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CADMIUM ACCUMULATION AND ITS EFFECTS ON GROWTH AND CERTAIN METABOLIC ACTIVITIES IN TOMATO (*LYCOPERSICON ESCULENTUM*).

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ABSTRACT

This paper describes cadmium accumulation and its effects at graded concentration on growth and certain metabolic activities in tomato (Lycopersicon esculentum). High soil-Cd levels induced interveinal chlorosis in young expanding leaves which turned to necrosis at later stage of growth. Plant height, total area, total leaf biomass, total plant biomass and fruit yield decreased (up to 74%) in plant grown in Cd added solids Cadmium supply increased the number of leaves indicating that the tomato plants in response to Cd allocated a greater proportion of photo assimilate for growth and development of photosynthetic organs (leaves), Catalase activity and concentration of chlorophyll, ascorbic acid, N and P declined significantly at higher Cd supply. Cadmium accumulation was greater in root, followed in decreasing order by leaf fruit and shoot. It is concluded that cadmium, in concentrations generally in the contaminated agricultural solid, soils, is inhibitory to growth and metabolism of tomato plants.

KEYWORDS: Cadmium, Photosynthetic organ, Metabolism, Catalase.

INTRODUCTION

Cadmium a common environmental contaminant has various routes of entry into biotic component of the ecosystems. Among other major sources, some agricultural practices such as phosphatic fertilizers, town-refuse composts application, sewage, sludge disposal and mining, smelting, metal refining waste incineration and automobiles add cadmium into the environment. Agricultural soils are mainly contaminated by phosphatic fertilizers, sludge disposal and atmospheric fall out.[1,2] The accumulations of Cd in the agricultural soils and increased uptake by plants have word-wide concern since occurrence of Cd in the food chain is the most important source for human contamination.[3] Cadmium is regarded as one of the most toxic metals, although there is no rigid order of toxicity of trace metals in the environment. Being a non-essential element for both plants and animals, there are no critical concentrations below which deficiency of the element would occur. Upper critical concentrations mark the beginning of phytotoxicity. Uptake and translocation of Cd in different plant parts are related to its concentration in the soil, absorption characteristics of species and cultivars, nature of edible parts age of plants and some environmental factors.[4] The present investigation aimed at studying the accumulation and effects of cadmium on growth and metabolism of tomato sine this is one of the most widely used vegetable crop of the world.

MATERIAL AND METHODS

The present study was designed to examine cadmium accumulation and its effect on tomato plants grown at solid Cd levels generally found in contaminated agricultural solid.[2] For this purpose, well manured garden solid (pH=7.3 organic carbon=0.88%, available P=0.005% exchangeable K=0.10% cation exchange capacity=16.5 meg100g) was used. Soil was divided into four classes. Soils of class 1.2 annd 3 were supplemented with 5.00(T_1) 10.0(T_2) and 20.0(T_3) Meg Cd/Kg.respectively, soil of class 4 with no Cd supplement served as control. These soils were filled in the earthen pots of 30 cm diameter (five pots per soil class). Earlier rids with this species indicated that the container size used in these experiments did not restrict root growth. Uniformly sized, twenty day old seeding tomato solid form around the root. Five individuals were harvested immediately to determine an initial fresh to dry weight relationship. After initial observations on height, number of leaves etc. seedlings were planted in earthen pots (1per pot) filled with soils as described above. Samples were collected from the control and each set of treatment on day 45(at 65 days of plant age) and one day 75 (at 95 days of plant age). Fifty percent of plants were harvested at each sampling date. Plant height and number

of leaves, flowers, and fruits were recorded. Chlorophyll pigments were extracted in 80%acetone. The optical densities of extracts were measured at 645 and 663 mm and concentrations determined using the formula given by Mactachtan and Zalik.[6] For ascorbic acid determination, the method given by Keller and Schwager[7] was followed. The catalos activity was determined following the method described in Sharma et.al.[8] For biomass determination. Plants were separated into leaf, stem and root and oven dried separately at 80^{0C} to constant weight. Dry powdered samples were used for the determination of total nitrogen[9] and phosphorus.[10] The concentrations of Cd in different plants parts were obtained in oven-dried plant material by atomic absorption spectrometry after digestion.[11] The test was performed to test the level of signification difference.

