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Studies on the effect of cadmium chloride with super phosphate on *Capsicum annuum* l. and *Acora calamus* l.

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Abstract

Heavy metals such as cadmium chloride, lead, mercury, chromium, cobalt etc. may cause many problems to plants, animals and the health of human beings. In this research, the effect of cadmium chloride on seed germination percentage, biomass and biochemical compounds of *Capsicum annum* L. and *Acoras calamus* L. were investigated. The experiments were carried out by pot cultures and during the period of four weeks. The samples were collected after 28th day and used for morphological and biochemical studies. The results of this study indicated that cadmium chloride with super phosphate had very low toxic effects on seed germination than cadmium chloride treated seeds.

Keywords: *Capsicum annuum*, *Acora calamus*, pollutants

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Introduction

Inorganic pollutants occur as natural elements in the earth's crust or atmosphere and human activities such as mining, industry, agriculture and military activities promote their release into the environment, leading to toxicity (Fargasova, 1994) heavy metals may enter the human body through food, water, air or absorption through the skin (Life Extention, 2003). Heavy metals interferes 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 (Gardea-Torresday et al., 2004; Roy et al., 2005). Unlike organic compounds, metals cannot be degraded (Salt et al., 1995) and their cleanup requires their immobilization and toxicity reduction or removal. Currently, conventional remediation methods of heavy metal contaminated soils include electro-kinetic treatment, chemical oxidation or reduction, leaching, solidification, vitrification, excavation and offsite treatment. But a majority of these technologies are costly to implement and cause further disturbance to the already damaged environment (Bio-Wise, 2003).

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 (EPA, 1996). Some of them are dangerous to health or to the environment (Eg. Mercury, Cadmium, Lead, Chromium) (Michael Hogan, 2010). Certain elements are actually necessary for humans in minute amounts (Co, Cu, Cr, Mn, Ni) while others are carcinogenic or toxic, affecting, among others, the central nervous system (Mn, Hg, Pb, Ar), the kidneys or

liver (mercury, lead, cadmium, copper) or skin, bones, or teeth (nickel, cadmium, copper, chromium) (Ron Zevenhoven, 2001). The objectives of this study is to determine the effects of cadmium chloride with phosphate combination on seed germination, plant growth, biomass and examine their uptake by *Capsicum annuum* L. and *Acorus calamus* L. plants.

Materials and Methods

The present study was carried out to analyse the effect of $CdCl_2$ on seed germination percentage, biomass and biochemical compounds of *Capsicum annuum* and *Acoras calamus*. The experiments were carried out by pot cultures. Experiments were carried out during the 28 days. Healthy seeds especially uniform size, colour and weight were choosen for the experiments. *Capsicum annuum* L. and *Acoras calamus* L. plants were grown in pots in untreated soil (control) and in soil to which cadmium chloride had been applied 10 mg/kg of soil and in soil 10 mg of cadmium chloride with 50 mg of super phosphate. Plastic mugs were used as pots. Each pots contained 3 kg of soil and in another type along with cadmium chloride 50 mg of super phosphste is used, which was thoroughly mixed with the soil. Ten seeds were sowed in each pot. All parts were watered in twice a day. Three sets of replicates were maintained for the entire work. After first and second week, the seeds were uprooted and used for the experimental studies. Plant samples were collected after 28^{th} day and used for morphological and biochemical studies. Three plants from each replicates of a pot were analysed for its various parameters and the average was calculated. These mean values of the replicated were tabulated.

Morphological parameters

The morphological parameters such as length of root and shoot, number of rootlets, dry weight of plantlets were determined for every sample.

Dry matter production (g/plant^{-1}): To estimate the dry weight, root and shoot portions were separated and dried at 80^0C for 48 hrs in a hot air oven and then weighed using digital balance.

Results

Effect of heavy metals on seed germination

The present research demonstrated a concentration dependent inhibition of the seed germination with regards to 10 mg/kg of cadmium chloride and 10 mg/kg of cadmium chloride with 50 mg super phosphate (Table 1). The results of this study indicated that cadmium chloride levels had very low toxic effects on seed germination while cadmium chloride with super phosphate at the same doses increased seed germination.

Effect of heavy metals on root growth

Presence of super phosphate with heavy metal concentration in the soil media caused root length decrease with stunt growth of roots (Table 1 & 2). The dose of 10 mg/kg of cadmium chloride promoted the root growth of the plants as compared to the root growth of the plants treated with soil consisting of heavy metal with super phosphate but not as compared to control plants.

Effect of heavy metals on shoot growth

The effects of heavy metals and heavy metal with super phosphate on the shoot growth are different from their effects on root growth (Table 1 & 2). The shoot

length was found slightly reduced than the control *Capsicum* sp. and *Acorus calamus* plants in pot consisting of super phosphate and cadmium chloride.

