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BIOLOGICAL NUTRIENTS OF CR3+ COMPOUNDS AND PHYTOREMEDIATION OF HEXAVALENT CHROMIUM POLLUTED SOIL BY USING *GOMPHRENA GLOBOSA* (L).

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ABSTRACT

The global wide industrialization has induced different heavy metal pollution and dramatic changes in the biological, chemical and physical environment, including changes in plants and animal diversity, increasing atmospheric CO2 concentrations, increasing mean annual temperature, and changes in precipitation patterns. The importance of phytoremediation processes and biodiversity is increasingly considered for the cleanup of the metal contaminated and polluted ecosystems. It is an emerging green technology that can be considered for remediation of contaminated sites because of its low cost, aesthetic advantages, and long term applicability. The present study was under taken to determine the importance of $Cr^{3}+$ compounds in biological system and effects, control measures of $Cr6^{+}$ through phytoremediation technology.

KEYWORDS: Industrialization, Hexavalent chromium, trivalent chromium, Biodiversity, Ecosystem, Plants and animal, CO2 concentrations.

INTRODUCTION

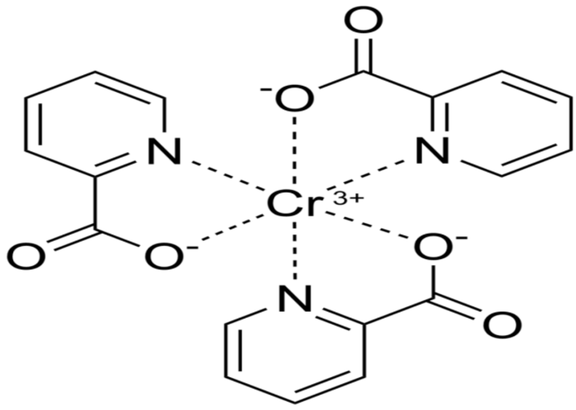
Chromium is a chemical element under the symbol Cr with atomic number of 24, categorized in transition metals. It is an industrially important metal that has the potential to contaminate drinking water, natural ecosystem and agricultural land sources. The hexavalent ionic form of chromium, also known as Cr^{6+}, is more water soluble, more easily enters living cells, and is much more toxic than the trivalent ionic form known as $Cr^{3}+$. Trivalent chromium is an essential trace element in the human diet and its deficiency may cause a disease called "chromium deficiency". The $Cr^{3}+$ in this form is to potentiate the action of insulin, acting in combination with the glucose tolerance factor (ATSDR, 2000). The Cr (VI) is a well-documented toxin and carcinogen (Baruthio, 1992; Stearns, 2007). Hexavalent chromium is a human carcinogen, clastogenic effects as determined by the National Toxicology Program (NTP), the International Agency for Research on Cancer (IARC), the U.S. Environmental Protection Agency (U.S. EPA), and OEHHA (NTP, 1998; IARC, 1980b.

Physical and Chemical Properties:

Chromium generally occurs in small quantities associated with other metals, particularly iron. The atomic weight of chromium is 51.996. Metallic chromium melts at 1,875° C, and boils at 2,680° C; its specific gravity is 7.19. The most common valences of chromium are +3 and +6. Chromium salts are characterized by a variety of colors, solubility and other properties. The name "chromium" is from the Greek word for color. The most important chromium salts are sodium dichromate and potassium chromates (Hodgman *et al*., 1961).

Biological importance of Chromium III picolinate:

The Food and Nutrition Board of the US National Academy of Science set the adequate intake of Cr^3+ (**Chromium III picolinate**) chromium at 25 µg day for adult women and 35 µg day for men. Chromium III picolinate found in food and dietary supplements and considered to be safe (Deshmukh *et al*, 2009). It is required for glucose metabolism and is found in food and feed in concentrations between 0.05 and 2.4 mg/kg. Deficiency of Cr^3+in animals may cause diabetes, arteriosclerosis, growth problems, and eye cataracts (Mertz, 1993) and (Deshmukh *et .al*,2009).



Chromium III picolinate[$Cr(C_6H_4NO_2)_3$]

Phytoremediation of Cr^{6+}:

Phytoremediation is defined as the use of plants to remove pollutants from the environment or to render them harmless (Salt *et al*., 1998). Five main subgroups of phytoremediation have been identified:

Phytoextraction: Plants remove metals from the soil and concentrate them in the harvestable parts of plants (Kumar *et al*., 1995).

Phytodegradation: Plants and associated microbes degrade organic pollutants (Burken and Schnoor, 1997).