RESULT AND DISCUSSION

Interveinal chlorosis was observed in young leaves of T_2 and T_3 plants at 30 days of growth in Cd supplemented soils. Chlorosis intensified and turned to necrosis in other 30 days. No visible injury symptoms were observed in T plants foliar chlorosis in the recently expanded leaves of tomato due to Cd supply resembled earlier findings.[12] Plant height decreased significantly at higher Cd levels (**Table: 1**).

Table 1: Effects of varying cadmium levels on development of tomato plants (mean values per plant).

Measurement	Cd (mg/Kg) 65 days	Cd (mg/Kg) 95 days
	0.00 5.00 10.00 20.00	0.00 5.00 10.00 20.00
Height	52 54 50 4	110 106 82 62
Leaf (No.)	30 32 36 40	31 33 40 44
Flower (No)	- - - -	58 52 35 24
Shoot (gDW)	5.8 5.7 4.1 3.0	13.2 12.5 7.9 6.2
Root (gDW)	1.6 1.9 2.1 1.1	2.2 2.9 1.6 1.1
Fruit (No)	- - - -	- 27 26 148
Total leaf area(cm^2)	815 812 725 605	840 826 706 580
Biomass	10.9 11.1 9.0 6.3	18.7 18.7 12.1 9.3

DW: dry weight
Level of significance: *P<0.0. =05: P<0.001 :***< 0.001.

Although the number of leaves increased successively in treated plants total leaf area and its biomass decreased significantly in T_2 and T_3 plants. There appeared an initial increase in root biomass successive decline that finally terminated to significant reduction in total plant biomass. Yield components were significantly reduced in T_2 and T_3 plants **(Table 2).**

Table 2: Effects of varying cadmium levels on chlorophyll, ascorbic acid, catalase activity and Total N and P concentrations in tomato plants.

Measurement	**Cd (mg/Kg) 65 days**	**Cd (mg/Kg) 95 days**
	0.00 5.00 10.00 20.00	**0.00 5.00 10.00 20.0**
Chlorophyll a	4.60 4.50 3.20 2.60***	3.10 3.10 2.75* 2.51***
Chlorophyll b	3.10 3.05 2.12* 1.62***	2.60 2.65 2.00* 1.38***
Ascorbic acid	11.25 11.90 8.60 6.65***	11.00 11.80 7.50 6.10***
Catalase	4.25 4.40 2.01***1.60***	4.00 3.95 0.92 0.50
Nitrogen		
Root	10.20 12.00 7.45** 5.85***	9.80 10.00 6.12** 4.10***
Shoot	12.25 2.25 11.80 10.50*	10.30 10.45 9.40 8.70*
Leaf	28.50 28.00 21.20* 15.10***	22.20 20.51 12.60 8.52***
Phosphorus		
Root	3.20 3.51 3.86 2.95	3.00 3.40 2.55* 1.92***
Shoot	4.50 4.45 4.10 3.45**	4.10 4.00 3.44** 2.80**

Values in mg g^{1}dry wt.unless mentioned otherwise 1m molesH_2O_2 decomposed /100 mg fresh wt. Levelofsignificance:*P<0.05:<0.01:***P<0. wt.Levelofsignificance:*P<0.05:<0.01:***P<0.001.

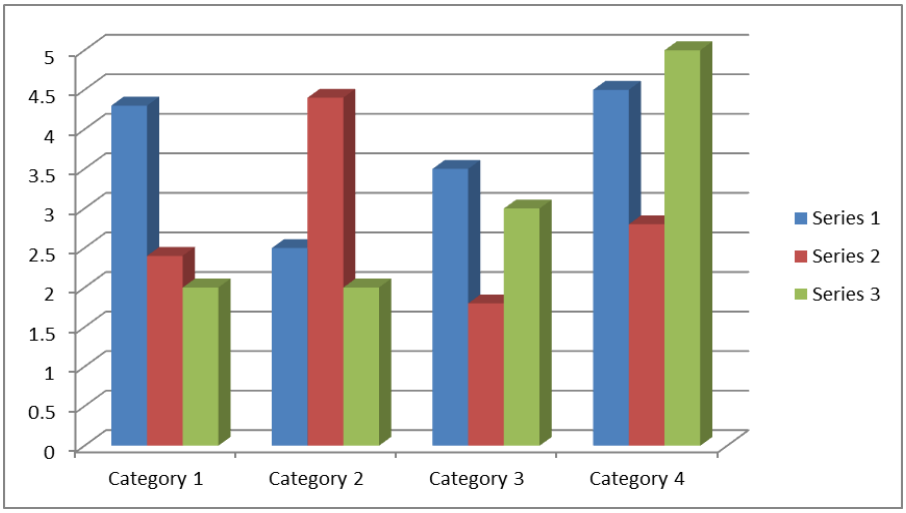

Fig. 1: Effects of varying cadmium levels on chlorophyll, ascorbic acid, catalase activity and Total N and P concentrations in tomato plants.

