**Studying of interaction effect between organic matter and arsenic element on transfer coefficient (TC) in cress plant**

Ali Gholami¹, Alireza Jafarnejadi ², Elahe Kardan*³

1, 3- Department of Soil Science, Science and Research Branch, Islamic Azad University, khouzestan, Iran.  
2- Soil and Water Research Department of Agricultural and Natural Resources Research Center of Khouzestan, Iran

*Corresponding Author Email: emkardan1987@gmail.com

Abstract

This research was done aimed to Studying of Interaction Effect between Organic Matter and Arsenic Element on Transfer Coefficient (TC) in Cress plant. The research was performed in the flowerpot format in a completely randomized format design as factorial with three replications. The treatments included two levels of organic substance (0 and 10 tons per hectare) and three levels of arsenic (0, 20 and 40 mg/kg). After full growth of the plant, the total arsenic concentrations were measured using atomic absorption device in aerial organs of the shoots and in the soil. The statistical analysis and means comparison were performed using MSTAT-C software and applying DMRT method at 5% and 1% levels. The results showed that arsenic treatment effect on the element retention rate in the plant shoot was significant at 1% level. Also, the results from comparing the means of interactions showed that the arsenic absorption at 40 mg/kg treatment in the presence of organic substance increased by 22% compared to control treatment. Also, in any level of organic material with increasing levels of arsenic, the transfer coefficient has increased; so that the highest Arsenic rate reading in the organic material and 20 mg/kg Arsenic treatment was observed as 42 percent. However, it is noteworthy that due to the plant's ability to absorb arsenic and other heavy elements, planting of this plant in order to grow vegetables for food should be avoided in the lands that are likely to be contaminated with these elements. Finally, it was suggested that given the plant ability to absorb, this plant can be used as a purifier plant to purify arsenic-contaminated soil.

**Keywords:** Arsenic Element, Organic Matter, Transfer Coefficient, Cress.

Introduction

Heavy metals due to non-biodegradability and harmful biological effects on the organisms at low concentrations have a significant importance in environmental contamination area (Alloway, 1990). These metals find their ways from various sources to the environment, plant body and eventually to the food chain of humans and animals and cause serious damages. For example, in humans, anemia, hypertension, mental retardation and a variety of cancers are of consequences due to consumption water or foods contaminated with heavy metals. Arsenic is one of the most toxic elements that are used in various industries such as glassworks, metallurgy, electronics, and ball making, steel, paint industries and enter into the components of environment such as soil and water through many ways. There are some methods to reduce soil and water contamination that are so expensive. Washing soils contaminated with heavy metals by acid, treatment of industrial wastewaters in refineries and excavation and soil burial in a safe place can be mentioned as examples. Another technology that is a very low-cost and simple method comparing with other refining approaches includes using plants to remove soil contamination, which is called green refinement. Since the modifying material such as organic modifiers can increase the plant ability to absorb the contaminants, a variety of animal manures can be used for this purpose. Dong et al. (2008) studied the effect of Arbuscular - Mycorrhizal fungus Glomus mosseue in a culture including Trifolium repens Linn and Lolium perenne L. on the tolerance of these plants in arsenic contamination conditions. The plants inoculated with Mycorrhiza...
caused an increase in phosphorous absorption versus decrease in arsenic transport from roots to shoots, which suggested an increase in plants resistance to arsenic. Moreno et al. (2008) studied the resistance of some Mediterranean plants against the presence of arsenic contamination. Myrtus communis, Arbutus unedo and Retama sphaerocarpa were the plants that were examined. Among these three plants, the plant species of A. unedo showed the greatest sensitivity against arsenate. In general, the arsenic accumulated mostly in the roots of these plants. Although M. communis has had the highest absorption compared to two other species, but R. sphaerocarpa showed the highest amount of arsenic transportation from the plant root to its shoots. Finally, M. communis and R. sphaerocarpa were determined as appropriate species for re-developing vegetation cover in soils contaminated with average concentrations of arsenic. The potential of green refining of arsenic contaminated soils by two plants of green onion and ornamental cabbage. The results showed that, given the low absorption of arsenic by green onion, this plant cannot be a good option for removing arsenic contamination from the contaminated soils (Ladan, 2011).

