



**ORIGINAL ARTICLE**

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## **Studies On The Effect Of Cadmium Chloride With Super Phosphate On *Capsicum annum* L.**

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### **ABSTRACT**

*In this study carried out to know the toxic effect of Cadmium chloride alone and which with 10% of super phosphate on Capsicum annum by seed germination percentage, shoot length, root length, fresh weight, dry weight, leaf number, leaf area and biochemical content were analysed such as chlorophyll 'a' & 'b', total chlorophyll, total sugar and starch. The experiments were carried out by pot cultures in the duration of four weeks. Plant samples were collected from end of every week and then they were subjected to various parameters and values are tabulated. The toxicity of cadmium chloride was reduced in the additional fertilizer of 10% of super phosphate.*

*Keywords: Cadmium Toxicity, Capsicum annum*

Received 10.06.2015

Revised 10.08.2015

Accepted 19.09.2015

### **INTRODUCTION**

Heavy metals are elements having densities greater than 5 g cm<sup>3</sup> and denote metals and metalloids that are associated with pollution and toxicity but also include essential elements (1). Heavy metals may enter the human body through food, water, air or absorption through the skin (6). Heavy metal toxicity and the danger of their bioaccumulation in the food chain represent one of the major environmental and health problems of our modern society. Heavy metals interfere with several metabolic processes, causing toxicity to the plants as exhibited by reduced seed germination, root and shoots growth and phytomass, chlorosis, photosynthetic impairing, stunting and finally plant death (5&7).

Cadmium chloride is a crystal structure, composed of two-dimensional layers of ions, it is known as CdCl<sub>2</sub>·H<sub>2</sub>O and CdCl<sub>2</sub>·5H<sub>2</sub>O (3). The objectives of this study is to determine the effects of Cadmium chloride with Superphosphate combination on seed germination, plant growth, biomass and examine their uptake by *Capsicum annum* plants.

### **MATERIALS AND METHODS**

The laboratory experiments were conducted in the department of Botany, Government Arts College, Thiruvannamalai, Tamil Nadu, India. The present study was carried out to analyse the effect of CdCl<sub>2</sub> and super phosphate on seed germination percentage, biomass and biochemical compounds of *Capsicum annum*. The experiments were carried out by pot cultures. The selected plants *Capsicum annum* were used on an experimental work on this study. The duration of the experimental period was 28 days. Healthy seeds, especially uniform size, colour and weight were chosen for the experiments.

The experiments were carried out during the period of January-February 2015. *Capsicum annum* plants were grown in pots in untreated soil (control) and in soil with individual amount of cadmium chloride (5, 10, 25, 50 and 100%) and with super phosphate (10%) of soil. Each pot contained 3kg of air dried soil. Cadmium chloride was finally powdered and applied to the surface of soil, which was thoroughly mixed with the soil. Ten seeds were sowed in each pot.

Plant samples were collected from First week to fourth week (I, II, III and IV<sup>th</sup> week) and after plant materials were used to screen the effect of test samples especially morphological and biochemical characters. Three plants from each replicate of a pot were analysed for its various parameters and the average was calculated. These mean values of the replicates were tabulated.

In this experimental part seed germination percentage, shoot length, root length, the fresh weight, dry weight, leaf number, leaf area and biochemical content such as chlorophyll 'a', chlorophyll 'b', total chlorophyll, total sugar and starch were analysed and also the morphological studies of cadmium chloride and super phosphate on *Capsicum annum*, seed germination percentage, vigour index, tolerance index and percentage of phytotoxicity were analysed.

