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EFFECT OF HEAVY METALS IN ARACHIS HYPOGEA L (GROUNDNUT) AND ITS TREATMENT

Damera Vineeth[1]*, Chinna. Venkateshwar[2] and Syeda Azeem Unnisa[3]

Department of Botany, University College of Science, Osmania University, Hyderabad-500007, Telangana State, India.

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***Correspondence for Author**
Dr. Damera Vineeth
Department of Botany, University College of Science, Osmania University, Hyderabad, Telangana State, India.

ABSTRACT

The present study deals with heavy metals toxicity in *Arachis hypogea* plant parts and its treatment by calcium hydroxide which is an annual herb plant belongs to family Fabaceace. Pot culture experiments with *Arachis hypogea* were conducted till productivity levels at Greenhouse of Botanical Garden, Department of Botany, Osmania University, and Hyderabad. The three treatments consist of Treatment I control without any addition of heavy metals to the soil, Treatment II - heavy metals spiked into the soil and Treatment III-1% of Calcium Hydroxide added along with heavy metals to the soil. The results revealed that when compared to treatment I-control and treatment III with $Ca(OH)_2$, in treatment II high concentrations of heavy metals Ni, Cd and Cr are found in root, stem, leaf and seed of *Arachis hypogea*. In addition, the plants grown in 1% Calcium hydroxide treated soil, reversed the growth suppression and inhibited the heavy metal toxicity in plants as evidenced by reduced heavy metals concentrations in plant parts. The study concludes that medicinal plant *Arachis hypogea* affected with heavy metals can be treated or remediate by using calcium hydroxide.

KEYWORDS: *Arachis hypogea*, heavy metals, calcium hydroxide, atomic absorption spectroscopy, remediation.

INTRODUCTION

Contamination of soil with heavy metal is one of the major environmental stress for higher plants and heavy metals are generally considered toxic to cells. Toxic metals first accumulate in soil to reach the plants through roots. Metal toxicity has direct or indirect effects on plants.

Heavy metals are enriched in the environment by human activities of different kinds [7] .Thus there is probably bigger problem with anthropogenically supplied metals with high levels of bio-available metals than with background levels originating from bedrock with slow weathering. A heavy metal contaminated atmosphere, geosphere and hydrosphere pose a serious threat to plants. The majority of the studies have been associated with various industries and agriculture activities. Nevertheless in many cases of naturally high occurrence of heavy metals, there is often a close link with human derived contamination. However the heavy metals released by human activities day by day are becoming potentially toxic for the organisms. The environment is polluted by the contamination of heavy metals is a major problem for human health and environmental quality[6] ,the poison nature of heavy metals , high potentiality with plants and animals finally results in toxicity[5] ,[10], [12] . In different types of soils effect of ionic strength and variation in pH on absorption of heavy metals such as, Ni, Cd and Cr is different [14].

MATERIALS AND METHODS

1. **Arachis Hypogea**

Arachis hypogea an important oil seed yielding crop, belongs to the family. It is an annual herbaceous plant growing 30 to 50 cm tall. Although appearing and referred as a nut, it is actually the underground pod of a legume rather than true nut. The seeds pods and whole plants are also a source of animal fodder, fiber for paper production and green fertilizer.

2. **Seed Material**

The experimental plant i.e. Arachis *hypogea* (Ground nut) belongs to fabaceae is one of the important oil seed crop of India. The certified seeds of Arachis *hypogea* (Ground nut) K-6 Var seeds were purchased from Regional Agriculture Research Station, Warangal, Telangana State, India. Seeds with uniform size, colour and weight were chosen for experimental purpose. Seeds were grown in earthen pots in at Greenhouse of Botanical Garden, Department of Botany, Osmania University Hyderabad. The plants were grown without pesticides, fertilizers and no addition of any type of manure. The crop was harvested after productivity level.

3. Soil Preparation

20 Kgs of black soil was used for the pot experiments; the soil consists of 15.4% of clay, 3.5% of total carbon and was maintained at P^H 6.5.

4. **Treatments** Treatment-I: 20 Kg of black soil was filled in 15 clay pots as control, Treatment-II: 20 Kg of black soil spiked with heavy metals was filled in 15clay , Treatment-III: 20 Kg of black soil spiked with heavy metals and 1% Ca $(OH)_2$ was filled in 15 clay pots.

5. **Heavy Metal Solution Preparation**

The heavy metal solution was prepared in the laboratory by following the [2] guidelines .The different concentrations of heavy metals prepared are cadmium (10ppm), chromium (20ppm), nickel (16ppm).These heavy metals were dissolved in 150 liters of distilled water and sprayed on 600kg of black soil and dried in shade for 10 days for proper mixing of heavy metals in soil.

