et a*l., 1983 and Rubio *et al*., 1994). Since Ca and K are two plant nutrients that have a direct role *in* cell growth regulation (Claussen *et al*., 1997 ; Becker *et al*., 2002) the elucidation to germinate of Cd on uptake, accumulation and distribution both elements in plants seems indispensable. The objective of present study is to examine the effect of cadmium on germination, growth, photosynthetic pigments, protein content,sugar content and peroxidise activity of tomato seedling.

2. MATERIALS AND METHODS

Tomato seeds **(***Lycopersicon esculentum* L.**)** were obtained from authorized private agro centre, Cuddalore. The seeds were surface sterilized with 0.1 % Mercury chloride for 10 minutes, and then rinsed extensively with distilled water. Seeds were placed on soil filled plastic pots with different concentrations (10,20,30,40 and 50 µm) of cadmium to germinate in laboratory condition. After 7, days the rates of seed germination were determined. For each cadmium chloride concentration about 20 seeds were tested in three separate experiments. The chlorophyll, protein content and peroxidise activity were estimated 15-day-old tomato seedlings.

3. RESULTS AND DISCUSSION

Present investigation revealed that germination was inversely proportional to the concentration of Cd. The lower concentration of Cd showed increased plant height and phytomas. Cadmium affected root more than shoot, leading to a lower tolerant index for root. The phenomenon can be attributed to the fact that roots are the first organs receiving cadmium ions from soil through apoplastic transport,resulting in a higher Cd accumulation (Drazkiewicz *et al*., 2003). However higher concentration (50ppm) hampered the plant height and phytomass significantly. These observations are in agreement with those of (Mehindirata *et al*.,2000 and Ali khan and Siddhu 2006). Cadmium significantly reduced the pigment contents (chlorophyll a,b total chlorophyll and carotenoid) (**Table2**).

Heavy metals induced changes in chlorophyll contents may be ascribed to the decreased Fe contents in leaves or an impairment of the ability of roots for transport of Fe. These could be a sequence of Cd induced changes Mg and Fe contents in leaf. (Battacharyya and Choudhari 1994) reported the inhibition of chlorophyll biosynthesis at protochlorophyllide stage by interference with the enzyme protochlorophyllide reductase. Low concentration of Cd (10 ppm) did not affect soluble sugar contents but higher concentration induced a significant increase at (50 ppm) which remained nearly unchanged (**Table2**).

Inhibition in protein content at higher concentration (50 ppm) were observed while lower concentration (10 ppm) was found to elevate the protein contents. Cadmium treatment decreased the protein contents of seeds at higher concentration, which was further confirmed by Steffens (1997) , Rolia *et al*., (2010). Chlorophyll-a content exceeded that of chlorophyll-b in all test plants, which has been proved by other researches (Mobin and Nafees, 2007, Yasemin *et al*., 2008). Cadmium caused a decline in carotenoid content (Thapar *et al*., 2008). In this study, the carotenoid content fell as cadmium concentrations increased (**Table 2**).

Peroxidises which constitute a wide variety of hemecontaining enzyme act in a wide range of normal and stress related physiological processes in plants (Bruce *et al*., 1993). In *Phaseolus vulgaris* roots and ascorbate peroxidases and raised lipid peroxidation (Chaoui *et al*., 1997). Cadmium affected peroxidase activity differently. At low concentrations (10, 20 and 30ppm) the rates of peroxidase activity in both roots and shoots were higher than that 50ppm $CdCl_2$ (**Table3**).

Table 1: Effect of different concentrations of Cadmium on germination studies of tomato (*Lycopersicon esculentum*).

Concentrations of $CdCl_2$ (ppm)	Seed germination (%)	Shoot length (cm/seedling)	Root length (cm/seedling)	Fresh weight (g/seedling)	Dry weight (mg/seedling)
Control	100	9.5±0.35	7.8±0.15	3.80±0.04	2.99±0.01
10	100	9.1±0.30	7.6±0.36	2.95±0.08	2.80±0.1
20	90	8.9±0.20	6.5±0.10	2.55±0.15	2.15±0.15
30	70	8.5±0.20	5.5±0.20	2.15±0.1	1.95±0.17
40	60	7.9±0.30	5.1±0.20	1.75±0.05	1.65±0.12
50	40	7.2±0.15	4.7±0.32	1.54±0.03	1.25±0.20

Table 2: Effect of different concentrations of Cadmium photosynthetic pigments of tomato (*Lycopersicon esculentum*).

Concentrations of $CdCl_2$(ppm)	Chlorophyll a (mg/g F.W)	Chlorophyll b (mg/g F.W)	Total chlorophyll (mg/g F.W)	Carotenoid (mg/g F.W)
Control	0.59±0.05	0.45±0.01	1.04±0.01	0.25±0.01
10	0.56±0.03	0.41±0.01	0.99±0.01	0.22±0.01
20	0.45±0.12	0.38±0.02	0.83±0.01	0.20±0.01
30	0.35±0.02	0.29±0.34	0.64±0.01	0.16±0.01
40	0.31±0.03	0.25±0.01	0.56±0.01	0.13±0.01
50	0.21±0.02	0.1o±0.03	0.54±0.01	0.11±0.01

Table 3: Effect of different concentrations of Cadmium on protein,soluble sugar content and peroxidise activities in tomato (*Lycopersicon esculentum*).

Concentrations of $CdCl_2$ (ppm)	Protein	Soluble sugar	Peroxidise
Control	0.43±0.03	0.35±0.03	0.07±0.02
10	0.39±0.01	0.29±0.02	0.35±0.02
20	0.35±0.02	0.21±0.01	0.33±0.02
30	0.29±0.01	0.19±0.01	0.29±0.02
40	0.25±0.02	0.17±0.01	0.06±0.02
50	0.21±0.02	0.14±0.02	0.05±0.02

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