**Table – 1: Effect of Cadmium chloride and Super phosphate on morphological studies of *Capsicum annum* seedlings**

S.No	In different concentrations	Germination percentage	Vigour index	Tolerance index	Percentage of phytotoxicity
1	Control	100.00	1156	-	-
2	5 % Cadmium chloride	100.00	1293	1.0236	4.36
3	10 % Cadmium chloride	89.00	1517.38	0.8295	7.04
4	25 % Cadmium chloride	81.00	1400.93	0.7916	10.83
5	50 % Cadmium chloride	72.00	1283.76	0.7359	16.40
6	100% Cadmium chloride	67.00	1041.85	0.6034	29.65
7	5 % Cadmium chloride +10 % Super phosphate	99'00	2310	1.0436	2.14
8	10 % Cadmium chloride +10 % Super phosphate	100.00	2419	1.2417	2.78
9	25 % Cadmium chloride +10 % Super phosphate	100.00	2566.83	1.3629	3.17
10	50 % Cadmium chloride +10 % Super phosphate	93.00	2436.67	1.1516	4.06
11	100 % Cadmium chloride + 10 % Super phosphate	88.00	2393.74	1.0618	14.28

**Table – 2: Effect of Cadmium chloride and Super phosphate on Shoot length (cm Plant<sup>-1</sup>) of Seedlings of *Capsicum annum***

S.No	In different concentrations	I Week (cm)	II Week (cm)	III Week (cm)	IV Week (cm)
1	Control	9.9	13.2	17.8	21.3
2	5 % Cadmium chloride	10.3	13.5	18.1	21.5
3	10 % Cadmium chloride	10.7	13.7	18.4	21.7
4	25 % Cadmium chloride	10.1	13.4	18.2	21.4
5	50 % Cadmium chloride	9.6	13.3	17.9	21.2
6	100 % Cadmium chloride	9.0	12.9	17.6	20.9
7	5 % Cadmium chloride + 10 % Super phosphate	10.2	13.9	18.7	22.1
8	10 % Cadmium chloride + 10 % Super phosphate	10.9	14.2	18.9	21.9
9	25 % Cadmium chloride + 10 % Super phosphate	11.3	14.6	19.1	22.3
10	50 % Cadmium chloride + 10 % Super phosphate	10.8	14.3	18.8	21.8
11	100 % Cadmium chloride + 10 % Super phosphate	10.6	13.9	18.3	21.0

**Table – 3: Changes in Seedlings of Root length of *Capsicum annum***

S.No	In different concentrations	I Week(cm)	II Week (cm)	III Week (cm)	IV Week (cm)
1	Control	5.5	8.7	12.6	16.4
2	5 % Cadmium chloride	5.8	9.0	12.9	16.7
3	10 % Cadmium chloride	6.1	9.3	13.3	17.0
4	25 % Cadmium chloride	5.7	9.1	13.1	16.9
5	50 % Cadmium chloride	5.4	8.9	12.8	16.6
6	100 % Cadmium chloride	5.1	8.6	12.5	16.3
7	5 % Cadmium chloride + 10 % Super phosphate	6.4	9.7	13.8	17.6
8	10 % Cadmium chloride + 10 % Super phosphate	6.6	9.9	14.1	17.9
9	25 % Cadmium chloride + 10 % Super phosphate	6.9	10.2	14.5	18.2
10	50 % Cadmium chloride + 10 % Super phosphate	6.3	9.8	14.3	17.8
11	100 % Cadmium chloride + 10 % Super phosphate	5.9	9.5	13.9	17.5

**Table – 4: Influence of Cadmium chloride and Super phosphate on Fresh weight (gm plant<sup>-1</sup>) of seedlings of *Capsicum annum***

S.No	In different concentrations	I Week (cm)	II Week (cm)	III Week (cm)	IV Week (cm)
1	Control	2.120	4.240	6.960	9.160
2	5 % Cadmium chloride	2.170	4.340	7.260	9.190
3	10 % Cadmium chloride	2.190	4.380	7.470	9.250
4	25 % Cadmium chloride	2.165	4.330	7.430	9.210
5	50 % Cadmium chloride	2.110	4.280	7.380	9.180
6	100 % Cadmium chloride	1.922	4.244	7.320	9.130
7	5 % Cadmium chloride + 10 % Super phosphate	2.310	4.420	7.530	9.200
8	10 % Cadmium chloride + 10 % Super phosphate	2.360	4.380	7.590	9.260
9	25 % Cadmium chloride + 10 % Super phosphate	2.420	4.430	7.670	9.330
10	50 % Cadmium chloride + 10 % Super phosphate	2.380	4.375	7.610	9.295
11	100 % Cadmium chloride + 10 % Super phosphate	2.325	4.320	7.560	9.210