6. **Preparation of Adsorbent Solution**

1.5 kg of 1% Ca $(OH)_2$ was added to the 300kgs of soil spiked with heavy metals.

7. **Acid Digestion of Plant Samples**

The plant material of *Arachis* such as root, stem, leaf and seeds were taken after harvesting and The plant material was dried , grinded into fine powder .The 10mg of powder(Rhizome and Leaf) was digested in triple acid ($HCLO_4$: HCL: HNO_3(5:1:1),) [1]. And heated at 80-100^{o}C for 3 hours on hot plate. After digestion, samples were diluted with 20ml milky water (Millipore instrument) and incubated for about 24 hours and analyzed directly by using Atomic Absorption Spectrophotometer (Model: Perkin Elmer Analyst 100) for detection of Ni, Cd and Cr.

RESULTS

The treatments results of *Arachis hypogea* contaminated with heavy metals are given in table (1) and impact of heavy metal & treatment is shown in fig 1, 2 and 3

Table 1: Treatment of Heavy Metals in Arachis Hypogea (Mg/Kg of Dry Weight)

Plant parts of Arachis hypogea	Heavy metals (ppm)	No:I Treatment (Control soil)	No:II Treatment (Soil + Heavy metal)	No:III Treatment (Soil + Heavy metal+ 1%Ca$(OH)_2$
		Mean ± S.D	Mean ± S.D	Mean ± S.D
Root	Ni	0.225±0.07	0.708±0.15	0.263±0.07
	Cd	0.140±0.06	0.400±0.13	0.014±0.06
	Cr	0.355±0.09	0.940±0.18	0.446±0.09
Leaf	Ni	0.479±0.06	0.883±0.13	0.500±0.07
	Cd	0.260±0.12	0.740±0.26	0.300±0.13
	Cr	0.242±0.03	0.555±0.09	0.264±0.04

Stem	Ni	0.214±0.03	0.459±0.09	0.264±0.04
	Cd	0.150±0.03	0.280±0.07	0.140±0.03
	Cr	0.118±0.03	0.313±0.06	0.150±0.04
Seed	Ni	0.574±0.06	0.974±0.13	0.590±0.06
	Cd	0.290±0.11	0.800±0.27	0.390±0.12
	Cr	0.243±0.04	0.497±0.08	0.250±0.04

