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Impact of Chromium on Chlorophyll Content of Weed Plants: A Comparative Study

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Abstract:- Nowadays, heavy metal contamination is being increased and it can affect the growth of plants, animals and human health. Phytoremediation technology using plants to extract heavy metals from the soil as well as water. The effective results of a phytoextraction method depend on sufficient plant yield and accumulate high amount of metals in plant shoots and/or roots. The present study was carried out to examine the effects of heavy metal on weed plants like *Ipomea carnea* and *Jatropha gossypiifolia.* Stem cutting of these plants was exposed to four concentrations (0, 5, 10, 15 ppm) of potassium dichromate. Chromium accumulation capacity of those plants was compared in a pot and hydroponic culture methods. Total chlorophyll content was reduced gradually while increasing chromium (IV) concentrations.

Keywords:- *Contamination, heavy metals, Phytoremediation, metal accumulation and plant growth.*

I. INTRODUCTION

Heavy metals are potential pollutant to environmental pollution by the anthropogenic activities such as mining, smelting, electroplating, productions of energy and fuels, transmit of power generation, productions iron and steel, manufacture of paints, production of metal-containing pesticides for agriculture activities, waste-sludge disposing and military activities [1, 2, 3]. Past few decades, metal contaminations are being increased, its detrimental impacts on the growing plants and human health. Some heavy metals such as Zn, Cu, Mo, Mn, Co, and Ni are essential for key biological processes and pathways development [4]. However, remaining toxic heavy metals like As, Pb, Cd, Hg, Cr, Al, Be and others can decrease crop production when their concentration enhanced. These toxic metals cause changes in morphological features and metabolic disorders of plants that contribute to the reduction in yield productivity [5].

Chromium is an essential metal that is used in metal plating, aluminium coating, synthesizing organic compounds, tanning leathers and wood conserving companies [6]. Chromium is typically found in the environment in two oxidation states such as hexavalent (Cr VI) and trivalent (Cr III). Cr(VI) is riskier transferable than Cr(III) and more challenging to remove from soil and water. The EPA categorizes Cr(VI) is a known human carcinogen causing cancer but Cr(III) not cause cancer [7]. The increased concentration of chromium in plants can detrimentally impact the growth parameters. Ultimately there is a loss of vegetation, and land sometimes becomes barren. Chromium enters the food chain of animals and humans through the consumption of plant material [8]. Chromium was considerably disturbing the metabolic rate of plants such as barley [9], Citrullus [8], cauliflower [10], various vegetables [11] and crop production in India [12].

The plants are accumulating the metal contaminants mainly in their roots and shoots; in particular, roots can accumulate high amount of metal, then less amount translocate to the shoots and leaves [13, 14]. The use of certain living organisms, particularly ornamental plants for removal of heavy metals, referred to as phytoremediation, is a low-cost, eco-friendly, secure, less abruption and efficient technology [15, 16]. It can remove, transfer, and degrade the metal contaminants in soil, sediment, and water to a less harmful form [17].

Many studies indicate that heavy metals have effects on chlorophyll content in plants. Plants have been the capability to tolerate, uptake and accumulate the high concentration of metals in their parts are termed as hyperaccumulators [18]. The Chlorophyll content is regularly determined in plants to evaluate the impact of heavy metal pressure, as changes in chlorophyll content are linked to visible symptoms of plant illness and photosynthetic activity [19]. With these aspects, the present study examined the impacts of Cr metal on the content of total chlorophyll in weed plants such as *Ipomea carnea* and *Jatropha gossypiifolia.*

II. MATERIALS AND METHODS

A. Experimental setup

Hydrophonic (distilled water as a medium) and pot (soil as a medium) methods were exposed to growing the experimental plants. Different concentrations of Cr (VI) solutions (0, 5, 10, 15 ppm) were prepared by using pure $K_2Cr_2O_7$ (analytical grade) as a source of Cr.

In hydroponic culture method, the five stem cuttings were immersed (the quarter portion was submerged in water medium) to different concentrations of Cr (VI) solutions including distilled water (control 0 mg/l). For each treatment, 1 L Cr (VI) solution and 4 L of distilled water placed in a plastic container (25 cm depth and 30 cm dia). Each treatment has accompanied replicate with five plants. During 60 days of the experimental study, aeration was done by fish tank aerator and evapotranspiration losses were also observed and refilled with distilled water.

In Pot culture method, the five stem cuttings were buried (the quarter portion was fixed in soil medium) with different concentrations (0, 5, 10, 15 ppm). Each treatment has three plastic containers and adds soil mixture red soil, sand, compost (1:1:1). During the 60th days of the experimental period, the pot plants were exposed to room temperature. Six plants were harvested in each treatment of both plants and both culture method at 15th, 30th and 60th days. Plants were washed well-using freshwater and taken for the analysis of Chlorophyll content.