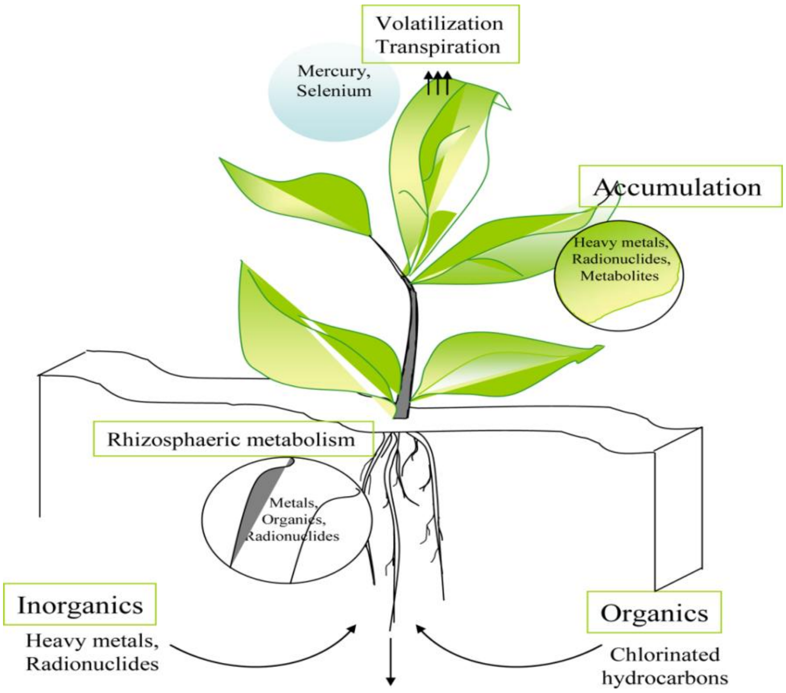
Rhizofiltration: Plant roots absorb metals from waste streams (Dushenkov *et al*., 1995).

Phytostabilisation: Plants reduce the mobility and bioavailability of pollutants in the environment either by immobilization or by prevention of migration (Vangronsveld *et al*., 1995; Smith and Bradshaw, 1972).

Phytovolatilisation: volatilisation of pollutants into the atmosphere via plants (Burken and Schnoor, 1999; Banuelos *et al*., 1997).

Metal absorption and transportation:

Transport proteins and intracellular high-affinity binding sites mediate the uptake of metals across the plasma membrane. A comprehensive understanding of the metal transport processes in plants is essential for formulating effective strategies to develop genetically engineered plants that can accumulate specific metals. Several classes of proteins have been implicated in heavy metal transport in plants. These include the heavy metal (or CPx-type) ATPases that are involved in the overall metal-ion homeostasis and tolerance in plants, the natural resistance-associated macrophage protein (Nramp) family of proteins,(Williams LE, 2000) and the cation diffusion facilitator (CDF) family proteins.



MATERIALS AND METHOD

Plant material and VAM (*Arbuscular mycorrhiza*) treatment:

The seeds of *Gomphrena globosa* (L). were collected from Tamil Nadu Agricultural University, Coimbatore. Seeds were sowed in field area of hexavalent chromium polluted soil in Walajapet area, Vellore district at 26˚C with treatment of *Arbuscular mycorrhiza* (VAM) on control to 5gm, 10gm, 15gm, 20gm and 25gm at 15 to 90 days interval. Twenty five seeds were sowed in each row for all treatment and fields were irrigated twice a day. Each treatment contained three replications, without *Arbuscular mycorrhiza* (VAM) treated soil was used as control and removed deleterious substances from the substrate as well as from the root surface (Zhang, 2001). The plants were authenticated from Botanical Survey of India, Southern region, Tamil Nadu Agricultural

University, Coimbatore [BSI/SRC/5/23/2013-14/2003]

Growth analysis:

At each time of the experiment, plants were collected and determined Root length, Shoot length, No.of. leaves per plant, No.of. flowers per plant and Fresh weight of the plants. The plants were divided into shoot, root and leaves. These were oven dried at 85 ˚C until they reached a constant mass to measure the respective dry weights. Three plants per replications were collected.

Gomphrena globosa , (L).