Fig (1) Treatment-I Control soil

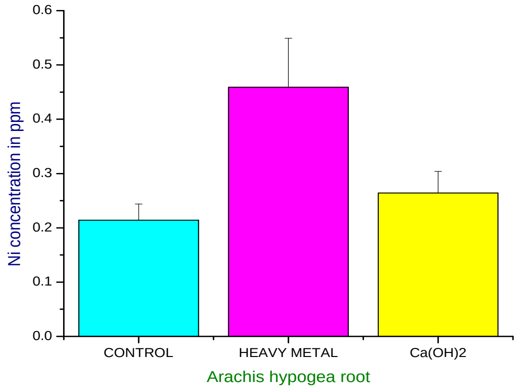
Fig (2) Treatment-II Soil+Heavy metal

Fig (3) Treatment-III Soil

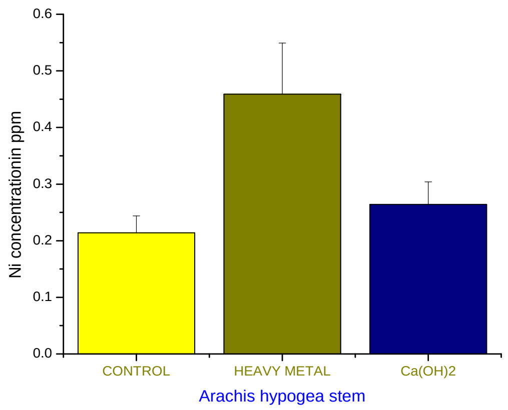
Heavy Metal+1% Ca $(OH)_2$

1. **Nickel**

It was observed that effect of nickel addition on growth and nutrient uptake of plants studied by grown in control soil, the concentration of nickel in root were 0.225± 0.07mg/kg, in leaf0.479±0.06mg/kg, in stem 0.214±0.03mg/kg and in seed0.574±0.065mg/kg. Plants grown in heavy metal treated soil, the Ni concentration in root was 0.708±0.15mg/kg, in leaf0.883±0.13mg/kg, in stem 0.459±0.09mg/kg and in seed0.974±0.13mg/kg, and in plants grown in soil with heavy metal treatment + 1% Ca $(OH)_2$ as barrier and the Ni concentration in root was 0.263±0.07mg/kg, in leaf0.500±0.07mg/kg, in stem 0.264±0.04mg/kg and in seed0.590±0.06mg/kg. In 1984, FAO/WHO set permissible limit for Ni is 1.683ppm [8],[9] . Thus, in *Arachis hypogea* concentrations of nickel in root, leaf, stem and seed are within the permissible limit. Hence, it is recommended that application of 1% Ca $(OH)_2$ is a good barrier to inhibitor for heavy metal entry into *Arachis hypogeal* .The impact of Ni and its treatment in various parts of a *Arachis hypogeal* is depicted in fig 4,5,6,7.



Fig(4)



Fig(5)

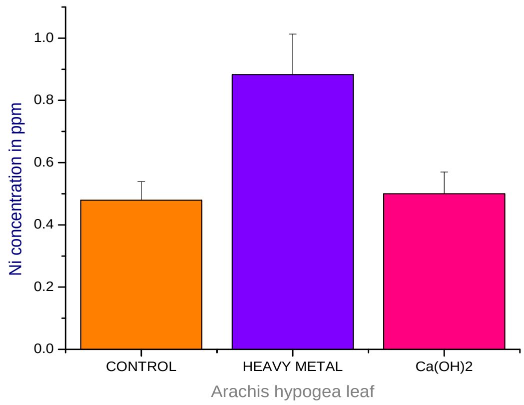


Fig (6)

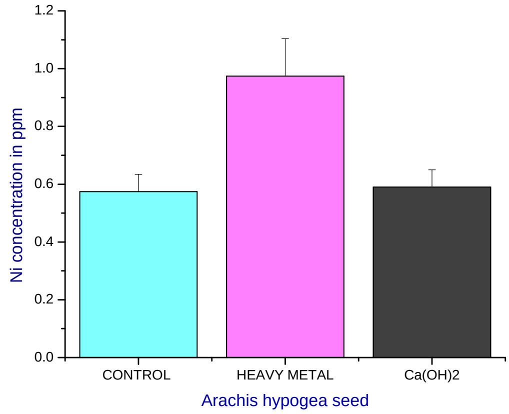
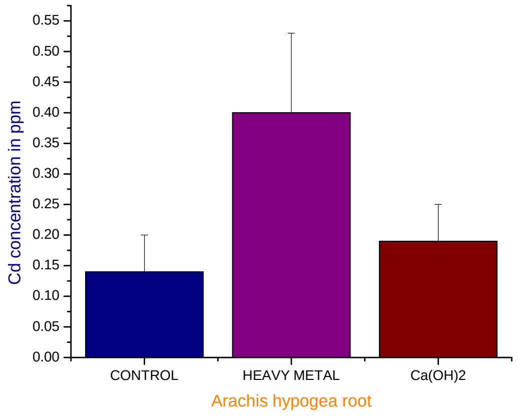


Fig (7)

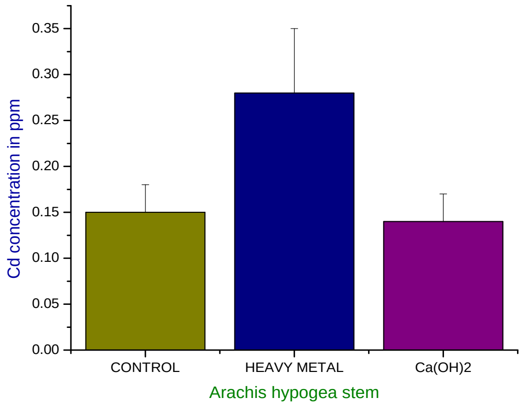
II. Cadmium

Cadmium is biopersistent and once absorbed by an organism, remains resident for many years although it is eventually excreted. Cadmium (Cd) is a highly toxic trace element and has been ranked No.7 among the top toxins [3]. Cadmium and lead reduced the leaf area of radish [13]. Cadmium effects on plant growth the concentration of cadmium in root was 0.140±0.06mg/kg, in leaf 0.260±0.12mg/kg, in stem 0.150±0.03kg and in seed 0.290±0.11mg/kg when plants grown in control soil. Plants grown in heavy metal treated soil, the Cd concentration in root was 0.400±0.13mg/kg, in leaf 0.740±0.26mg/kg, in stem 0.280±0.07mg/kg and in seed 0.800±0.27mg/kg and in plants grown with heavy metal treated +1% Ca $(OH)_2$ as barrier soil, Cd concentration in root was 0.190±0.06mg/kg, in leaf mg/kg0.300±0.13mg/kg, instem0.140±0.03mg/kg and in seed0.390±0.12mg/kg. The permissible limit set by WHO is 0.06 to 0.26p pm [8,9]. Thus, in *Arachis hypogea* concentrations of Cadmium in root, leaf, stem and seed are within the permissible limit.

