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Effect of hexavalent chromium on germination and morphological changes of *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. The importance of phytoremediation processes considered to clean the metal contaminated and polluted ecosystems. The present study was under taken to determine the effects* Cr^{6+} *on germination and morphological changes of Gomphrena globosa ,(L) through phytoremediation technology under different concentration of VAM(Control (without VAM treatment), 5g, 10g, 15g, 20g and 25g VAM / kg of soil) treatments. The present study was concludes that Gomphrena globosa ,(L) could grow under hexavalent chromium polluted soil of Vellore district and applied different concentrations of VAM treatment (Arbuscular mycorrhiza) such as, Control (without VAM treatment), 5g, 10g, 15g, 20g and 25g VAM / kg of soil increase the plant growth and development except control plant(without VAM treatment) and reclaimed the Cr [VI] infected soil through phytoremediation method with treatment of VAM.*

Keywords—Industrialization, Hexavalent chromium, Biodiversity, Ecosystem, Plants and animal.

I. 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.

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 W, 1993) and (Deshmukh *et .al*,2009).

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

II. 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 field 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

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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.

Fig.1: Gomphrena globosa , (L). grown under Cr ^{6}+ polluted soil with treatment of VAM

Statistical analysis:

The data pertained to all the characters studied were subjected to statistical analysis using two way analysis (Anova). The values were meant for three replications of all the treatments and control. The data were analyzed using SPSS v16.0. Analysis of variance (ANOVA) was carried out, followed by Duncan's method.

III. RESULTS AND DISCUSSION

The ornamental plant of *Gomphrena globosa* , (L). data was revealed morphological growth nature of Hexavalent chromium polluted soil. Germination and growth development data shown superior growth nature and tolerate chromium stress under 5gm to 20gm VAM treatment in soil. Table No.1 shown Growth , Phytotoxicity , Tolerance index, Vigour index, Germination percentage of *Gomphrena globosa* , (L). The Table No.2.shown Root length, Shoot length, Total no.of leaves, Leaf area(Cm^2).The fig.2.shown the *Gomphrena globosa* , (L). grown under Cr ^{6}+ polluted soil with treatment of VAM These data concluded to withstands the heavy metal tolerance of hexavalent chromium **(Cr^{6+})** polluted soil in *Gomphrena globosa* , (L) plant. The maximum values of tolerance index, below toxicity level and percentage of phytotoxicity were found in 20 gm VAM/ kg of polluted soil when compare to low germination percentage and below morphological growth was observed in control plants of with out VAM treated *Gomphrena globosa* plant. It has completely adopting edaphic factors of hexavalent chromium polluted soil of heavy metal contaminated environmental areas with treatment of Arbuscular mycorrhiza (VAM). The earlier reports shown the similar findings by Bonet *et al.*, 1991 who studied the inhibitory effect of growth and germination of higher hexavalent chromium concentration on bush bean (*Phaseolus vulgaria* L.) plants was also confirmed by other researchers (Cervantes *et al*., 2001; and Mohanty and Patra, 2012). The reduction of germination percentage may be due to the accumulation of metals which may inhibits the seed germination by existing deleterious effect on the activities of hydrolytic enzymes involved in the mobilization of major seed reservoirs.

Table.1: Effect of various treatment of Arbuscular mycorrhiza at hexavalent chromium polluted soil on germination studies of Gomphrena globosa , (L).- 15 DAS plant.

Treatment (gm kg^{-1} soil)	Germination Percentage (%)	Vigour index	Tolerance index	Toxicity level	Percentage of phytotoxicity
Control	35.5	191.7	0.251	79.37	73.99
5	53.3 (+50.14)	479.7 (+150.2)	0.431	71.02	62.58
10	57.7 (+62.53)	565.46 (+194.9)	0.475	65.14	60.26
15	62.2 (+75.21)	696.64 (+263.4)	0.770	61.48	53.62
20	71.1 (+100.2)	885.75 (+362.0)	0.894	58.92	46.18
25	59.3 (+67.04)	843.4 (+339.9)	0.830	61.08	52.72

*Per cent over control values are given in the parentheses

ANOVA

Source of Variation	*SS*	*Df*	*MS*	*F*	*P-value*	*F crit*
Rows	63.50213	5	12700.43	0.941025	0.476106	2.71089
Columns	15.48971	4	387242.6	28.69233	4.9308	2.866081
Error	2.699276	20	13496.38			
Total	81.691116	29				

Table.2: Effect of various treatment of Arbuscular mycorrhiza at hexavalent chromium polluted soil on morphological changes of Gomphrena globosa ,(L).-15 DAS plant.

Treatment (gm kg^{-1} soil)	Plant height (cm)	Root length (cm)	Shoot length	Total no of leaves	Leaf area (Cm^2)
Control	5.44	1.92	3.52	4.58	11.21
5	9.46 (+67.21)	4.37 (+127.6)	5.09 (+44.60)	6.45 (+40.82)	23.68 (+111.2)
10	10.48 (+82.13	4.89 (+154.6)	5.59 (+58.80)	6.76 (+47.59)	29.73 (+165.2)
15	11.35 (+106.9)	5.19 (+170.3)	6.16 (+75.00)	6.84 (+49.34)	38.53 (+243.7)
20	12.63 (+130.3)	5.77 (+200.5)	6.86 (+94.88)	7.65 (+67.03)	51.40 (+358.5)
25	11.70 (+115.1)	5.45 (+183.8)	6.25 (+77.55)	7.48 (+63.31)	49.81 (+344.3)

*Per cent over control values are given in the parentheses

ANOVA

Source of Variation	*SS*	*Df*	*MS*	*F*	*P-value*	*F crit*
Rows	47.4061	6	79.01017	2.319427	0.065813	2.508189
Columns	4.48952	4	1122.382	32.94872	1.9909	2.776289
Error	0.8175483	24	34.06451			
Total	52.7131683	34				

IV. 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 techniques of phytoremediation by using *Gomphrena globosa* ,(L) , which is a cost-effective and environmentally friendly technique under suitable concentration of VAM treatments . Phytoremediation under diverse conditions and contaminants require evaluation of field performance. A multidisciplinary research effort that integrates the phytoremediation technology in different heavy metal contaminated soil.

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