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AVAILABILITY OF CADMIUM METAL IN BARLEY (*Hordeum vulgare*) BY CHANGING THE SOIL pH

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ABSTRACT

The plant growth was markedly increased at the alkaline pH range of soil. The effect of cadmium was not significantly marked as hazardous as would be expected at all the pH levels on all growth parameters. Cadmium affected the synthesis of chlorophyll in the plants grown in the soil of varying pH values.

KEYWORDS: Cadmium, toxicity, biomass, chlorophyll, Nitrogen

Although cadmium is not essential for plant growth it is often readily taken up and accumulated by plants. Cadmium reaches plants or the soil they grow on by a variety of means, Including water, air pesticides, fertilizers and solid wasted. The predominant mode of cadmium uptake is through plant roots and is affected by numerous soil, plant and environmental factors.

MATERIALS AND METHODS

In the study, the response of *Hordeum vulgare* (Barley) to toxic level of 200µg g-1 cadmium was studied in the plants growing in thermacol cups. The plants were grown in the controlled growth room in 300ml. thermocol cups, each cup was taken 200 gram oven dried soil. The cups were perforated at bottom to prevent water logging and were placed in another non-perforated cup which served as reservoir for excess water. Either 100ml. deionized water or different pH solutions were added to the soil to bring the soil pH level to the desired concentrations viz -2pH, 4pH,6pH, 8pH, 10pH and 12pH. In each set, 10 seeds of *H.vulgare* were grown and after one week only 5 plants were continued to grow. After attending the age of 15 and 30 days. The following physiological, biological and biochemical parameters were studied.

TOXICITY ASSESSMENTS

The phytotoxicity was evaluated by taking the values of following parameters after 15 and 30 days. Growth length of root/shoot, fresh and dry weight were determined, after the date of sowing.The chlorophyll pigments were extracted in 80% acetone from 100mg leaf tissues and chl. content was determined as described by Strain and Svec ,(1966) by measuring the absorbance and 665 and 649 nm using a UV-Vis. spectrophotometer. Estimation of total nitrogen content were determined by Nesselarization method as suggested by Mc Donald ,(1978). Estimation of total nutrient in term of sodium, and calcium Concentrations of the soil were determined by flame photometer by Jackson,(1962).

RESULTS AND DISCUSSION

The results showed that plant growth was markedly increased at the alkaline pH range of soil. The effect of cadmium was not significantly marked as hazardous as would be expected at all the pH levels on all growth parameters viz. Root/shoot length, fresh/ dry mass production(Table- 1). It has been reported that plants do not take up and accumulate cadmium from soil reallily because the availability of soil Cd and its uptake and accumulation by plants are affected by many soil and factors including pH, CEC, Organic matter content. It may be possible that in our experiments Cd would not seen on the parameters. It has been found that in radish, lettuce and soyabean, cadmium concentration were increased at low pH range (John et al. ,1972; Miller et al., 1976). Williams and David, (1976) observed in their study that cadmium uptake by subterranean clover increased when the pH was lowered and decreased when pH was raised.

Our experiments resulted that chlorophyll contents were decreased in the plants grown in acidic soil (pH range from 2 to 6) while increased in the plants grown in alkaline soil (pH range from 8 to 12). Cadmium markedly

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Table 1 : Effect of soil pH and pH + Cd on root length, shoot length and fresh and dry weight of plants after 15 days and 30 days

Concentration	Root length [cm]		Shoot length [cm]		Fresh wt. [g/plant^{-1}]		Dry wt. [g/plant^{-1}]	
	15 day	30 day	15 day	30 day	15 day	30 day	15 day	30 day
control [DW]	24.81	19.16	4.40	2.59	0.431	0.319	0.162	0.114
200 ppm Cd	21.1	18.07	4.02	2.44	0.457	0.285	0.325	0.106
2.0 pH	11.84	16.26	3.36	2.52	0.414	0.352	0.165	0.102
4.0 pH	18.79	15.96	4.05	2.06	0.448	0.240	0.086	0.168
6.0 pH	19.84	15.41	4.08	2.53	0.444	0.242	0.166	0.168
8.0 pH	22.95	17.13	4.22	2.34	0.469	0.248	0.335	0.104
10.0 pH	22.29	15.82	4.31	2.59	0.489	0.267	0.184	0.111
12.0 pH	21.64	18.25	4.49	2.41	0.543	0.296	0.088	0.116
2.0 pH + 200 ppm Cd	10.49	17.71	2.11	2.46	0.315	0.330	0.156	0.115
4.0 pH + 200 ppm Cd	21.36	17.89	4.25	2.27	0.498	0.242	0.159	0.110
6.0 pH + 200 ppm Cd	20.85	19.06	4.18	2.53	0.495	0.294	0.086	0.104
8.0 pH + 200 ppm Cd	21.47	18.58	4.18	2.15	0.513	0.256	0.087	0.108
10.0 pH + 200 ppm Cd	21.51	17.67	3.78	2.05	0.495	0.240	0.157	0.110
12.0 pH +	20.17	18.78	3.93	2.64	0.486	0.252	0.088	0.098