Ascorbic acid, however, showed a slight increase in T_1 plants. Catalase activity reduced significantly in T_2 and T_3 plant. Total N and P concentrations, except an initial increase in root of T_1 plant decreased in all the treatment compared with the control and the maximum decline was observed in leaf. The decrease in chlorophyll concentration as also reported by Hunter and Vegnano[14] had a clear impact on plants photosynthetic efficiency and hence on plant biomass accumulation. Ascorbic acid and catalase activity showed a slight improvement at 5 mg/Kg of Cd supply. Poscherieder et.al.[15] Have reported increased catalase activity at high Cd supply coincides with the findings in barley[13] Tomato roots showed an initial increase in biomass Roots of T_1 plants retained N and P at initial stage indicating reduced translocation of these nutrients to above ground plant parts at low level of cadmium.

The tissue concentration of cadmium was greatest in root followed in decreasing order by leaf, fruit and shoot in all treatments. **(Table 3.).**

Table 3: Cadmium accumulation (µg/g/dry wt.) in different parts of tomato plant grown in soils supplemented with varying of cadmium.

Measurement	Cd(mg/Kg) 65 days	Cd (mg/Kg) 95 days
	0.00 5.00 10.00 20.00	0.00 5.00 10.00 20.00
Root	ND 9.22 23.54 36.10 ±0.85 ±2.10 ±2.80	ND 13.25 32.65 69.00 ±1.12 ±2.80 ±5.20
Shoot	ND 3.10 6.95 10.12 ±0.22 ±0.50 ±1.10	ND 5.10 9.20 13.15 ±1.40 ±1.75 ±1.10
Leaf	ND 7.50 16.20 22.75 ±0.60 ±1.12 ±2.15	ND 11.35 26.20 48.50 ±1.10 ±1.80 ±3.25
Fruit	ND - - ND	10.45 26.15 46.18 ±0.92 ±1.12 ±2.80

ND: Not detectable.
Values are mean ISE for three replicate samples.

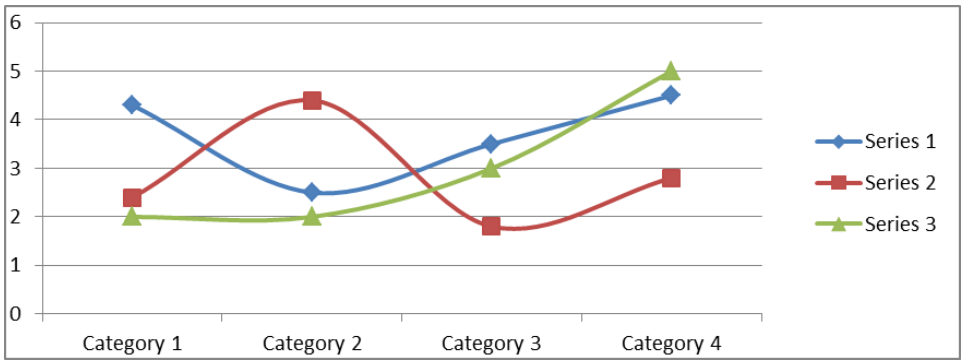

Fig. 2: Cadmium accumulation (µg/g/dry wt.) in different parts of tomato plant grown in soils supplemented with varying of cadmium.

The accumulation of cadmium in different parts of the tomato plant was similar with an earlier report John[16] reported concentration of Cd in the leaf of eight food crops in soil supplement with 40 mg Cd/Kg ranged from 18.5 mg/Kg (cauliflower) to 264.7 mg/Kg (radish). Jarvis et.al[17] using 23 different species of crops, observed the Cd accumulation in shoot was significantly low. The study indicated that cadmium in concentrations generally found in agricultural soils receiving phosphates fertilizers and sewage sludge disposal, is inhibitory to growth and metabolism of tomato plants. Furthermore, cadmium is an important constituent of a number of a number of biocides used in agricultural to increase yield. Since tomatoes are used in the cooked vegetables as well as in salads and chatni preparations of Indian recipes, accumulation of cadmium in the fruits may have severe consequences in long-run.

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