**Table – 5: Impact of Cadmium chloride and Super phosphate on Dry weight (gm plant<sup>-1</sup>) of *Capsicum annum* seedlings.**

S.No	In different concentrations	I Week (cm)	II Week (cm)	III Week (cm)	IV Week (cm)
1	Control	0.630	0.970	2.120	4.380
2	5 % Cadmium chloride	0.680	1.030	1.160	4.420
3	10 % Cadmium chloride	0.750	1.090	2.200	4.470
4	25 % Cadmium chloride	0.730	1.060	2.190	4.430
5	50 % Cadmium chloride	0.675	1.010	2.140	4.390
6	100 % Cadmium chloride	0.620	0.980	2.100	4.320
7	5 % Cadmium chloride + 10 % Super phosphate	0.800	1.120	2.350	4.500
8	10 % Cadmium chloride + 10 % Super phosphate	0.850	1.170	2.390	4.540
9	25 % Cadmium chloride + 10 % Super phosphate	0.880	1.200	2.420	4.560
10	50 % Cadmium chloride + 10 % Super phosphate	0.790	1.120	2.380	4.490
11	100 % Cadmium chloride + 10 % Super phosphate	0.740	1.080	2.310	4.460

**Table – 6: Efficacy of Cadmium chloride and super phosphate on leaf number (plant<sup>-1</sup>) of *Capsicum annum***

S.No	In different concentrations	I Week (cm)	II Week (cm)	III Week (cm)	IV Week (cm)
1	Control	5.19	8.80	12.60	13.60
2	5 % Cadmium chloride	6.60	9.00	13.02	14.88
3	10 % Cadmium chloride	7.97	10.40	14.80	16.60
4	25 % Cadmium chloride	6.26	8.17	8.40	15.50
5	50 % Cadmium chloride	5.05	7.80	7.62	13.57
6	100 % Cadmium chloride	4.85	6.47	7.01	12.78
7	5 % Cadmium chloride + 10 % Super phosphate	7.60	10.40	15.80	15.16
8	10 % Cadmium chloride + 10 % Super phosphate	8.0	12	17	19
9	25 % Cadmium chloride + 10 % Super phosphate	8.0	14	19	22
10	50 % Cadmium chloride + 10 % Super phosphate	6.0	11	15	20
11	100 % Cadmium chloride + 10 % Super phosphate	5.0	10	13	18

**Table – 7:Effect of Cadmium chloride and super phosphate on leaf area (cm plant<sup>-1</sup>) of *Capsicum annum***

S.No	In different concentrations	I Week (cm)	II Week (cm)	III Week (cm)	IV Week (cm)
1	Control	17.37	14.62	20.90	29.08
2	5 % Cadmium chloride	18.37	15.89	21.07	32.16
3	10 % Cadmium chloride	19.93	18.80	23.18	34.05
4	25 % Cadmium chloride	16.40	16.32	22.00	33.26
5	50 % Cadmium chloride	14.77	13.44	19.78	31.79
6	100 % Cadmium chloride	13.47	11.23	17.01	28.94
7	5 % Cadmium chloride + 10 % Super phosphate	18.72	17.611	24.15	35.23
8	10 % Cadmium chloride + 10 % Super phosphate	16.24	18.11	25.11	36.40
9	25 % Cadmium chloride + 10 % Super phosphate	13.42	20.46	27.90	38.72
10	50 % Cadmium chloride + 10 % Super phosphate	12.78	19.31	26.47	37.67
11	100 % Cadmium chloride + 10 % Super phosphate	10.63	17.19	25.07	34.63

