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Accumulation of chromium and its effect on growth of (*Allium cepa cv. Hybrid)*

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ABSTRACT

Chromium is a heavy metal, this element is considered as an environmental hazard. .Toxicity effects of chromium on growth and development of plants including inhibition of germination process, decrease of growth and biomass of plant. The aim of this research is to study accumulation of Cr^{+3} and its effect on the growth of onion plant (Allium cepa cv. Hybrid). Thus, Onion seedlings grown in pots including soil and sand with raito 1:1 undergoing ,different treatments of Cr^{+3} (0, 5,10, 20, 40, 50, 100, 150, 200 mg/L). after 4 week seedlings were removed and morphophysiology parameters like root length, shoot length and dry weight of plants and accumulation of Cr^{+3} in roots and shoots were determined. The results indicated that the concentrations more than 150 mg/L chromium cause the reduction of morphophysiology parameters in the treatment plants rather than control plant and Cr^{3+} addition in the cultures caused enhancement of chromium content in roots and shoots of plant seedlings. It was also noted that accumulation of chromium in the roots were much higher than the shoots of the seedlings under treatment

Keywords: accumulation ,chromium, growth, heavy metal, onion plant

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INTRODUCTION

Chromium is the 7thmost abundant element in the earth's crust [11]. The extensive use of various chromium (Cr) compounds in numerous industries has caused increasing concern about environmental contamination with this element [20]. Chromium has different oxidation states that in nature, Cr exists in two different stable oxidation states, trivalent chromium Cr (III) and hexavalent chromium Cr (VI). Both Cr (III) and Cr (VI) differ in terms of mobility, bioavailability and toxicity [16,11]. Uptake and toxic effects of chromium dependent on its oxidation state. Both forms of chromium are toxic, but the solubility and toxicity of the Cr^{+3} form is less than Cr^{+6} form [10]. Chromium enters the food chain through consumption of plant material. A high concentration of Cr has been found to be harmful to vegetation. As the chromium concentration in plants increases, it adversely affects several biological parameters.Ultimately there is loss of vegetation, and land sometimes becomes barren.[22] Symptoms of Cr phytotoxicity include inhibition of seed germination or of early seedling development, reduction of root growth, leaf chlorosis and depressed biomass. There are many studies on Cr toxicity in crop plants.Chromium significantly affects the metabolism of plants such as barley (*Hordeum vulgare*) , *citrullus*, *cauliflower*, vegetable crops, *wheat* (*Triticum aestivumcv.HD2204*) and maize (*Zea mays*). [3] Increase of chromium concentration in the environment of plants growth causes an increase in the plant tissues, but exposure to high concentrations of chromium impaired in some the physiological processes and ultimately reduce the growth of plants and lead to toxic symptoms. [21] in the current research the ability of Allium cepa which is a consuming and eatable food, for the purpose of accumulating chromium elements and the effects of these elements on the growth process of plants (dried weight and root length and aerial par) were reviewed.

MATERIALS AND METHODS

The plant onion seeds were soaked in the water for 2 hours and then they were taken to the pots that consisted of farming soil and they were irrigated the mount of field capacity. The features of the soil used , are shown in table 1. 2 weeks after germination, different concentrations of Cr^{+3} (0, 5, 10, 20, 40, 50,100, 150, 200 mg / L) were created by chromium nitrate and seedlings were treated by these concentrations.the experiment was performed a completely randomized design with three replications.

Soil	PH	EC (ds/m)	O.C(%)	Cr(ppm)	Clay(%)	Silt(%)	Sand(%)
1	7.95	4.3	.098	1.391	8.88	36	55.12

Table1. Selected chemical and physical characteristics of soil studied

During the period of growth, the light period included 16 hours light and 8 hours darkness and temperature was 24± 4 ° C. after 4 weeks seedlings were removed and morphophysiology parameters like root length, shoot length and dry weight of plants and accumulation of Cr^{+3} in roots and shoots were determined. In order to evaluate the amount of chromium accumulation in root and shoot, 0.05 g dry tissue of shoot were poured in a 25 mL Erlenmeyer flask. Then 3 ml of concentrated nitric acid were added to the tissues and were placed for 72-48 hours invitro and then they were heated slowly for 2-3 hours,until finally a clear solution was obtained. Due to oxidation of the carbonic and organic nitrogen components in the form of CO2 and NO2 and other nitrogen gases exit the tissue environment, the mineral elements of the plant remained in the wet ash plant. After cooling, the capacity of the remained solution was increased to 25 mL by distilled water and then it was filtered by filter paper and from these solution filtered,was used to measure chromium in the plant tissues by the atomic absorption spectrophotometry system (AAS) model Shimadzu AA-670 in wavelength 357/9.[8]

