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HEAVY METAL CONTAMINATED WATER APPLICATION AND HOW IT AFFECTS SOIL AND PLANTS THROUGH PHYTOREMEDIATION

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ABSTRACT

Water is increasingly being applied for irrigation in vegetable cultivation in the peri-urban zones of rapidly rising cities. Wastewater being used by Farmers is heavily polluted with poisonous heavy metals as a result of industrial discharge and other human activities. As a result, long-term wastewater application is detrimental to soil and vegetable health. The current study looked at the heavy metal concentration (As, Cd, Cr, Hg, and Pb) in agricultural soil, water, and vegetable samples. Heavy metals are the high-density content and not easily accumulated in the soil and water. these metals are dissolved in soil through anthropogenic processes, like humans are using the metals like mercury in lab and after the use they dispose these metal on the soil surface. When these metals are put on the soil surface they decompose and leach into the soil subsurface layer after that they percolate into groundwater.

KEY WORDS : Heavy metal contamination, Heavy metals determination, Sources of heavy metals, Phytoremediation through mustard.

INTRODUCTION

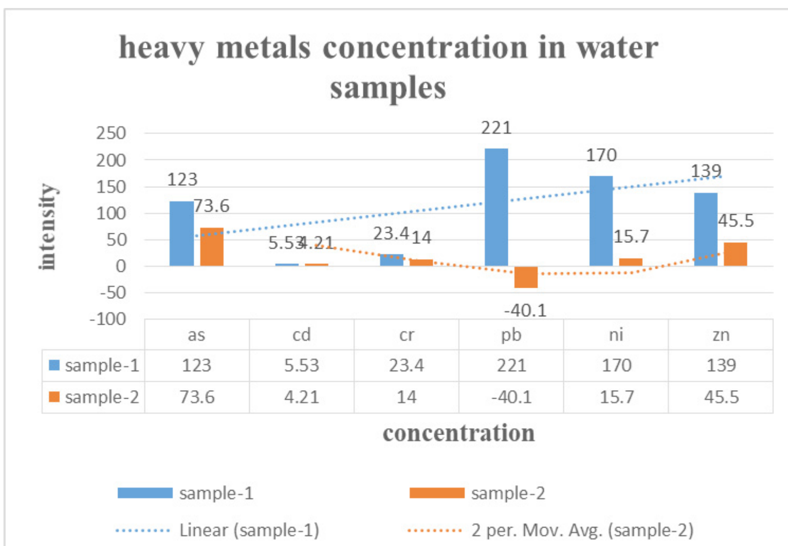
Heavy metals are inherently present in the Earth's mantle and are found in all ecosystems, however their concentration has risen dramatically because of anthropogenic activity. Heavy metals are natural elements that are necessary for living organisms, but at higher amounts, they become poisonous. The degree of pollutants in lakes because of pollutants varies depending on geographical area, economic growth, and pollution sources. then heavy metals like lead, mercury, cadmium, and chromium are dissolved this process only by the anthropogenic activities, also after the use of metals they are disposed on the soil surface when these metals are put on soil surface they leach into the soil subsurface layer after that they percolate into groundwater. Heavy metals are non-biodegradable in nature and can survive in soil for a long time, therefore they tend to bioaccumulate in the ecological food chain through primary intake, followed by secondary and tertiary consumption. Heavy metals drain from the ash ponds, contaminating the land, surface water, and ground water. These metals have been shown to inhibit plant and microbial population survival and growth. According to certain research, most of the components found in coal ash can leak into ground water. Groundwater samples collected near a coal ash disposal site in Orissa, India, revealed higher amounts of Zn, Cu, and Pb in tube well water near an ash pond. Higher heavy metal concentrations disrupt plant metabolic functions and reduce crop growth; they disrupt physiological and biochemical processes, respiration, and organelle degeneration, and restrict photosynthesis. In some cases, plants are directly die due to blocking of their internodes and stem accumulation of metals in their plant body. These metals are highly persistence in nature and not easily decomposed and when these metals are accumulated or attached to the soil particles in the soil then they made interference to the absorption of nutrients from the soil through the roots by plants. The plants are not able to absorb water and nutrients from the soil then the plant or crop lead to die or shows nutrient deficiency symptoms. In some cases, plants are directly died due to blocking of their internodes and stem accumulation of metals in their plant body.