**Table – 8:Effect of Cadmium chloride and super phosphate on chlorophyll –‘a’ content (mg g<sup>-1</sup> fresh weight) of *Capsicum annum***

S.No	In different concentrations	I Week (cm)	II Week (cm)	III Week (cm)	IV Week (cm)
1	Control	0.329	0.563	0.823	0.873
2	5 % Cadmium chloride	0.364	0.577	0.848	0.979
3	10 % Cadmium chloride	0.394	0.598	0.925	0.983
4	25 % Cadmium chloride	0.270	0.459	0.763	0.755
5	50 % Cadmium chloride	0.242	0.406	0.726	0.716
6	100 % Cadmium chloride	0.223	0.354	0.688	0.651
7	5 % Cadmium chloride + 10 % Super phosphate	0.387	0.630	0.873	0.986
8	10 % Cadmium chloride + 10 % Super phosphate	0.455	0.671	0.973	0.991
9	25 % Cadmium chloride + 10 % Super phosphate	0.489	0.788	0.987	0.998
10	50 % Cadmium chloride + 10 % Super phosphate	0.463	0.697	0.868	0.886
11	100 % Cadmium chloride + 10 % Super phosphate	0.406	0.533	0.736	0.817

**Table – 9:Effect of Cadmium chloride and super phosphate on chlorophyll –‘b’ content (mg g<sup>-1</sup> fresh weight) of *Capsicum annum***

S.No	In different concentrations	I Week (cm)	II Week (cm)	III Week (cm)	IV Week (cm)
1	Control	0.153	0.355	0.554	0.652
2	5 % Cadmium chloride	0.183	0.389	0.584	0.709
3	10 % Cadmium chloride	0.196	0.440	0.505	0.792
4	25 % Cadmium chloride	0.166	0.315	0.430	0.557
5	50 % Cadmium chloride	0.139	0.288	0.399	0.524
6	100 % Cadmium chloride	0.069	0.229	0.309	0.456
7	5 % Cadmium chloride +10 % Super phosphate	0.239	0.461	0.599	0.725
8	10 % Cadmium chloride +10 % Super phosphate	0.293	0.493	0.602	0.857
9	25 % Cadmium chloride +10 % Super phosphate	0.356	0.529	0.673	0.883
10	50 % Cadmium chloride +10 % Super phosphate	0.317	0.467	0.626	0.767
11	100 % Cadmium chloride + 10 % Super phosphate	0.270	0.434	0.587	0.603

**Table -10: Influence of Cadmium chloride and super phosphate on total chlorophyll content (mg g<sup>-1</sup> fresh weight) of *Capsicum annum***

S.No	In different concentrations	I Week (cm)	II Week (cm)	III Week (cm)	IV Week(cm)
1	Control	0.382	0.855	1.265	1.396
2	5 % Cadmium chloride	0.451	0.869	1.279	1.685
3	10 % Cadmium chloride	0.483	0.898	1.393	1.718
4	25 % Cadmium chloride	0.276	0.668	1.195	1.211
5	50 % Cadmium chloride	0.226	0.592	1.117	1.206
6	100 % Cadmium chloride	0.298	0.485	0.993	1.142
7	5 % Cadmium chloride + 10 % Super phosphate	0.524	0.886	1.394	1.205
8	10 % Cadmium chloride + 10 % Super phosphate	0.589	0.923	1.457	1.283
9	25 % Cadmium chloride + 10 % Super phosphate	0.636	1.106	1.489	1.398
10	50 % Cadmium chloride + 10 % Super phosphate	0.552	0.975	1.336	1.356
11	100 % Cadmium chloride + 10 % Super phosphate	0.516	0.883	1.263	1.271

**Table - 11: Impact of Cadmium chloride and super phosphate on total sugar content (mg g<sup>-1</sup> fresh weight) of *Capsicum annum***