RESULTS AND DISCUSSION

Data obtained from statistical analysis shows that with increasing the concentration of Cr^{+3} , increased its amount in roots and shoot of plants significantly. So that the plants treated with concentrations of 200 mg/L Cr^{+3} have the highest rate of chromium (Figure 1 and 2), and shows a significant difference with the plants treated with other concentrations of Cr^{+3} ($p \leq 0/05$), also the concentration of Cr^{+3} in the root is more than shoot. In the present study, with the increase of concentration of Cr^{+3} , its value increased in the onion root tissue. These results are consistent with the results reported in the case of *wheat* [14,17], *corn* [13,9] ,*cabbage*[7] and *black bean*[6]. Generally the amount accumulation of chromium in different parts of plants is different because there are restrictions on the transfer of chromium from the root to the apex of the plants which is probably due to binding of this ion form at the place of cationic exchange in the root and it is non-removable [21]. So the maximum amount of chromium absorbed by plants remain in the roots and only a small part of it, is transferred to shoot , so the roots consists of more chromium than the shoot [12]. the reason for the higher accumulation in roots of the plants could be because Cr is immobilized in the vacuoles of the root cells [1,4].

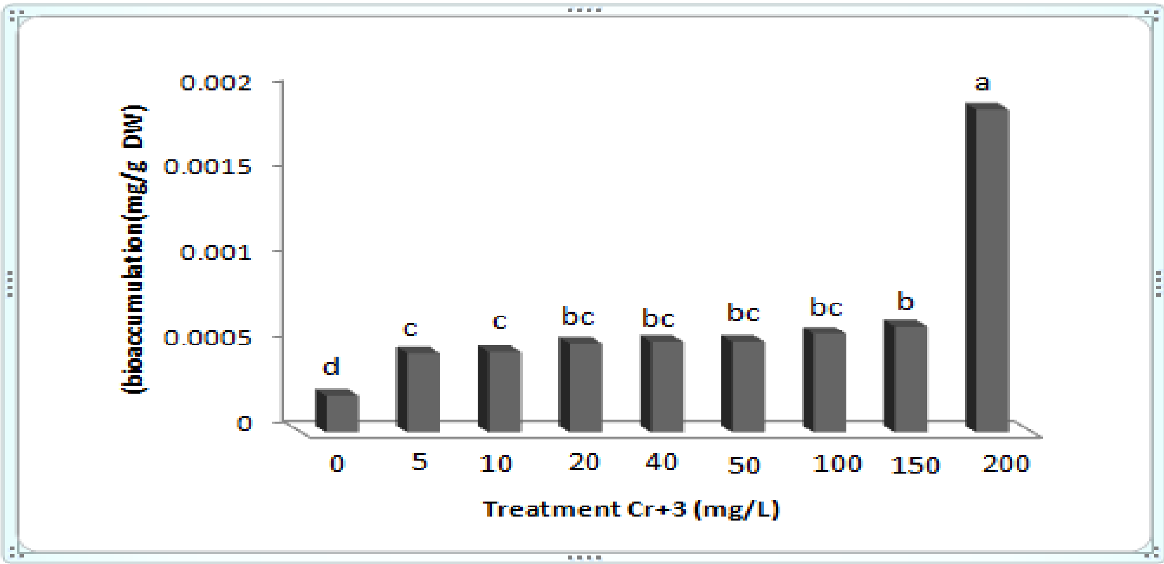

Fig1: **Bioaccumulation of chromium in Shoot by *Allium cepa***

******The coulumns that with a letter in common are not significantly different at p≤ 0.05 according to Duncan test*

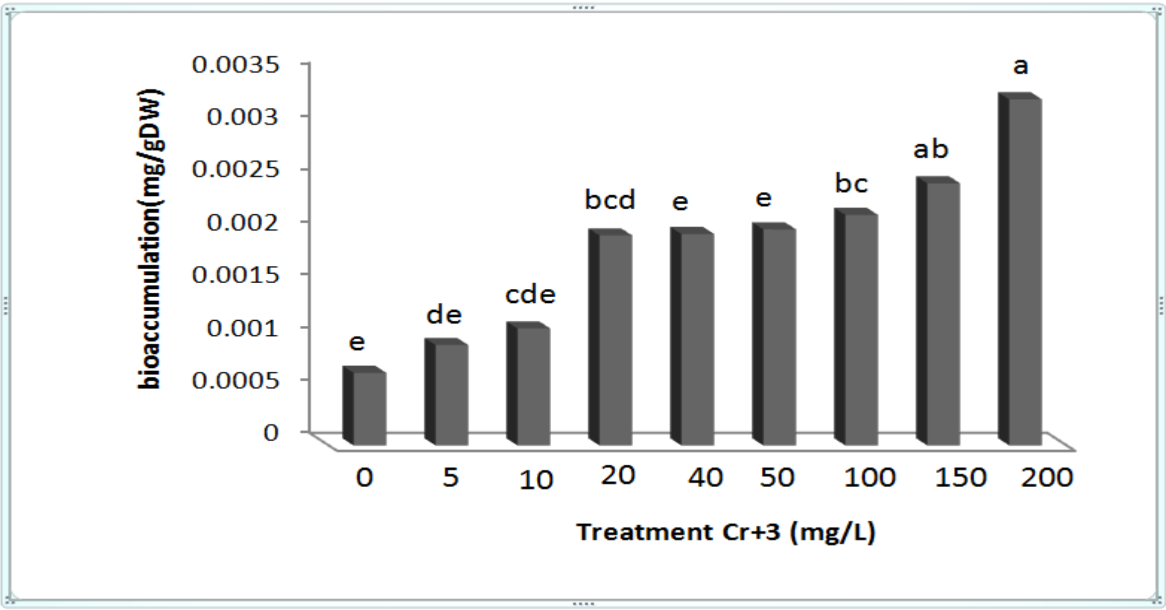

Fig 2: bioaccumulation of Chromium in Root by *Allium cepa*

The coulumns that with a letter in common are not significantly different at $p \leq 0.05$ according to Duncan test

Based on the results of statistical analysis, the increase of concentration of Cr^{+3} higher than 100 mg/L reduce onion plant growth (the root and shoot dry weight and length), (Figure 3,4,5,6). Comparing of the average of dry weight of root and shoot indicates that with the increasing concentration of Cr^{+3} in the medium, in the concentrations more than 150ppm,decreased root and shoot dry weight, this reduction in root and shoot dry weight in comparison to the control plant is not significant($p \leq 0/05$), Also the increase of Cr^{+3} in concentrations