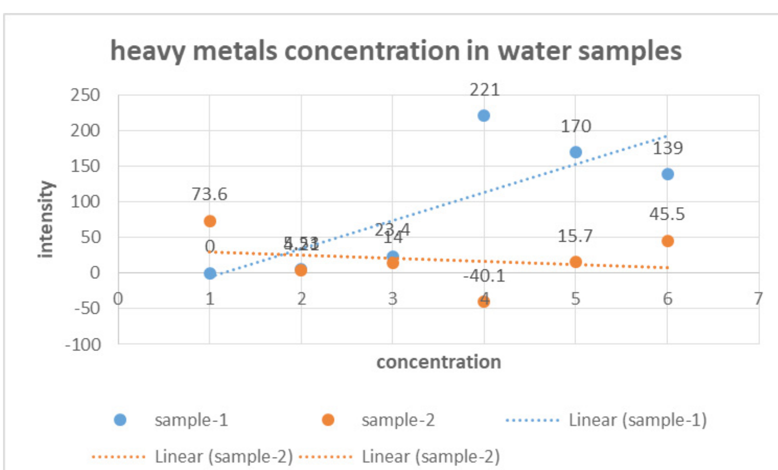
Methods of heavy metals determination in water, soil and plant samples

The estimation of heavy metals contamination in water by using the atomic absorption spectroscopy (AAS) or Inductively Coupled Plasma (ICP) and in soil and plant field emission scanning electron microscopy (FESEM) was used for the determination of heavy metals. The heavy metal availability in contaminated soil and mustard plants leaf accumulation is determined by field emission scanning electron microscopy (FESEM)-EDS method. Here we figured out heavy metals like arsenic, mercury, chromium, cadmium, and lead in soil and plant leaf. At magnifications ranging from 10x to 300,000x, field emission scanning electron microscopy (FESEM) delivers topographical and elemental information with nearly infinite depth of field. Field emission scanning electron microscopy (FESEM) delivers clearer, less electrostatically distorted pictures with spatial resolution down to 1 1/2 nanometers—three to six times better than conventional scanning electron microscopy (SEM) and ither side heavy metal content in water samples are determined by ICP method in central lab at CSSRI- Karnal.

Heavy metal analysis and percentage in water, soil, and plants

Contaminated metals occur when water is applied to the soil and crops. After taking two water samples from an industrial area, we identified the metal percentage in contaminated water. These water samples are evaluated by ICP method, as a consequence, the results for samples-1 are as follow: pb (221), cr (23.4), as (123L), zn (139), cd (5.53), and ni (170) in PPB, and samples-2, As (73.6), cd (4.21), cr (14.0), pb (-40.1), zn (45.5), and ni (15.7) in PPB. They





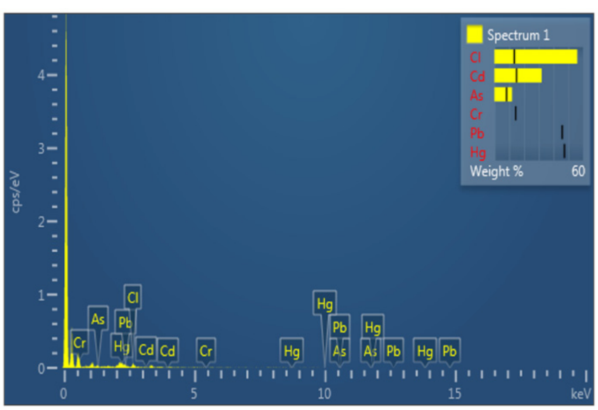
are shifted from the marginal to the hazardous level by seeing their values. Bioaccumulation factors for heavy metals in soil (Hg, Cr, Cd, Pb, and as) were varied from 0.00, 16.54, 0.00, 0.00, and 83.46. Translocation factors for heavy metals in leaf of mustard are (Cr, As, Cd, Hg, and Pb) were varied from 42.19, 33.47, 15.07, 0.00, and 9.27 mg/kg. These metal accumulation in soil and plants are determined through the FESEM method at central lab in lpu. See the bar and graph of heavy metal percentage in contaminated water below mentioned image.

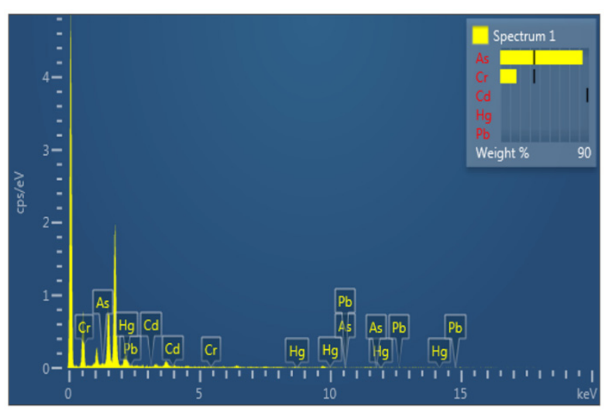
Effect of heavy metal contaminated water applied to soil and plants