S.No	In different concentrations	I Week (cm)	II Week (cm)	III Week (cm)	IV Week (cm)
1	Control	3.107	9.031	11.058	11.024
2	5 % Cadmium chloride	3.426	9.513	11.848	12.188
3	10 % Cadmium chloride	4.817	9.931	12.260	12.813
4	25 % Cadmium chloride	3.366	6.923	9.425	10.529
5	50 % Cadmium chloride	3.184	6.279	8.643	10.182
6	100 % Cadmium chloride	2.775	5.613	7.031	9.514
7	5 % Cadmium chloride + 10 % Super phosphate	4.713	9.817	12.969	10.895
8	10 % Cadmium chloride + 10 % Super phosphate	5.178	9.976	13.156	12.907
9	25 % Cadmium chloride + 10 % Super phosphate	5.356	10.143	13.367	12.975
10	50 % Cadmium chloride + 10 % Super phosphate	4.893	10.104	12.001	10.675
11	100 % Cadmium chloride + 10 % Super phosphate	4.732	9.095	11.038	8.399

**Table - 12: Effect of Cadmium chloride and super phosphate on starch content (mg g<sup>-1</sup> fresh weight) of *Capsicum annum***

S.No	In different concentrations	I Week (cm)	II Week (cm)	III Week (cm)	IV Week (cm)
1	Control	3.732	4.527	5.925	7.895
2	5 % Cadmium chloride	4.244	5.119	6.548	8.233
3	10 % Cadmium chloride	4.566	5.249	6.798	8.645
4	25 % Cadmium chloride	3.224	4.102	6.432	8.243
5	50 % Cadmium chloride	2.539	3.429	5.823	7.791
6	100 % Cadmium chloride	1.825	2.569	5.123	7.122
7	5 % Cadmium chloride + 10 % Super phosphate	4.418	5.873	6.632	8.648
8	10 % Cadmium chloride + 10 % Super phosphate	4.572	5.981	6.884	8.972
9	25 % Cadmium chloride + 10 % Super phosphate	4.873	6.213	6.927	9.432
10	50 % Cadmium chloride + 10 % Super phosphate	3.312	5.648	5.784	8.723
11	100 % Cadmium chloride + 10 % Super phosphate	3.220	5.327	5.923	8.325

**Table – 13: Changes of amino acid contents (mg g<sup>-1</sup> fresh weight) of *Capsicum annum***

S.No	In different concentrations	I Week (cm)	II Week(cm)	III Week (cm)	IV Week (cm)
1	Control	2.293	3.312	5.282	6.463
2	5 % Cadmium chloride	3.523	4.576	6.565	7.675
3	10 % Cadmium chloride	3.668	4.757	6.329	7.734
4	25 % Cadmium chloride	2.038	3.225	5.060	6.321
5	50 % Cadmium chloride	1.786	2.867	4.675	5.785
6	100 % Cadmium chloride	1.442	2.546	4.249	5.472
7	5 % Cadmium chloride + 10 % Super phosphate	4.185	5.287	6.722	7.959
8	10 % Cadmium chloride + 10 % Super phosphate	4.658	5.674	7.351	8.829
9	25 % Cadmium chloride + 10 % Super phosphate	5.015	6.472	7.677	8.932
10	50 % Cadmium chloride + 10 % Super phosphate	4.867	5.378	6.300	7.132
11	100 % Cadmium chloride + 10 % Super phosphate	4.059	4.675	5.867	6.675

## RESULTS AND DISCUSSION

The toxicological studies, the effect of Cadmium chloride with super phosphate on the plant of Chilli (*Capsicum annum*L.) were carried out. Individual compound of the cadmium chloride and with 10% super phosphate of different concentrations especially C, 5, 10, 25, 50 and 100 % were analyzed with equal durations especially I, II, III and IV week of pot culture.