B. Plant Chlorophyll (a, b, and total) analysis

The leaves were analyzed for chlorophyll content by 200 mg leaves were chopped into small pieces and crushed in the mortar & pestle, that contains were extracted using 80% acetone and filtrated through a cloth. The extract was centrifuged and the supernatant was taken for chlorophyll content and absorbance was measured at 645 nm and 663 nm for chlorophyll a, b and total chlorophyll respectively by using a visible spectrophotometer (Systronics-108). Then chlorophyll a, b and total chlorophyll were calculated by below equations [20, 21].

Chlorophyll a (fresh weight of leaf, mg/g) = [12.7 (OD of 663nm) - 2.69 (OD645)] × V/1000 × W
Chlorophyll b (fresh weight of leaf, mg/g) = [22.9 (OD of 645nm) - 4.68 (OD663)] × V/1000 × W
Total Chlorophyll (fresh weight of leaf mg/g) = [20.2 (OD of 645nm) - 8.02(OD663)] × V/1000 × W
Where OD = Optical Density, V = Volume of a sample, W = Weight of a sample.

The data were examined through one-way analysis of variance (ANOVA) to conclude the effect of Cr and least significant difference (LSD) tests were executed to the statistical significance of the differences between means of treatments by Duncan's multiple range test at the 0.05 probability level ($P<0.05$) using a statistical tool (SPSS Version, 20).

III. RESULTS AND DISCUSSION

The results of the chlorophyll content of the selected two weed plants were presented in Table 1-2. The primary observation is a high concentration of chromium significantly decreasing the content of Chlorophyll a, b and total chlorophyll of plants. Both culture method of two plants, pigment levels are significantly decreased at 5, 10 and 15 ppm of chromium when compared to control. Chlorophyll a and b content significantly reduced in the highest concentration (15 ppm) of the experiment, it reveals that the chromium metal can affect the chlorophyll content of the plants.

	Method	**Hydroponic**		**Pot**	
Test	**Day**	**Chl-a**	**Chl-b**	**Chl-a**	**Chl-b**
Control	0	0.92	0.64	0.96	0.65
	30	1.06	0.78	1.10	0.84
	60	1.14	0.85	1.18	0.92
5 ppm	0	0.92	0.63	0.95	0.66
	30	1.06	0.76	1.08	0.83
	60	1.12	0.82	1.16	0.90
10 ppm	0	0.90	0.63	0.93	0.65
	30	1.03	0.74	1.06	0.80
	60	1.08	0.78	1.10	0.87
15 ppm	0	0.91	0.64	0.94	0.65
	30	0.98	0.70	1.02	0.76
	60	0.96	0.68	1.00	0.75

Table 1:- Effect of Cr (IV) on Chlorophyll Content (mg/Kg) of *Jatropha SP.*

	Method	Hydroponic		Pot	
	Day	Chl-a	Chl-b	Chl-a	Chl-b
Control	0	1.05	0.72	1.08	0.74
	30	1.16	0.86	1.20	0.88
	60	1.22	0.93	1.27	0.96
5 ppm	0	1.04	0.70	1.06	0.73
	30	1.14	0.85	1.22	0.86
	60	1.18	0.90	1.25	0.92
10 ppm	0	1.05	0.71	1.08	0.73
	30	1.13	0.83	1.20	0.84
	60	1.16	0.88	1.22	0.88
15 ppm	0	1.06	0.72	1.07	0.72
	30	1.11	0.80	1.15	0.81
	60	1.08	0.76	1.14	0.77

Table 2:- Effect of Cr(Iv) on Chlorophyll Content (Mg/Kg) of *Ipomea Sp.*

In *Jatropha* and *Ipomea* plants chlorophyll a is reduced at higher concentration of Cr than chlorophyll b. Among both culture method, Hydroponic was found less chlorophyll content than pot method. This difference may be due to nutrients differ in the medium. Because natural soil has some nutrient to plant growth [21]. Two experimental plants are considerably affected by 15 ppm of Cr (VI) at the 60th day. The *Jatropha* plant has affected in earlier and fewer values of Chlorophyll a and b than *Ipomea* plant when compared at 15 ppm of concentration.

Estimated chlorophyll in both plants *Ipomea carnea* and *Jatropha gossypiifolia* was gradually decreasing with increasing concentration of Cr in a pot and hydroponic culture method were shown in Fig. 1a- 2b. Total chlorophyll of Jatropha was found 2.6 mg/g at control; it was decreased to 2.3 mg/Kg at 15 ppm in hydroponic culture method. In pot culture method, showed 2.7 mg/g at the control and it was reduced 2.4 mg/Kg at 15 ppm concentration of chromium. In Hydroponic and pot culture methods fo Ipomea plant, the chlorophyll content was decreased to 2.4 and 2.5 respectively. Cr has been proven to be aggressive, oxidative damage-inducing agent and effective competitors for essential metal cofactors involving in chlorophyll biosynthesis [22].