Effect of heavy metals on biochemical content

Out of this experiment super phosphate with heavy metal supplemented plants gave higher profile in

Table 1. Effect of cadmium chloride and super phosphate on the growth of *Capsicum annuum* L

Parts Length (cm)	7th day			14th day			21st day			28th day		
	Control	10% $CdCl_2$	10% $CdCl_2$ + Super phosphate	Control	10% $CdCl_2$	10% $CdCl_2$ + Super phosphate	Control	10% $CdCl_2$	10% $CdCl_2$ + Super phosphate	Control	10% $CdCl_2$	10% $CdCl_2$ + Super phosphate
Roots	22	12	15	35	23	28	48	30	40	60	35	48
Rootlets	28	24	22	45	43	32	70	69	48	82	76	59
Stem	98	53	76	130	120	126	159	148	155	170	153	168
Leaves	3	3	3	5	5	5	7	9	7	9	14	8
Leaf length	20	16	18	52	30	43	67	38	50	80	45	57
Whole plant height	120	65	91	165	143	154	207	178	195	230	188	216

Table 2. Effect of cadmium chloride and super phosphate on the growth of *Acoras calamus* L

Parts Length (cm)	7th day			14th day			21st day			28th day		
	Control	10% $CdCl_2$	10% $CdCl_2$ + Super phosphate	Control	10% $CdCl_2$	10% $CdCl_2$ + Super phosphate	Control	10% $CdCl_2$	10% $CdCl_2$ + Super phosphate	Control	10% $CdCl_2$	10% $CdCl_2$ + Super phosphate
Roots	73	48	65	130	75	102	165	98	113	190	110	125
Rootlets												
Stem	32	18	24	66	27	43	83	39	68	95	48	75
leaves	2	2	2	4	4	4	5	5	4	7	6	5
Leaf length	98	62	73	188	98	145	133	408	179	285	155	186
Whole plant height	220	216	208	350	335	312	408	133	390	452	432	413

Table 3. Effect of cadmium chloride and super phosphate on biochemical content of *C. annuum* and *A. calamus*

In different conditions	Amino acid readings at 525 nm		Starch readings at 620 nm	
	Capsicum annuum	*Acoras calamus*	*Capsicum annuum*	*Acoras calamus*
Control	0.12	0.10	0.08	0.09
10%cadmium chloride	0.06	0.01	0.11	0.12
10% cadmium chloride + Super phosphate	0.10	0.06	0.10	0.10

biochemical content then control plants (Table 3).

Discussion: Plants use photosynthetic energy to extracts ions from the soil and concentrate them in their biomass, according to nutritional requirements (Kramer and Chardonnens, 2001). Zn is relatively mobile in soils and is the most abundant metal in root and shoot of

contaminated plants as it is in soils. This metal is necessary as a minor nutrient and it is known that plants have special zinc transporters to absorb this metal (Zhu et al., 1999). However, an excessive accumulation of this element in living tissues leads to toxicity symptoms (shen et al., 2002). An ultrastructural study using transmission electron microscopy revealed the retention of unchelated Pb mainly in cell wall of roots, particularly around intercellular spaces (Wenger et al., 2003). Cadmium also is considered to be mobile in soils but is present in much smaller concentrations than Zn (Zhu et al., 1999). Moreover, many studies have demonstrated that Cd taken up by plants accumulates at higher concentrations in the roots than in the leaves (Boominathan and Doran, 2003).

Alloway (1995) mentioned that alyssum species which are naturally adapted to serpentine soils can accumulated over 2% Ni. The uptake by some plants has been confirmed for Cd (up to 0.2% Cd in shoot dry biomass) but the presence of phosphate fertilizer in the soil induce the uptake of cadmium chloride upto greater extend then present normally Organic matter in soil could effectively increase the activity of metals in soil and improve metal mobility and distribution in soil. The application of natural fertilizer (compost and vermicompost) in soils has helped in increase in metal mobility through the formation of soluble metal- organic complexes (Yang et al., 2005). In addition, exudation of organic compounds by plant roots, such as organic acids, influence ion solubility and uptake (Klassen et al., 2000) through their effects on microbial activity, rhizophere physical properties and root-growth dynamics (yang et al., 2005). The higher concentrations uptake of heavy metals (Cu, Zn, Fe, Al and Mn) by alfalfa (*Medicago sativa*) was reported by Rebah et al. (2002).

Conclusion

The present work concluded the effectiveness of cadmium chloride 10 mg/kg and 10 mg/kg of cadmium chloride with 50 mg super phosphate on *Capsicum sp*. and *Acorus calamus*. The results of 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.

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