Materials and Methods

The experiment was performed in the flowerpot format in the greenhouse of the Agriculture and Natural Resources Research Center, Khouzestan, Iran. The soil texture used in this study was clay loam and was prepared from the field of Agricultural Research center in Dezful. The studied soil was air dried for 24 hours and then was sieved through a 2 mm sieve; then it was contaminated with the desired concentrations. To contaminate the soil, a certain amount of sodium hydrogen arsenate, 7 hydrated (Na2HAsO.7H2O) was dissolved in water based on experiment treatments and was sprayed as a solution on the soil surface and fully mixed with the soil. Then, the organic matter (rotten and powdered sheep manure) up to the amount required was weighted based on 10 tons per hectare and was added to the pots having treated with organic material. Then, considering the specific gravity of soil (1.35 g/cm3) and based on the size of the pots (average diameter of 18 cm and height equal to 12 cm), the amount of soil required was calculated and potting was performed. Finally, the pots were left for 10 days for pollutants and soil interactions and creating conditions close to nature in the greenhouse environment. Then, the seeds of cress (broad-leaved cress) with 90% viability were planted in pots and were watered lightly to prevent drought stress. At the end of growth period, the plant was completely removed from the pot; then it was well washed with distilled water and dried; after drying in oven at 75 degrees Celsius temperature for 24 hours, the plant was ground and then was extracted with hydrochloric acid, and finally was read by atomic absorption device. The soil samples were also extracted with nitric acid and hydrochloric acid and were read by atomic absorption device (Khodaverdi and Homaei, 2008). The data obtained from lab reading were ultimately examined using the MSTAT-C software, and statistical analysis and means comparing were performed by Duncan method at 5% and 1% levels, as well as drawing diagrams using Excel software.

Results and Discussion

Table 1. Analysis of variance mean squares of features studied

<table>
<thead>
<tr>
<th>Transfer coefficient (TC)</th>
<th>Arsenic concentrations in soil</th>
<th>dry Weight of Shoot</th>
<th>Arsenic concentrations in shoot of plant</th>
<th>Degrees of freedom</th>
<th>Changes of resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.103*</td>
<td>122.6*</td>
<td>0.153*</td>
<td>35.87*</td>
<td>2</td>
<td>Repeat</td>
</tr>
<tr>
<td>0.001*</td>
<td>564.9*</td>
<td>0.271*</td>
<td>30.3*</td>
<td>1</td>
<td>Organic matter</td>
</tr>
<tr>
<td>0.165**</td>
<td>4561**</td>
<td>1.74**</td>
<td>284.59**</td>
<td>2</td>
<td>Concentrations of Arsenic Interactions</td>
</tr>
<tr>
<td>0.066*</td>
<td>530.3*</td>
<td>0.259*</td>
<td>12.87*</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>0.021*</td>
<td>86*</td>
<td>0.059*</td>
<td>10.52*</td>
<td>10</td>
<td>Error</td>
</tr>
</tbody>
</table>
The results of means comparison of organic matter treatments on arsenic concentration accumulation in the plant shoot showed that by increase in organic matter, the concentration of arsenic in plant shoot has followed an increasing trend. The highest arsenic concentration in the plant shoot has been observed in the 10 mg/kg treatment (ton per acre) of the organic matter and the lowest amount has been observed in control treatment, so that with increasing the organic matter, the arsenic concentration has...
increased up to 40 percent in the plant. By increase in arsenic concentration from 0 to 40 (mg/kg), the plant transferring coefficient value has followed a significant increasing trend. The greatest value of plant transfer factor has been observed in arsenic 20 mg/kg treatment and the lowest value has been seen in control treatment as 20 percent, so that by increase in arsenic concentration from 0 to 20 treatments (mg/kg), the increase has reached to 35 percent. The results of means comparison of interaction effects of arsenic and organic material on the transfer coefficient showed that in any organic material level, with increasing of arsenic concentrations, the transfer coefficient has increased. Thus, the highest arsenic concentration reading in the treatment of organic materials and arsenic 20 (mg/kg) was observed as 42 percent.

**Conclusion and Recommendation**

Examining the interaction between organic matter and arsenic showed that with increasing organic matter, the plant transfer coefficient has increased; this indicates that the ability of arsenic absorption by cress plant will increase in the presence of organic matter. It is suggested that considering the ability of the cress plant to absorb arsenic element, this plant will be used as a purifier plant to purify the soils contaminated with arsenic. But since the cress plant is consumed by human and livestock, after planting it in the arsenic-contaminated areas, the plants should be transferred to a secure area and disposed to prevent their possible usage. Given the ability of plant to absorb arsenic and other heavy elements, it is recommended to avoid planting of this plant for growing food vegetables in the lands suspected to be contaminated with such elements. Also, according to appearance the symptoms of contamination for cress plant (at concentrations of 40 mg/kg) and reduced plant yield at this concentration, it is recommended to use the plant for purification of soil contaminated with arsenic at concentrations of 0 mg/kg to less than 40 mg/kg.

**References**

Khodaverdi Lu, Homaei HM. 2008. Green refinement modeling of soil contaminated with lead and cadmium, Science and Technology Agriculture and Natural Resources, Volume 11, Number 42.