more than 150 mg/L causes the decrease of root and shoot length (figure3,4) which this reduction in comparison to the control plants is significant ($p \leq 0/05$). Several studies have indicated the reduction of root and shoot dry weight and length of plants in treatment of chromium, it could be noted the *mesquite*[5], *wheat*[1] and *watermelon*[2] It is reported that inhibition of shoot growth by chromium, in fact is due to the root system damages [21].The reduction in the plant height might be mainly due to the reduced root growth and consequent lesser nutrient and water transport to the above part of the plant.In addition to this, chromium transport to the aerial part of the plant can have a direct impact on cellular metabolism of shoots contributing to the reduction of plant height.Also root was found to be more affected than shoot. This is due to the fact that chromium accumulated on root due to binding of chromium on the cell wall of root and retard cell division and cell elongation.The reason of the high accumulation in roots of the plants could be because chromium is immobilized in the vacuoles of the root cells. General decreased root growth due to inhibition of root cell division/ root elongation or to the extension of cell cycle in the roots [1].In general, since the root system is the first place which can be influenced by heavy metal of chromium, the reduction of roots growth which is determined by the reduction of length and dry weight, it leads to the lack of development and reasonable growth of root system and with reduction absorption levels and changes in the structure of cell membranes, water uptake decreased, drops the plant water content which it effects on the physiological processes such as transpiration, respiration and photosynthesis and eventually leads to decrease growth in all the parts of the plant [13,15]. On the other hand it was indicated that the high concentrations of chromium, effects on the nitrate reductase enzyme activity,reduced nitrogen uptake and nitrate fixation [18,19]. therefore due to presence of nitrogen as an essential element in the structure of many biological molecules, its reduction prevents the plant growth[19]. Therefore high concentrations of Cr^{+3} with a negative impact on the root system, as a result they cause plant height reduction and following that biomass reduction occurs.