Hence, it is recommended that application of 1% Ca $(OH)_2$ can inhibit the entry of heavy metals into *Arachis hypogea* .The Cd treatment in plant parts of *Arachis hypogeal* is shown in figures 8,9,10,11.



Fig(8)



Fig(9)

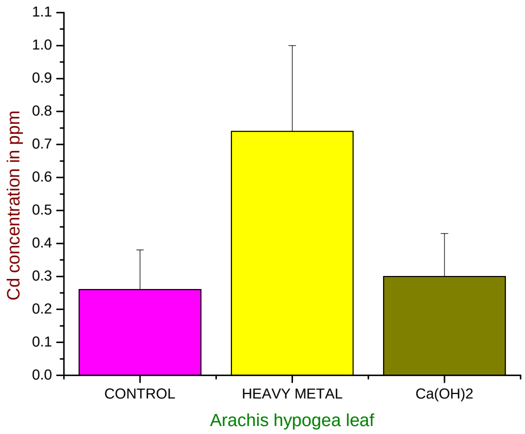


Fig (10)

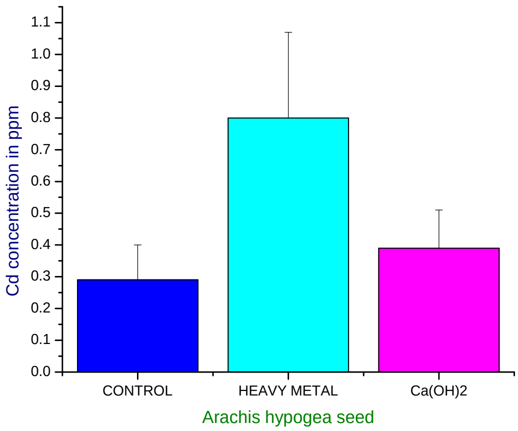


Fig (11)

III. Chromium

Chromium (VI) effects on mineral element composition in bush beans was experimented by [4].The concentration of chromium in root was 0.355±0.09mg/kg, in leaf 0.242±0.03 mg/kg, stem0.118±0.03mg/kg and in seed 0.243±0.04mg/kg when plants grown in control soil. Plants grown in heavy metal treated soil, the Cr concentration in root was 0.940±0.18mg/kg, in leaf 0.555±0.09mg/kg, in stem0.313±0.06mg/kg and in seed 0.497±0.08mg/kg and in plants grown with heavy metal treated +1% Ca $(OH)_2$ as barrier soil, Chromium concentration in root was 0.446±0.09mg/kg, in leaf0.150±0.0202mg/kg, in stem 0.264±0.04mg/kg andinseed0.250±0.04mg/kg. For crop plants, the WHO (2005) limits for chromium have not yet been established. However, permissible limits for chromium set by Canada were 2ppm in food crop material and 0.02mg/day in pulses crop WHO. Comparison of metal levels in the plants investigated with those proposed by FAO/WHO showed that the herbs have chromium concentrations equivalent to the limits permissible in edible plants.[8],[9], Cr is 0.016to 0.026ppm Thus, in *Arachis hypogea* concentrations of chromium in root, leaf, stem and seed are within the permissible limit. Hence, it is recommended that application of 1 % Ca $(OH)_2$ is a good barrier to stop heavy metal entry into *Arachis hypogea* .The treatment of heavy metal in *Arachis hypogeal* is depicted in figures 12,13,14,15.

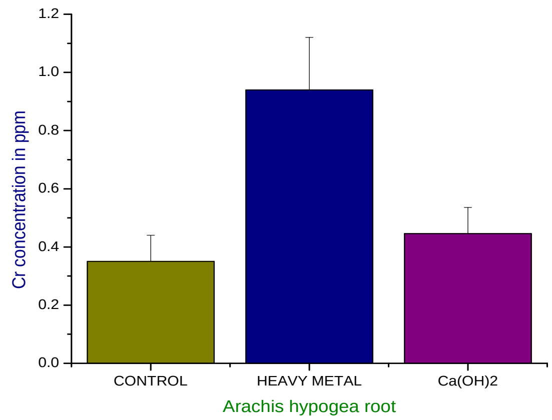


Fig (12)