RESULTS AND DISCUSSION

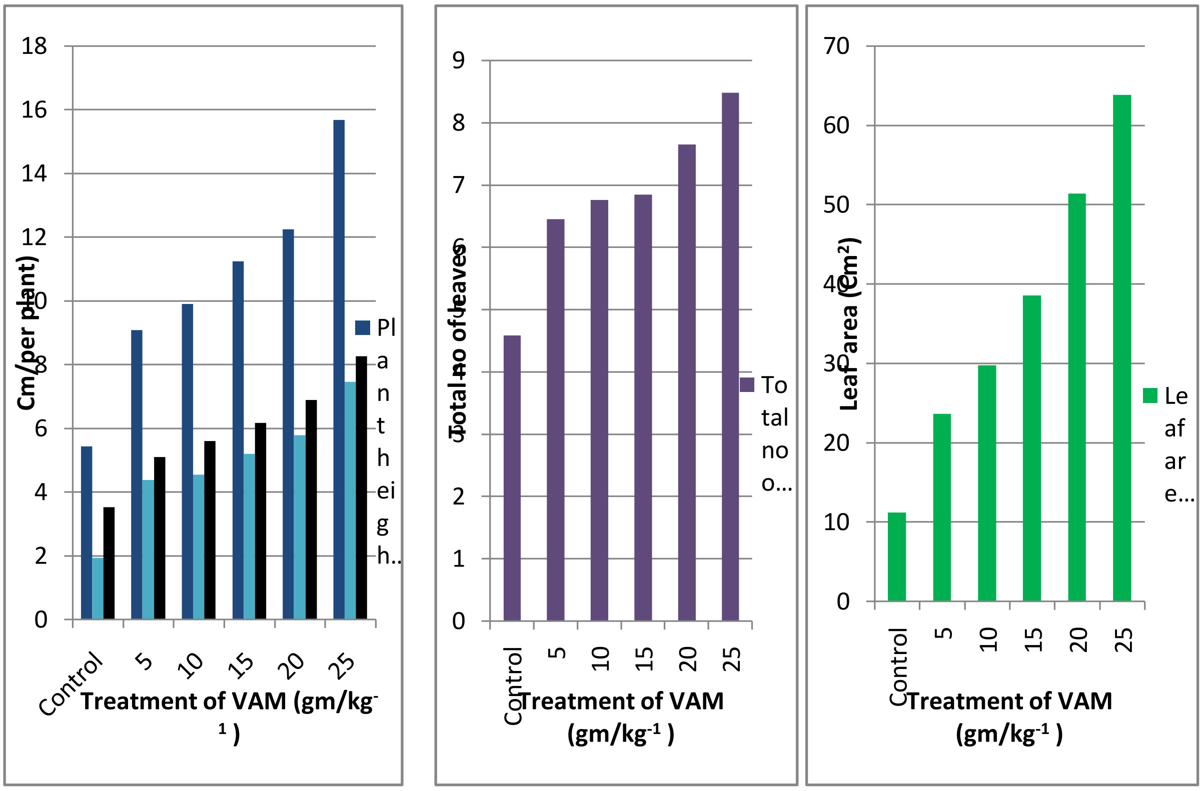
The ornamental plant of *Gomphrena globosa* (L). data was revealed morphological growth nature of Hexavalent chromium polluted soil. *Gomphrena globosa* , (L).expressed superior growth nature and tolerate chromium stress in soil. Table No.1 shown Growth, Phytotoxicity, Tolerance index, Vigour index, Germination percentage of *Gomphrena globosa* , (L). The **Fig.1** shown Root length, Shoot length, Total no.of leaves, Leaf area (Cm^2). These data concluded to withstands the heavy metal tolerance of hexavalent chromium **(Cr^{6+})** polluted soil of *Gomphrena globosa* , (L). . It has completely adopting edaphic factors of hexavalent chromium polluted soil of heavy metal contaminated environmental areas.

Table: 1..Effect of various treatment of Arbuscular mycorrhiza of hexavalent chromium polluted soil on morphological changes of *Gomphrena globosa* , (L).

Treatment (gm kg^{-1} soil)	Germination Percentage (%)	Vigour index	Tolerance index	Toxicity level	Percentage of phytotoxicity
Control	35.5	191.7			

			-	-	-
5	53.3 (-50.14)	479.7 (-44.57)	0.431	99.56	52.50
10	57.7 (-62.53)	565.46 (-52.12)	0.475	99.52	22.97
15	62.2 (-75.21)	696.64 (-58.25)	0.770	99.23	15.68
20	71.1 (-88.79)	885.75 (-65.99)	0.894	99.10	10.52
25	63.3 (-91.19)	843.4 (-71.59)	0.830	99.16	11.976

Fig.1. Effect of various treatment of Arbuscular mycorrhiza of hexavalent chromium polluted soil on morphological changes of *Gomphrena globosa* , (L).



CONCLUSION

The physical and chemical remediation processes are both a very difficult and expensive and adversely affect the soil ecosystem. A potential remediation method for Cr^{6+} and other classes of heavy metal contaminated sites is suitable for the technique of phytoremediation, which is a cost-effective and environmentally friendly technique. Deployment of phytoremediation under diverse conditions and contaminants require evaluation of field performance, which is complicated by the difficulty to characterize the mass balance of metal contaminants as well as the complexity of interactions that take place between soil, metal, and plants. A multidisciplinary research effort that integrates the work of plant biologists, soil chemists, microbiologists, and environmental engineers is essential for greater success of phytoremediation as a viable soil cleanup technique to develop pollution free green environments.

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