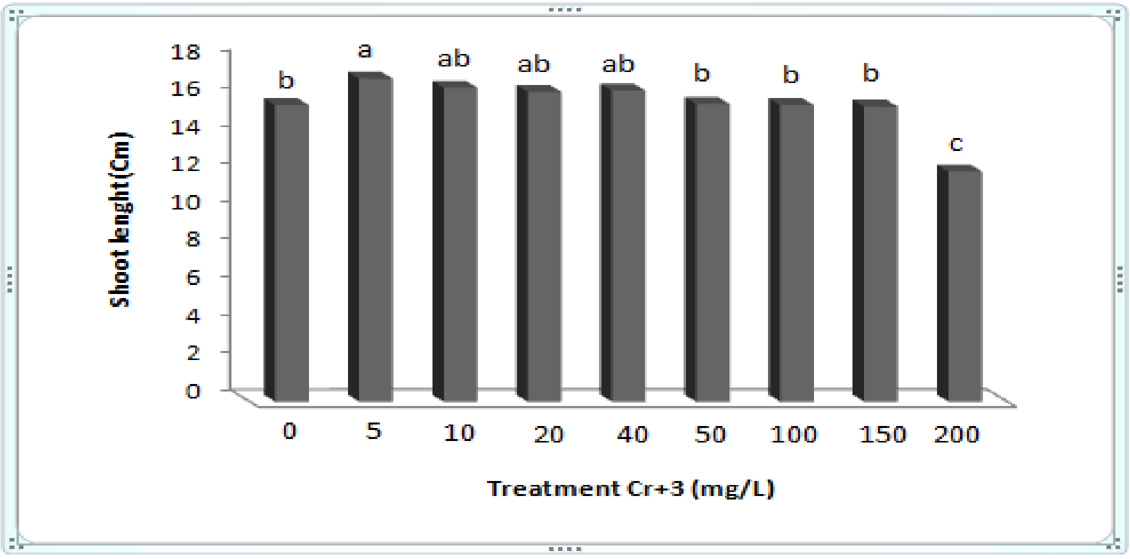

Fig3: Effect of Chromium on Shoot length of *Allium cepa*

**The coulumns that with a letter in common are not significantly different at p≤ 0.05 according to Duncan test*

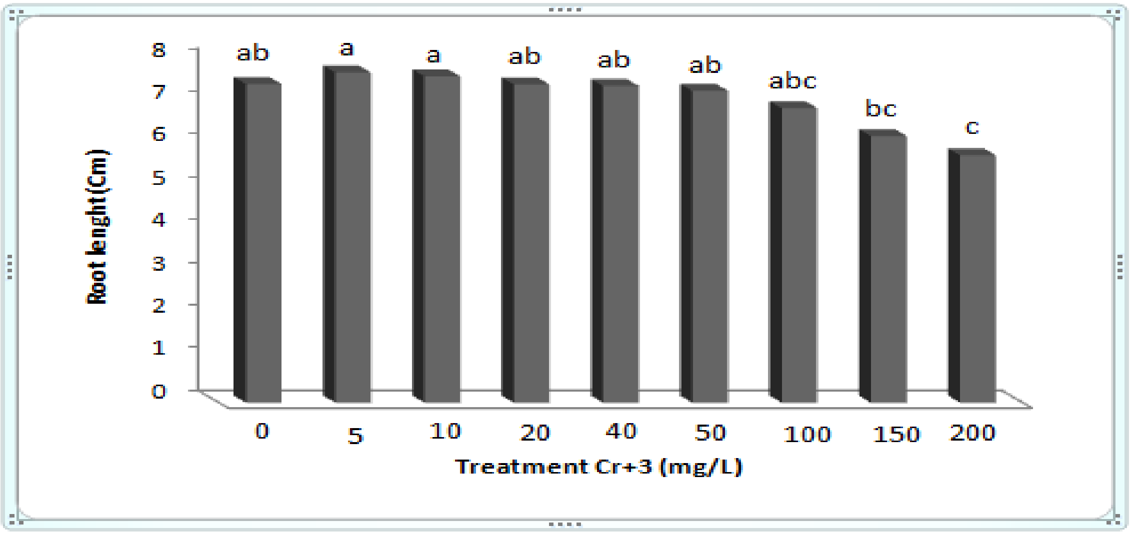

Fig4: Effect of Chromium on Root length of *Allium cepa*

**The coulumns that with a letter in common are not significantly different at p≤ 0.05 according to Duncan test*

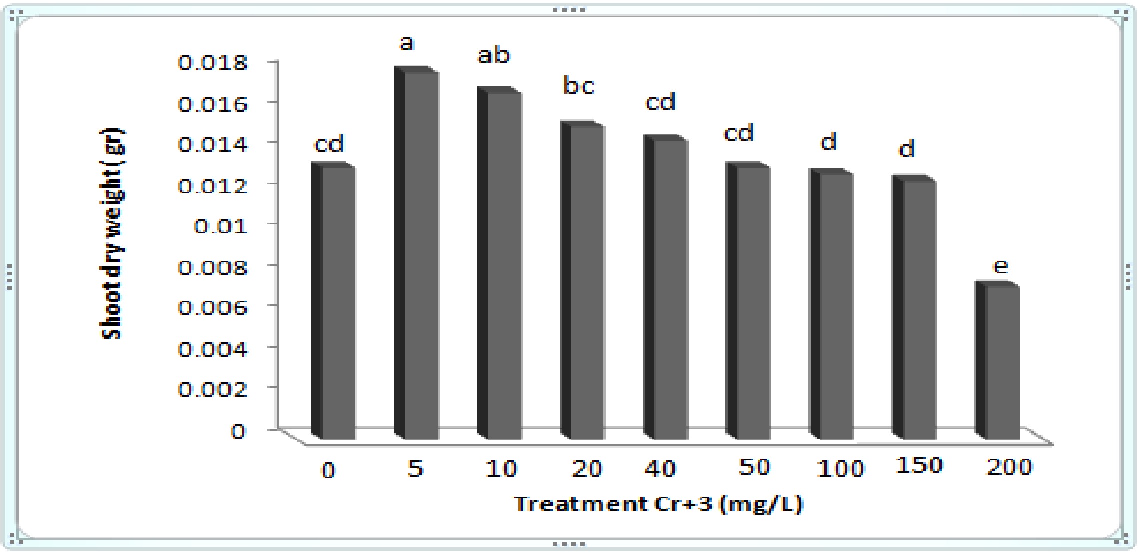

Fig5: Effect of chromium on Shoot Dry Weight of *Allium cepa*