The effectiveness were analyzed through the seed germination percentage, shoot length, root length, the fresh weight, dry weight, leaf number, leaf area and biochemical content such as chlorophyll 'a', chlorophyll 'b', total chlorophyll, total sugar and starch.

The morphological studies of cadmium chloride and super phosphate on *Capsicum annum*, seed germination percentage, vigour index, tolerance index and percentage of phytotoxicity were analysed in this experimental part. The effect of cadmium chloride was nullifying with 10% of Super phosphate. Cent percentage of seed germination observed on the 10% & 25% of cadmium chloride with 10% super phosphate. The lowest seed germination recorded from 100% cadmium chloride (Table 1; Graph 1- 4).

Vigour index was higher in 25 + 10% of cadmium chloride and Super phosphate and lower in 100% of cadmium chloride (Table -1). The same responses were recorded from the tolerance index studies, shoot length rootlength, fresh weight, dry weight, leafnumber and leaf area of seedlings and also the biochemical contents such as chlorophyll –'a', chlorophyll –'b', total chlorophyll, total sugar, starch and amino acids of *Capsicum annum*(Table 1-13).

The percentage of phytotoxicity was higher in higher concentration of cadmium chloride especially 50 and 100% of cadmium chloride. The effect of cadmium chloride and Super phosphate were measured from the seedling of this plant, the effectiveness were recorded from first week to fourth week (Table-1).

In this study, the morphological studies of cadmium chloride and super phosphate on *Capsicum annum*, seed germination percentage, vigour index, tolerance index and percentage of phytotoxicity were analysed in this experimental part. The effect of cadmium chloride was nullifying with 10% of Super phosphate. Cent percentage of seed germination observed on the 10% & 25% of cadmium chloride with 10% Super phosphate . The lowest seed germination recorded from 10% cadmium chloride. This type of work carried out and reported that, In higher plants and trees, the effect of Cr on photosynthesis is well documented. However, it is not well understood to what extent Cr-induced inhibition of photosynthesis is due to disorganization of chloroplasts' ultra structure (9), inhibition of electron transport or the influence of Cr on the enzymes of the Calvin cycle. Chromate is used as a Hill reagent by isolated chloroplast (4).

The phytoavailable cadmium chloride and super phosphate is usually very low due to its strong association with organic matter, Fe-Mn oxides, clays and precipitation as carbonates, hydroxides and phosphates (8).

Phytoremediation using trees provides a potential opportunity to extract or stabilize metals. Phytoextraction (uptake) involves the use of high yielding plants that readily transport targeted metals from soil to vegetation, allowing removal of metals by harvesting the plants, without damaging the soil or requiring its disposal to landfill.

Phytoremediation can be used to remove not only metals (e.g. Ag, Cd, Co, Cr, Cu, Hg, Mn, Mo, Ni, Pb, Zn) but also radionuclides (e.g. 90Sr, 137Cs, 239Pu, 234U, 238U) and certain organic compounds (2).

## CONCLUSION

The present work concluded the effectiveness of cadmium chloride 25 mg/kg + 10 mg/kg of 10mg super phosphate on *Capsicum annuum*. This study indicated that cadmium chloride had very low toxic effects on seed germination, shoot length, root length and biochemical profile but this toxicity level also reduced by the addition of super phosphate with cadmium chloride.

Thus, it is evident from the several research reports that judicious use and presence of heavy metals have toxic effects on plants, animals and other living organisms and affects the same after certain limits. Therefore, it is well needed to intensify the research programmes for better understanding of heavy metal toxicity on plants and allied areas to maintain the ecological harmony of the globe. Heavy metal toxicity was reduced with help of super phosphate as a way metal polluted land was leached by the plant enriched with these type of fertilizers.

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## CITATION OF THIS ARTICLE

Nirmala, R., Suresh, V. and Suresh Kumar, J. Studies On The Effect Of Cadmium Chloride With Super Phosphate On *Capsicum annuum* L.. Bull. Env. Pharmacol. Life Sci., Vol 3 [12] November 2015: 79-85