The heavy metal contaminated wastewater is used as seedling irrigation of mustard crop. In that wastewater heavy metals like nickel (Ni), cadmium (Cd), chromium (Cr), lead (Pb) and arsenic are present in those water samples. There are two samples selected in those one S1 having heavy metals are As (123), Cd (5.53), Cr (23.4), Pb (221), Ni (170), and Zn (139) And S2 contains heavy metals ranging from As (73.6), Cd (4.21), Cr (14), Pb (-40.1), Ni (15.7), and Zn (45.5). These metals are detected by the ICP method in ICAR-CSSRI Karnal, Haryana. When compared to normal field irrigated water, the quality of contaminated wastewater for irrigation is not safe in terms of pH, EC, SAR, RSC, and heavy metal content. In comparison to groundwater, contaminated wastewater has a higher nutrient (NPK) potential and heavy metal content. The contaminated heavy metal water after checking their quality parameters is not suitable for drinking and irrigation purposes in that water having prominent levels of toxic content metals like Cd, Cr, As, Ni, and Pb causes severe damage to the plant after it is transferred into biomagnification into food content. But from one point of view, if we see the contaminated metals saw by the mustard plant, it can clean the environment when growing it, but consumption of mustard in metal contaminated zones is harmful to humans as well as animals. We analysed the N, P, and K content in the seedling tray soil again after the seedlings grew, during their development phase of 1-24 days. The nitrogen levels are then expressed as percentages: s1 (178.35), s2 (205.61), s3 (201.91), s4 (209.52), and s5 (208.14). Here, we can observe that the nitrogen concentration is lower in the s3 and s5 samples, but the remnants are higher. The samples in phosphorus are s1 (19.84), s2 (20.21), s3 (26.15), s4 (21.26), and s5 (27.04). The phosphorus content in s3 and s5 has reduced, along with the nitrogen amount. Other potassium contaminated water applied soil values are as follows: s1 (121.38), s2 (127.17), s3 (142.21), s4 (109.49), and s5 (125.26). Potassium levels were reduced in the s1, s3, and s5 samples.

Phytoremediation through mustard crop

We can observe that the heavy metals are well observed by the mustard through the medium of soil. When we applied metal-contaminated water to the seedling tray of mustard, the mustard absorbed metals in large amounts, and that can be calculated in the presence of leaf through the FESEM method. The soil metal concentration also decreased. The heavy metal contaminants in soil are chromium (Cr), cadmium (Cd), mercury (Hg), lead (Pb), and arsenic (As). In all soil samples, the heavy metals are different. The metals are based on atomic percentage 22.22, 0.00, 0.00, 0.00 and 77.78 mg/kg, and weight percentage of metals are, and 16.54, 0.00, 0.00, 0.00, and 83.46 mg/kg, respectively. The atomic





Heavy metals are presence after application of contaminated water to seedling trays of mustard in first image of mustard leaf and 2nd image is metal contamination in soil.

percentages are (Cr)222200, (Cd) 000000, (Hg) 000000, (Pb) 000000, and (As) 777800 in parts per million (ppm), while the weight percentages are 165400, 000000, 000000, 000000, and 834600 ppm in per one seedling round in seedling tray soil. When the plant absorbs heavy metals from soil then these metals are accumulated in leaves and stem parts of plants. When the plant absorbs heavy metals from soil then these metals are accumulated in leaves and stem parts of plants. We Analyse the metals percentage in the leaf of the mustard plant and how much percentage of metals are absorbed by the roots. The heavy metals are like chromium (Cr), cadmium (Cd), mercury (Hg), lead (Pb), and arsenic (As). atomic percentage of heavy metals are 42.19, 15.07, 0.00, 9.27, and 33.47 mg/kg, and weight percentage of metals are 26.38, 20.37, 0.00, 20.10, and 30.16 mg/kg, respectively. The atomic percentages are (Cr) 421900, (Cd) 150700, (Hg) 0000, (Pb) 92700, and (As) 334700 in parts per million (ppm), while the weight percentages are 263800, 203700, 000000, 201000, and 301600 ppm in per one seedling round in seedling tray.

SUMMARY AND CONCLUSION

The use of metal contaminated water on the soil and crops can severely damage soil physical and chemical properties and also impact micronutrients and cause a sudden decrease of microbial activity in soil by the regular application of heavy metal contaminated water. First, we have to decrease the main source of heavy metal production and properly implement the renewal of metal water before it goes down to the subsurface layers of soil. We have proper sanitation before using contaminated water, and some industries are directly connecting their channels to a nearby pond or canal. This can severely impact the canal water and also aquatic marine systems. The government can take proper action on industries to maintain their proper sanitation and treatment of contaminated water before releasing it. The phytoremediation process can remove metals from the soil and store them in plant parts, making it a simple way to remove metal contaminated water or areas.

If you look at the all-soil samples, you will notice that samples s2, s3, and s5 gradually increased their N, P, and K content, and remined soil samples also increased their nutrient content through the addition of contaminated water. Regular application of contaminated water to the seedling trays after 20 days of seedling starts wilting and dyeing slowly because proper nutrient absorption is not there. Because these heavy metals are attached to the root hairs, they block the nutrient absorption in mustard seedlings. Later, the seedlings start drying, and finally they lead to their death. By the fesem method, we can observe that the heavy metals are highly accumulated in mustard seedlings by the absorption of water from the soil. Here is the final conclusion I have to give. That is, the heavy metal contaminated water application to the mustard seedling trays is highly observed from the soil, and these metals are accumulated in their plant bodies like roots, stems, and leaves through the phytoremediation process.

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