**The coulumns that with a letter in common are not significantly different at p≤ 0.05 according to Duncan test*

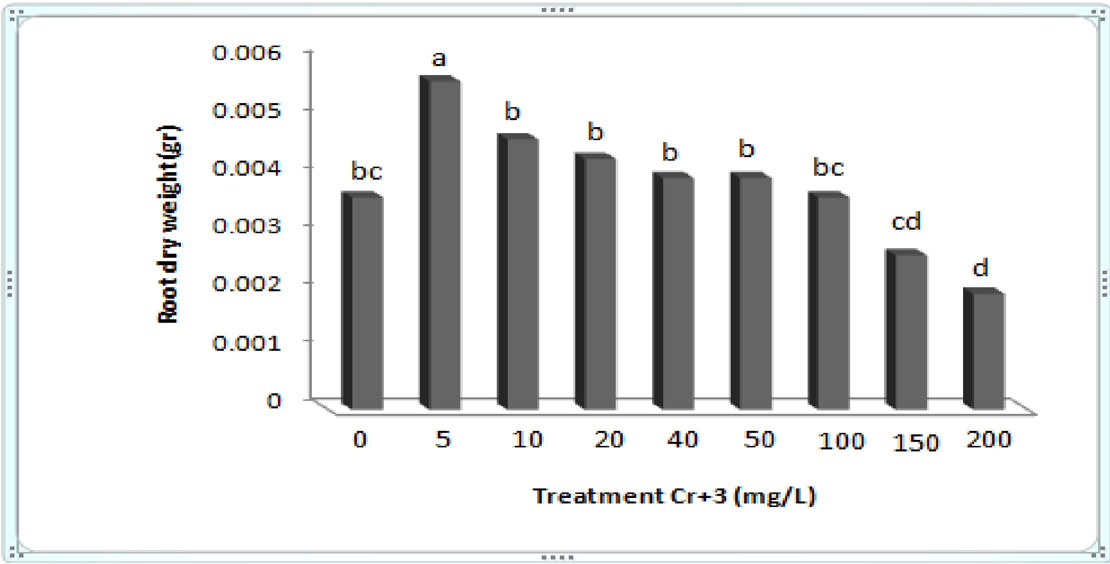

Fig6: Effect of chromium on Root Dry Weight of *Allium cepa*

**The coulumns that with a letter in common are not significantly different at p≤ 0.05 according to Duncan test*

CONCLUSION

Generally it can be concluded that high concentrations of chromium in Allium cepa despite lower growth was able to tolerate chromium and especially with accumulation of Cr^{+3} in the root tissue, it can be considered as a hyperaccumulator plant of this metal.

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