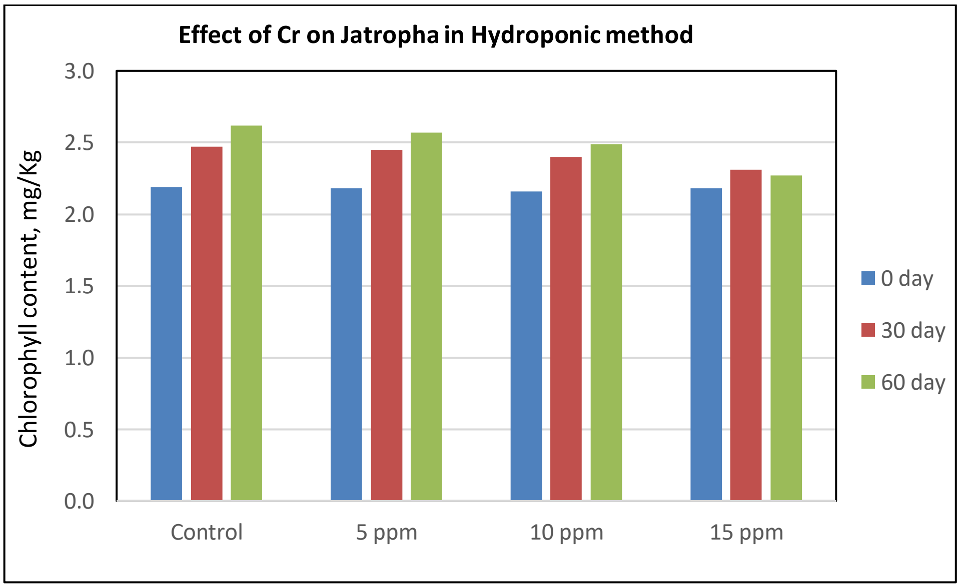

Fig 1a:- Effect of Cr (VI) on Total Chlorophyll content of *Jatropha sp.*

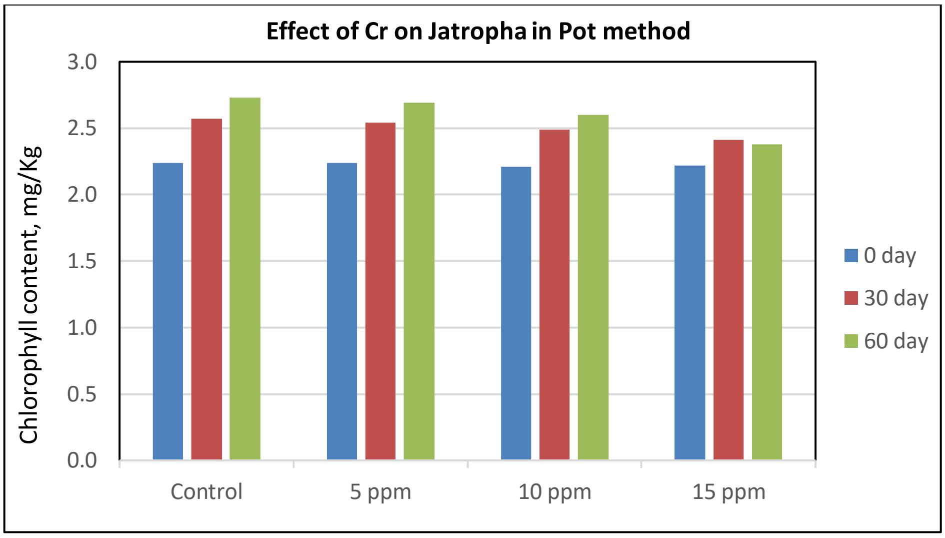

Fig 1b:- Effect of Cr (VI) on Total Chlorophyll content of *Jatropha sp.*

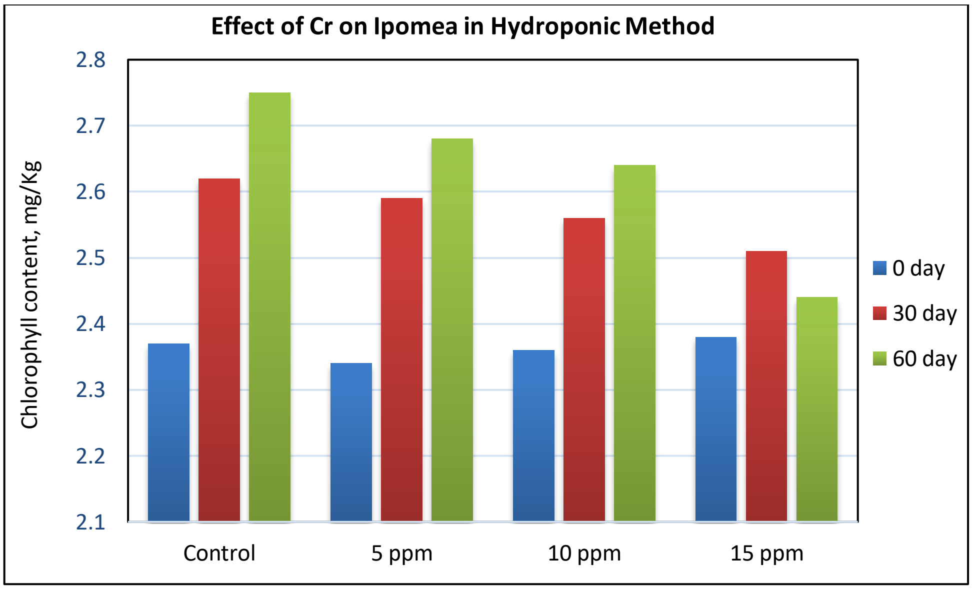

Fig 2a:- Effect of Cr (VI) on Total Chlorophyll content of *Ipomea sp.*

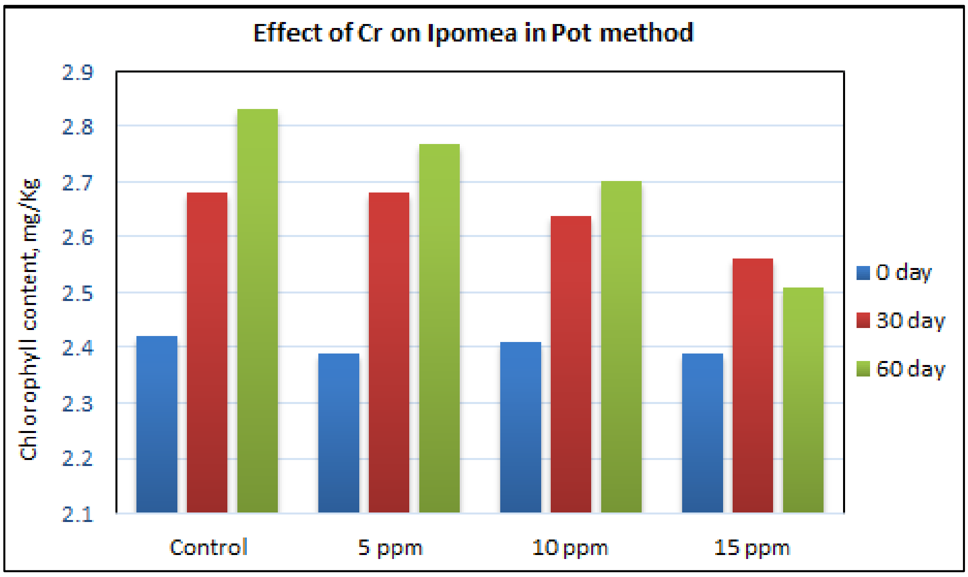

Fig 2b:- Effect of Cr (VI) on Total Chlorophyll content of *Ipomea sp.*

In the results of ANOVA, the null hypothesis is rejected the means differ significantly. Hence, the best concentration is the control for chlorophyll content in two culture methods of two selected plant species.

Photosynthesis of the plant abnormally reduced while increasing Cr(VI) concentrations in the experiment. Many earlier studies have been reported that the chlorophyll content of any plant was reduced when increasing Cr(VI) concentration [23]. It is supposed to be connected to a direct impact on chlorophyll pigment production. Other researchers have described a reduction in chlorophyll content of the plant, correlated with increased metal concentration [24, 25]. Other evident is the number of leaves is decreased during the last study period [26].

IV. CONCLUSION

Phytoextraction is a technology that removes heavy metals from the soil by various plants. Cr metal was a detrimental effect on plant growth when increasing their concentrations. The inhibition of plant growth by Cr mainly due to the accumulation in root, shoot and leaves. The study was observed the number of plant leaves is decreased during the last few days of the study period. It is due to the Cr accumulation in leaves of both experimental plants and affected their chlorophyll content. The total chlorophyll content of *Ipomea carnea* and *Jatropha gossypiifolia* were affected in the concentration of 15 ppm of Cr in the pot and hydroponic culture methods. Hence the present study was concluded that the selected weed plats can be extracted the Cr metal from the soil at lower concentrations (below 10 ppm) while higher concentration was affected the entire plant growth.

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