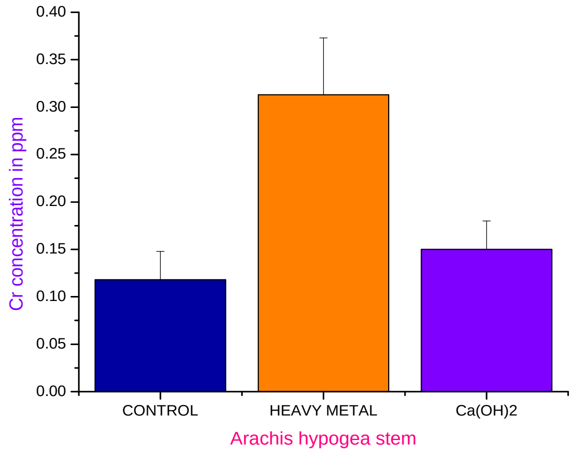


Fig (13)

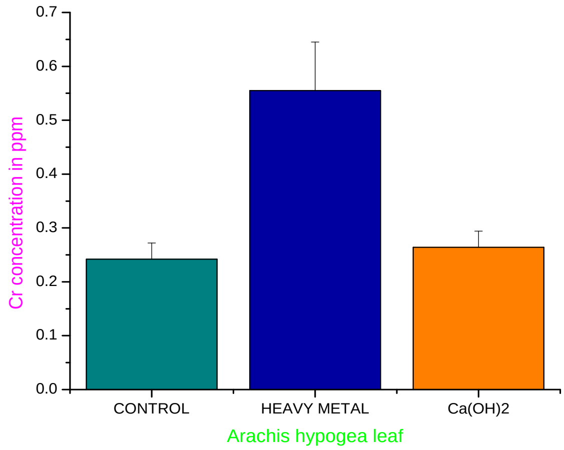


Fig (14)

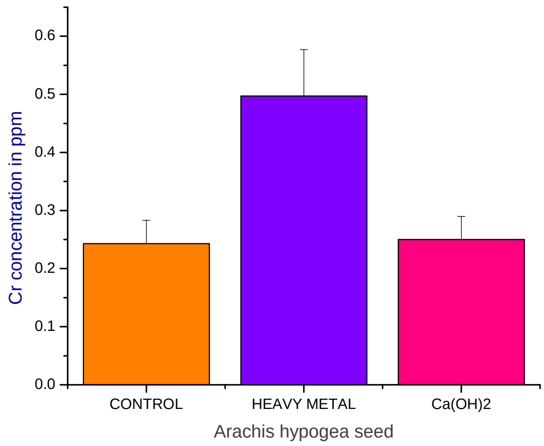


Fig (15)

DISCUSSION

The interactions between heavy metals and the properties of soil play an important role in the environment through their decreasing effect on the bioavailability of heavy metals, thus favorably affecting the environment. It has been demonstrated that some plants can actively or passively change H+ excretion under heavy metal stress. Such root-induced changes of rhizosphere pH play a major role in the bioavailability of many pH dependent nutrients, but also potentially toxic metals and a range of trace metals [11]. The interaction between nutrients, heavy metal and soil may occur at the level of plant and/or in the soil. In soil, nutrients and metal interact at the level of precipitation, surface absorption and formation of complexes with organic compounds [15]. Rhizosphere is an important environmental interface connecting plant roots and soil. The influence of root exudates on heavy metal bioavailability and toxicity is a consequence of change in the rhizosphere pH, redox potential and the number and activity of rhizospheric microbes, and the capacity for chelating with Ca $(OH)_2$. Some motile physiological changes would take place when plants are grown under heavy metal conditions, and then make a series of physical and chemical reactions of heavy metals in rhizosphere to affect their transfer in soil-plant system, which may be beneficial to decrease the metal availability and its absorption by plants. Therefore, it is understandable that the study of root rhizosp here has been one of the most important issues in toxicity and tolerance of metals.

CONCLUSION

The study concludes that *Arachis hypogea* oil seed crop plant used for human consumption for preparation of cooking oil and also for animals i.e oil cake used for fodder animal husbandry should be collected from an unpolluted natural habitat. The present study results reveal that heavy metal content in the plants, growing in polluted areas can reduces the productivity and yield when compared to plants grown in treated soil with of 1% $Ca(OH)_2$. Treatment with $Ca(OH)_2$ can inhibit the passage of heavy metals like Ni, Cd and Cr in to plant parts of *Arachis hypogea*.

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