*Average value

Table 2 : Effects of soil pH, pH+Cd on chlorophyll contents of plants after 15 days and 30 days

Concentration	Total Chlorophyll [µg g^{-1}ch fresh wt.]*Ave.value	
	15 day plant	30 day plant
Control [DW]	329	213
200 ppm Cd	327	209
2.0 pH	240	342
4.0 pH	277	155
6.0 pH	281	156
8.0 pH	312	231
10.0 pH	342	210
12.0 pH	345	219
2.0 pH + 200 ppm Cd	259	340
4.0 pH + 200 ppm Cd	181	228
6.0 pH + 200 ppm Cd	296	221
8.0 pH + 200 ppm Cd	323	188
10.0 pH + 200 ppm Cd	338	203
12.0 pH + 200 ppm Cd	337	228

*Average value

Table 2 : Effects of pH and pH+Cd on Nitrogen after 15 days plant

Concentration	Total Nitrogen [µg / nitrogen/mg of plant]	
	Root	Shoot
Control [DW]	0.058	0.106
200 ppm Cd	0.025	0.005
2.0 pH	0.062	0.056
4.0 pH	0.020	0.047
6.0 pH	0.040	0.076
8.0 pH	0.060	0.072
10.0 pH	0.047	0.088
12.0 pH	0.024	0.017
2.0 pH + 200 ppm Cd	0.041	0.032
4.0 pH + 200 ppm Cd	0.072	0.044
6.0 pH + 200 ppm Cd	0.058	0.037
8.0 pH + 200 ppm Cd	0.104	0.003
10.0 pH + 200 ppm Cd	0.039	0.014
12.0 pH + 200 ppm Cd	0.070	0.004

*Average value

Table 4 : Effects of pH and pH+Cadmium on Na, Ca after 15 day old plant

Concentration	Na[ppm]*Ave.value		Ca[ppm]*Ave.value	
	Root	Shoot	Root	Shoot
Control [DW]	44	52.5	35	25
200 ppm Cd	40	49	30	19.5
2.0 pH	65	81	51	40
4.0 pH	74	64.5	53.5	29.5
6.0 pH	49	70	58.5	38
8.0 pH	59	69	33	28
10.0 pH	57.5	73	40	33
12.0 pH	73.5	36	38.5	18
2.0 pH + 200 ppm Cd	91	66	38.5	61
4.0 pH + 200 ppm Cd	76	67	43	25.5
6.0 pH + 200 ppm Cd	97	68.5	48	50
8.0 pH + 200 ppm Cd	52.5	74	52	35
10.0 pH + 200 ppm Cd	74.5	74.5	52	36.5
12.0 pH + 200 ppm Cd	52	62.5	50	51

*Average value

affected the synthesis of chlorophyll in the plants grown in the soil of varying pH values (Table -2). Even though the plants grown in the cadmium amended soil of pH range from 8 to 12, showed the higher chlorophyll than the plants grow in lower pH. So it has been concluded that the effect of cadmium was not as emphasized as the effect of pH on the chlorophyll synthesis in our experiment. There is evidence that the availability of soil cadmium increased with decreasing soil pH probably because of increased solubility of many cadmium compounds such as hydroxides, carbonates and phosphates at the lower pH values (Anderson and Nilsson, 1974; Santilleen and Jurinak, 1975).

It may be possible that the biosynthesis of alpha amino levulinic and the precursor of porphyrin would be affected by the different pH range of soil. Because the ions or other conditions supported to its mechanism would not be fulfilled by the plants to uptake the ions in various pH condition. Miller et al., (1976) have suggested that the increased solubility of other ions (e.g Fe^{+3}, Mn^{+2}, Zn^{+2} and H^{+}) at low soil pH may cause a greater competition for exchange sites than occur in neutral to alkaline soils there by resulting in increased concentrations of cadmium in the soil solution. Here also the effect of cadmium on the total N2 content (Table-3) and Na and Ca ions found in plants was not so markedly (Table- 4).

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